PART 2

NRC-008A-A

Florida Power & Light Company
Turkey Point Plant, Units 6 & 7
COL Application

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CHAPTER 1 INTRODUCTION AND GENERAL DESCRIPTION OF THE PLANT

1.1 INTRODUCTION

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

Add the following paragraphs to the end of DCD Section 1.1.

STD SUP 1.1-1 This Final Safety Analysis Report (FSAR) incorporates the Design Control Document (DCD) (as identified in Table 1.6-201) for a simplified passive advanced light water reactor plant provided by Westinghouse Electric Company, the entity originally sponsoring and obtaining the AP1000 design certification documented in 10 CFR Part 52, Appendix D. Throughout this FSAR, the "referenced DCD" is the AP1000 DCD submitted by Westinghouse as Revision 19 including any supplemental material as identified in Table 1.6-201. Unless otherwise specified, reference to the DCD refers to Tier 2 information, including references to the sensitive unclassified non-safeguards information (including proprietary information) and safeguards information, contained in the AP1000 DCD. Such DCD information is included in this combined license application in the same manner as it is included in the AP1000 DCD, i.e., references in the DCD are included as references in the FSAR, and material incorporated by reference into the DCD is incorporated by reference into the FSAR. Appropriate agreements are in place to provide for the licensee's rights to possession (including constructive possession) and use of the withheld sensitive unclassified non-safeguards information (including proprietary information) and safeguards information referenced in the AP1000 DCD for the life of the project.

Appendix D to 10 CFR Part 52 is hereby incorporated by reference into the COL application.

PTN SUP 1.1-2 This FSAR is hereby submitted under Section 103 of the Atomic Energy Act by Florida Power & Light Company (FPL) to the NRC as part of the application for two Class 103 combined licenses to construct and operate two nuclear power plants under the provisions of 10 CFR Part 52 Subpart C.

1.1.1 PLANT LOCATION

Add the following text at the beginning of DCD Subsection 1.1.1:

PTN COL 2.1-1 Turkey Point Units 6 & 7 are part of the larger Turkey Point plant property located in unincorporated Miami-Dade County, Florida. The approximately 9400-acre Turkey Point plant property comprises two oil/gas-fired (Units 1 & 2), one gas-fired combined cycle (Unit 5), and four nuclear powered (Units 3, 4, 6, & 7) steam electric generating units. Figure 2.1-201 shows the Turkey Point property and the surrounding area within 50 miles. Figure 2.1-202 shows the general location of the Turkey Point property and localities surrounding the site within 10 miles. Figure 1.1-201 identifies the plant arrangement within the site.

The Turkey Point plant property is located approximately 25 miles south of Miami, 8 miles east of Florida City, and 9 miles southeast of Homestead, Florida. Miami-Dade County is bounded on the north by Broward County, on the west by Monroe and Collier Counties, on the east by Biscayne Bay and the Atlantic Ocean, and on the south by the Florida Bay and the Florida Keys (Monroe County). Miami-Dade County is located along the southeast tip of the Florida Peninsula and covers approximately 2000 square miles of land area with approximately one-third of the area consisting primarily of the Everglades National Park.

1.1.5 SCHEDULE

Add the following text to the end of DCD Subsection 1.1.5:

PTN COL 1.1-1 Table 1.1-203 displays the anticipated schedule for construction and operation of two AP1000 units at the Turkey Point site. A site-specific construction plan and startup schedule will be provided to the NRC after issuance of the COL.

1.1.6.1 Regulatory Guide 1.70

Add the following text to the end of DCD Subsection 1.1.6.1.

STD SUP 1.1-6

This FSAR generally follows the AP1000 DCD organization and numbering. Some organization and numbering differences are adopted where necessary to include additional material, such as additional content identified in Regulatory Guide 1.206. Any exceptions are identified with the appropriate left margin annotation as discussed in Subsection 1.1.6.3 and Table 1.1-202.

1.1.6.3 Text, Tables and Figures

Add the following text to the end of DCD Subsection 1.1.6.3.

STD SUP 1.1-3

Table 1.1-202 describes the left margin annotations used in this document to identify departures, supplementary information, COL items, and conceptual design information.

FSAR tables, figures, and references are numbered in the same manner as the DCD, but the first new FSAR item is numbered as 201, the second 202, the third 203, and consecutively thereafter. When a table, figure, or reference in the DCD is changed, the change is appropriately left margin annotated as identified above.

New appendices are included in the FSAR with double letter designations following the pertinent chapter (e.g., 12AA).

When it provides greater contextual clarity, an existing DCD table or figure is revised by adding new information to the table or figure and replacing the DCD table or figure with a new one in the FSAR. In this instance, the revised table or figure clearly identifies the information being added, and retains the same numbering as in the DCD, but the table or figure number is revised to end with the designation “R” to indicate that the table or figure has been revised and replaced. For example, revised “Table 4.2-1” would become “Table 4.2-1R.” New and revised tables and figures are labeled in the left margin as described in Table 1.1-202.

1.1.6.5 Proprietary Information

Insert the following text to the end of DCD Subsection 1.1.6.5.

STD SUP 1.1-4 Some portions of this FSAR may be considered as proprietary, personal, or sensitive and withheld from public disclosure pursuant to 10 CFR 2.390 and Regulatory Issue Summary (RIS) 2005-026. Such material is clearly marked and the withheld material is separately provided for NRC review.

1.1.6.6 Acronyms

Add the following text to the end of DCD Subsection 1.1.6.6.

PTN SUP 1.1-5 Table 1.1-201 provides a list of acronyms and abbreviations used in the Units 6 & 7 FSAR in addition to the acronyms identified in DCD Table 1.1-1, and system designation identified in Table 1.7-201 and DCD Table 1.7-2.

1.1.7 COMBINED LICENSE INFORMATION

Add the following text to the end of DCD Subsection 1.1.7.

PTN COL 1.1-1 This COL Item is addressed in Subsection 1.1.5.

PTN SUP 1.1-5

Table 1.1-201 (Sheet 1 of 8)
Acronyms and Abbreviations Used in the FSAR

Acronym/Abbreviation	Definition
ADAMS	Agency-wide Documents Access and Management System
AFB	Air Force Base
AGMTHAG	Atlantic and Gulf of Mexico Tsunami Hazards Assessments Group
ags	above ground surface
ALOHA	areal locations of hazardous atmospheres
AMC	Annual Maintenance Cost
AMO	Atlantic Multi-decadal Oscillation
ANSS	Advanced National Seismic System
AOC	Annual Operating Cost
AOV	air-operated valve
APT	aquifer pumping test
ARS	acceleration response spectra
B&PVC	Boiler and Pressure Vessel Code
BE	best estimate
bgs	below ground surface
BIL	basic insulation level
BLEVE	boiling liquid expanding vapor explosion
BODC	British Oceanographic Data Centre
BSSC	Building Seismic Safety Council
C&SF Project	Central and Southern Florida Flood Control Project
CAM	continuous air monitor
CBR	California bearing ratio
CCDP	conditional core damage probability
CDF	core damage frequency
CDI	conceptual design information
CEO	chief executive officer
CERP	Comprehensive Everglades Restoration Plan
CEUS	Central and Eastern United States
CNO	chief nuclear officer
COV	coefficient of variation
CPT	cone penetrometer testing
CRF	Capital Recovery Factor
CRREL	Cold Region Research and Engineering Laboratory

PTN SUP 1.1-5

Table 1.1-201 (Sheet 2 of 8)
Acronyms and Abbreviations Used in the FSAR

CSDRS	certified seismic design response spectra
CSR	cyclic stress ratio
CT-E	cooling tower east
CT-W	cooling tower west
CU	consolidated undrained
D/Q	deposition factors
DAC	derived air concentration
DBF	design basis flood
DCEM	Direct Cost of Equipment and Materials
DLC	Direct Labor Cost
DNAG	Decade of North America Project
DRS	design response spectra
DRS/ENV	surface-DRS-to-envelope-ARS ratio
DTPG	defined test plan groups
EAA	Everglades Agricultural Area
EAB	exclusion area boundary
ECCS	emergency core cooling system
ECL	effluent concentration limits
EDT	eastern daylight savings time
EERC	Earthquake Engineering Research Center
EF	enhanced Fujita
ENP	Everglades National Park
ENP-SDCS	Everglades National Park-South Dade Conveyance System
ENS	emergency notification system
EOP	emergency operating procedure
EP-ITAAC	emergency planning ITAAC
EPZ	emergency planning zone
EQ	environmental qualification
EQMEL	EQ master equipment list
ERO	emergency response organization
ESRI	Environmental Systems Research Institute
ETR	energy transfer ratio
FAC	flow accelerated corrosion
FAR	soil column away from the nuclear island
FAS	Floridan aquifer system

PTN SUP 1.1-5

Table 1.1-201 (Sheet 3 of 8)
Acronyms and Abbreviations Used in the FSAR

FCA	Federal Flood Control Act
FDEP	Florida Department of Environmental Protection
FEMA	Federal Emergency Management Agency
FFD	fitness for duty
FGS	Florida Geologic Survey
FHA	fire hazards analysis
FHWA	Federal Highway Administration
FIRS	foundation input response spectra
FMG	failure mode groups
FOS	factor of safety
FPL	Florida Power & Light Company
FRCC	Florida Reliability Coordinating Council
FRS	flow response spectra
FSAR	final safety analysis report
GBF	Gorringe Bank Fault
GCF	Gulf of Cadiz Fault
GEBCO	General Bathymetric Chart of the Oceans
GLORIA	geological long-range inclined asdic
GMRS	ground motion response spectra
GSU	main step-up transformer
HCLPF	high confidence, low probability of failure
HF	high frequency
HiRAT	high resolution acoustic televiewer probe
HMI	human-machine interfaces
HRHF	hard rock high frequency
HSF	Horseshoe Fault
HV	high voltage
ICF	Indirect Cost Factor
IDLH	immediately dangerous to life and health
IPEEE	individual plant examination of external events
ISC	International Seismological Centre
ISFSI	independent spent fuel storage installation
ISMCS	International Station Meteorological Climate Summary
ITA	inspections, tests, or analyses
ITAAC	inspections, tests, analyses, and acceptance criteria

PTN SUP 1.1-5

Table 1.1-201 (Sheet 4 of 8)
Acronyms and Abbreviations Used in the FSAR

ITP	initial test program
JOG	Joint Owners Group
JTWG	joint test working group
KGS	Kansas Geological Survey
LB	lower bound
LBR	limerock bearing ratio
LCCF	Labor Cost Correction Factor
LCD	local climatological data
LCO	limiting conditions for operation
LF	low frequency
LFL	lower flammability limit
LL	liquid limit
LLW	low level waste
LP	liquid penetrant
LTOP	low temperature overpressure protection
LU	land utilization
Ma	million years ago
MASW	multi-channel analysis of surface waves
MCAC	Mexico, Central America and Caribbean
MDWASD	Miami-Dade Water and Sewer Department
MIDAS	Middle America Seismograph Consortium
Mmax	maximum magnitude
MMI	modified mercalli intensity
MPF	Marqués de Pombal Fault
MPSSZ	Middleton Place-Summerville Seismic Zone
MSDS	material safety data sheet
MSE	mechanically stabilized earth
MSL	mean sea level
MSPI	mitigating systems performance indicators
MT	magnetic particle testing
MVA	megavolt ampere
MWR	makeup water reservoir
NAAQS	National Ambient Air Quality Standards
NAD	North American Datum
NAVD	North American Vertical Datum

PTN SUP 1.1-5

Table 1.1-201 (Sheet 5 of 8)
Acronyms and Abbreviations Used in the FSAR

NCDC	National Climatic Data Center
NDE	nondestructive examination
NEIC	National Earthquake Information Center
NERC	North American Electric Reliability Corporation
NESC	National Electric Safety Code
NESDIS	National Environmental Satellite Data and Information Service
NGDC	National Geophysical Data Center
NGVD	National Geodetic Vertical Datum
NI	soil column near the nuclear island
NIOSH	National Institute of Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NQAM	nuclear quality assurance manual
NRCS	National Resources Conservation Service
NS	non-seismic
NSSL	National Severe Storms Laboratory
NWS	National Weather Service
ODCM	offsite dose calculation manual
OSC	operations support center
OSHA	Occupational Safety and Health Administration
OW	observation well
PC	personal computer
PCP	Process Control Program
PDE	preliminary determination of epicenter
PEL	permissible exposure limit
PGA	peak ground acceleration
PI	plasticity index
PL	plastic limit
PL-E	parking lot east
PMF	probable maximum flood
PMH	probable maximum hurricane
PMP	probable maximum precipitation
PMSS	probable maximum storm surge
PMT	probable maximum tsunami
PMWS	probable maximum wind storm
POI	point of interest

PTN SUP 1.1-5

Table 1.1-201 (Sheet 6 of 8)
Acronyms and Abbreviations Used in the FSAR

PORV	power operated relief value
PPM	parts per million
PRSN	Puerto Rico Seismic Network
PS-ITAAC	physical security ITAAC
PSHA	probabilistic seismic hazard analysis
PST	preservice test
PT	liquid penetrant
PT&O	plant test and operations
PTN	Turkey Point Nuclear Plant
PVC	Polyvinyl Chloride
QAPD	quality assurance program description
QAPP	quality assurance program plan
QMS	quality management system
RAT	reserve auxiliary transformer
RCA	radiological controlled area
RCPB	reactor coolant pressure boundary
RCTS	resonant column torsional shear
RESRAD	residual radioactive
RIS	Regulatory Issue Summary
RO	reactor operator
RPV	reactor pressure vessel
RQD	rock quality designation
RRS	required response spectrum
RT	radiographic testing
RTDP	revised thermal design procedure
RTMC	real time monitor and control
RVT	random vibration theory
SA	spectral acceleration
SAMDA	severe accident mitigation design alternatives
SAMG	severe accident management guidance
SARA	Superfund Amendments and Reauthorization Act
SCBA	self-contained breathing apparatus
SDP	significance determination process
SDWWTP	South District Wastewater Treatment Plant
SERCC	Southeast Regional Climate Center

PTN SUP 1.1-5

Table 1.1-201 (Sheet 7 of 8)
Acronyms and Abbreviations Used in the FSAR

SFWMD	South Florida Water Management District
SGMP	steam generator management program
SLOSH	Sea, Lake, and Overland Surges from Hurricanes
SNM	Special Nuclear Material
SOG	seismicity owners group
SOV	solenoid-operated valve
SP	poorly graded sand
SP	spontaneous potential
SPR	single point resistance
SPT	standard penetration test
SRO	senior reactor operator
SS-ITAAC	site-specific ITAAC
SSC(s)	structure(s), system(s), and component(s)
SSHAC	Senior Seismic Hazard Analysis Committee
STA	Shift Technical Advisor
STL	Severn Trent Laboratories
SVF	St. Vincente Fault
SWV	shear wave velocity
SY-W	switchyard west
TAC	Total Annual Cost
TDS	total dissolved solids
TIBL	thermal internal boundary layer
TLD	thermo-luminescent dosimeter
TLV	threshold limit value
TNT	trinitrotoluene
TP	test pit
TRS	test response spectrum
TS	Technical Specification(s)
TWA	time-weighted average
UB	upper bound
UCSS	Updated Charleston Seismic Source
UFL	upper flammability limit
UFSAR	Updated Final Safety Analysis Report
UHRS	uniform hazard response spectra
UHS	ultimate heat sink

PTN SUP 1.1-5

Table 1.1-201 (Sheet 8 of 8)
Acronyms and Abbreviations Used in the FSAR

USACE	U.S. Army Corps of Engineers
USCB	United States Census Bureau
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
USDW	underground source of drinking water
USGS	United States Geological Survey
UT	ultrasonic testing
UTNM	universal transverse mercator
VCIS	ventilation climate information system
VPS	Pump House Building Ventilation System
WAC	waste acceptance criteria
WCA	water conservation area
WEC	Westinghouse Electric Company
WGCEP	Working Group on California Earthquake Predictions
WUS	Western United States
X/Q	atmospheric dispersion value
YBP	years before present

STD SUP 1.1-3

Table 1.1-202
Left Margin Annotations

Margin Notation	Definition and Use
STD DEP X.Y.Z-#	FSAR information that departs from the generic DCD and is common for parallel applicants. Each Standard Departure is numbered separately at an appropriate level, e.g., STD DEP 9.2-1, or STD DEP 9.2.1-1
NPP DEP X.Y.Z-#	FSAR information that departs from the generic DCD and is plant specific. NPP is replaced with a plant specific identifier. Each Departure item is numbered separately at an appropriate subsection level, e.g., NPP DEP 9.2-2, or NPP DEP 9.2.1-2
STD COL X.Y-#	FSAR information that addresses a DCD Combined License Information item and is common to other COL applicants. Each COL item is numbered as identified in DCD Table 1.8-2 and FSAR Table 1.8-202, e.g., STD COL 4.4-1, or STD COL 19.59.10.5-1
NPP COL X.Y-#	FSAR information that addresses a DCD Combined License Information item and is plant specific. NPP is replaced with a plant specific identifier. Each COL item is numbered as identified in DCD Table 1.8-2 and FSAR Table 1.8-202, e.g., NPP COL 4.4-1, or NPP COL 19.59.10.5-1
NPP CDI or STD CDI	FSAR information that addresses DCD Conceptual Design Information (CDI). Replacement design information is generally plant specific; however, some may be common to other applicants. NPP is replaced with a plant specific identifier. STD is used if it is common. CDI information replacements are not numbered.
STD SUP X.Y-#	FSAR information that supplements the material in the DCD and is common to other COL applicants. Each SUP item is numbered separately at an appropriate subsection level, e.g., STD SUP 1.10-1, or STD SUP 9.5.1-1
NPP SUP X.Y-#	FSAR information that supplements the material in the DCD and is plant specific. NPP is replaced with a plant specific identifier. Each SUP item is numbered separately at an appropriate subsection level, e.g., NPP SUP 3.10-1, or NPP SUP 9.2.5-1
DCD	FSAR information that duplicates material in the DCD. Such information from the DCD is repeated in the FSAR only in instances determined necessary to provide contextual clarity.

PTN COL 1.1-1

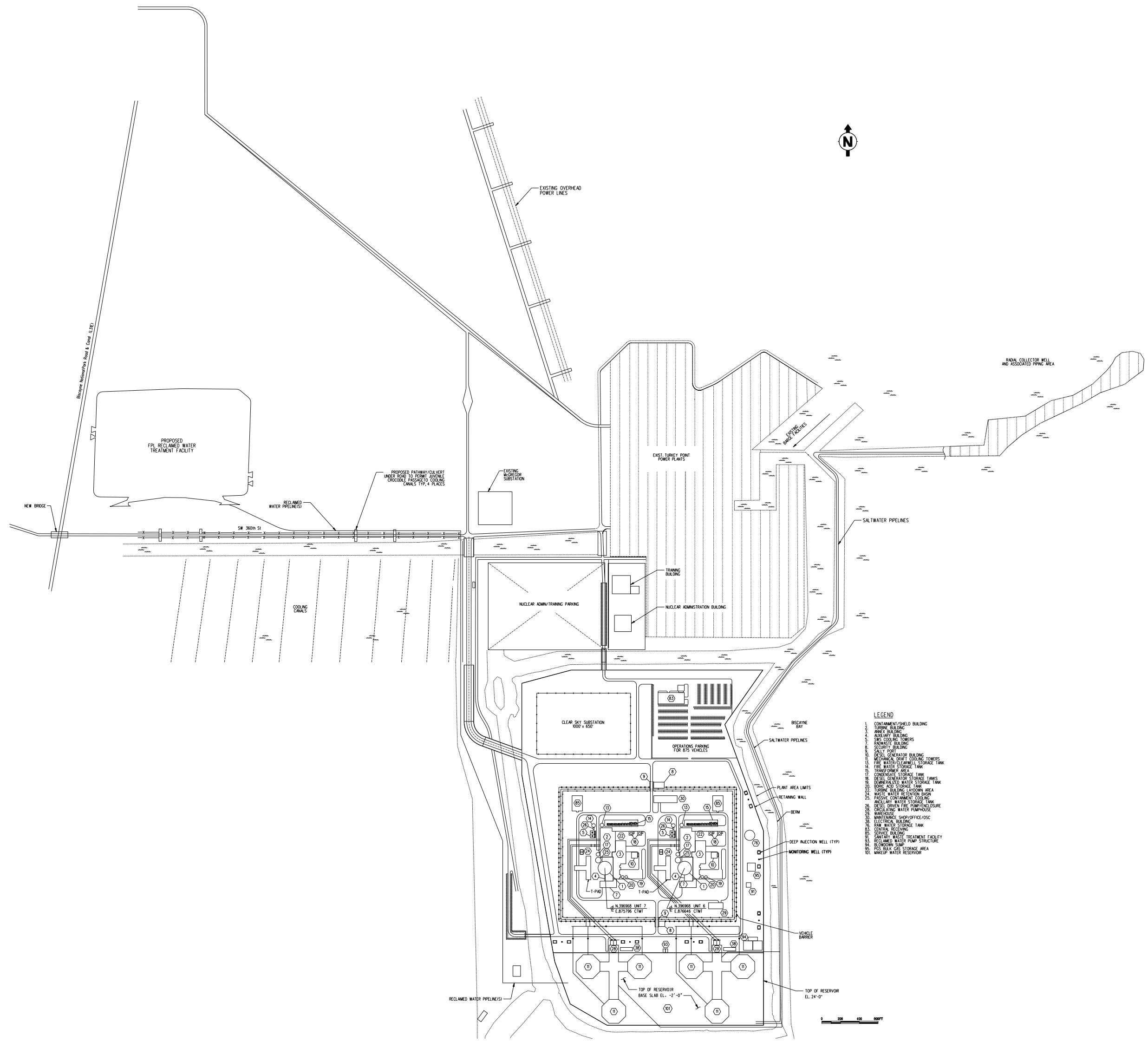
Table 1.1-203
Schedule for Construction and Operation of Units 6 & 7

Activity	Start	Finish
Unit 6		
Site Preparation	1Q 2017[(a)]	4Q 2022
Commence Construction Activities	4Q 2022	2Q 2027
Fuel Load, Commence Startup	4Q 2026	2Q 2027
Commence Operation	2Q 2027	—
Unit 7		
Site Preparation	1Q 2017[(a)]	4Q 2022
Commence Construction Activities	1Q 2024	2Q 2028
Fuel Load, Commence Startup	4Q 2027	2Q 2028
Commence Operation	2Q 2028	—

Note: Quarters are for the calendar year.
(a) Some road and bridge work initiated prior to receipt of COL.

PTN COL 2.1-1
PTN COL 3.3-1
PTN COL 3.5-1

Figure 1.1-201 Units 6 & 7 Layout



1.2 GENERAL PLANT DESCRIPTION

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

1.2.2 SITE DESCRIPTION

In Subsection 1.2.2 of the DCD, replace the information titled "Site Plan" with the following text.

Site Plan

PTN COL 2.1-1
PTN COL 3.3-1
PTN COL 3.5-1

A typical site plan for a single-unit AP1000 reference unit is shown in DCD Figure 1.2-2. The directions north, south, east, and west used in this description are the conventions used in the DCD for the orientation of AP1000 structures and equipment and differ from geographic north, south, east and west.

The Units 6 & 7 layout is shown on Figure 1.1-201. Principal structures and facilities, parking areas, and roads are illustrated. Orientation of the two units is such that "plant north" faces true north. Unless otherwise noted, directions in this FSAR are based on true north. The plant building floor elevation for design is North American Vertical Datum 1988 (NAVD 88) elevation 26'-0" and corresponds to DCD Elevation 100'-0". Therefore, the DCD elevation values are to be decreased by 74 feet to reflect actual site elevations. The actual plant grade floor elevation will vary to accommodate floor slope and layout requirements.

As stated in DCD Subsection 1.2.1.6.1, the power block complex consists of five principal building structures: the nuclear island, the turbine building, the annex building, the diesel generator building, and the radwaste building. Each of these building structures is constructed on an individual basemat. The nuclear island consists of the containment building, the shield building, and the auxiliary building, all of which are constructed on a common basemat.

DCD Figure 1.2-3 provides a functional representation of the principal systems and components that are located in each of the key AP1000 buildings. This figure identifies major systems and components that are contained in these structures.

Each of the two main cooling tower circulating water pump complexes consists of mechanical draft cooling towers, a pump basin, circulating water pumps, and associated piping. The cooling towers are located south of the reactors and the

circulating pumps are located near the cooling towers. The pumps circulate the cooling water from the pump basin to the main condensers and back to the cooling towers.

The FPL reclaimed water treatment facility, located northwest of Units 6 & 7, treats reclaimed water from the Miami-Dade Water and Sewer Department (MDWASD) and provides water to the makeup water reservoir south of Units 6 & 7. Pumps transfer makeup water to the circulating water system from the makeup water reservoir. Additionally, radial collector wells, located northeast of Units 6 & 7, provide saltwater as an alternative makeup water supply to the circulating water systems. Potable water from the MDWASD supplies the makeup requirements of the other plant systems.

Road access to the site is from the north and west.

There is no railway access to the site.

During construction, a heavy lift crane was used to place major pieces of equipment such as the turbine generator, reactor vessel, steam generators, containment ring sections, large structural modules, and other large or heavy equipment modules.

1.2.3 PLANT ARRANGEMENT DESCRIPTION

Add the following paragraph at the end of DCD Subsection 1.2.3:

PTN DEP 18.8-1 DCD Figure 1.2-18 is modified to reflect the relocation of the Operations Support Center by changing the description of room number 40318 from “ALARA BRIEFING RM AND OPERATIONAL SUPPORT CENTER” to “ALARA BRIEFING RM.”

1.3 COMPARISONS WITH SIMILAR FACILITY DESIGNS

This section of the referenced DCD is incorporated by reference with no departures or supplements.

1.4 IDENTIFYING AGENTS AND CONTRACTORS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

1.4.1 APPLICANT — PROGRAM MANAGER

Add the following paragraphs as the first two paragraphs in DCD Subsection 1.4.1:

PTN SUP 1.4-1 FPL is the applicant for Combined Licenses for Units 6 & 7 and will own and operate both units. FPL is an investor-owned regulated utility, primarily engaged in the generation, transmission, and distribution of electricity. The service territory covers the southern third and almost the entire eastern seaboard of the state of Florida. FPL supplies electric service to approximately 4.5 million customer accounts.

FPL owns and operates the following four nuclear power plants:

- St. Lucie Unit 1, near Ft. Pierce, Florida
- St. Lucie Unit 2, near Ft. Pierce, Florida (85 percent ownership, FPL is authorized to act as agent for the Orlando Utilities Commission of the city of Orlando, Florida and Florida Municipal Power Agency)
- Turkey Point Units 3 & 4, near Florida City, Florida

FPL began building nuclear power plants in the 1960s and has operated nuclear power plants since 1972.

Add the following paragraphs to the end of DCD Subsection 1.4.1:

PTN SUP 1.4-2 Contractors participating in preparing the COL application are addressed in Subsection 1.4.2.8.

Not all participants have been identified at this time. In particular, the AP1000 NSSS provider, architect-engineer, and constructor have not yet contracted. This section of the FSAR will be revised to include information identifying the NSSS provider, the architect-engineer, and the constructor following the establishment of

contracts for these purposes. This information will include descriptions of the technical qualifications of the NSSS provider, the architect-engineer, and the constructor, and address the division of responsibility among them and the operator.

Add the following new subsection after DCD Subsection 1.4.2.7:

PTN SUP 1.4-3

1.4.2.8 Other Contractors

Contractual relationships have been established with specialized consulting firms to assist in preparing the COL application for Units 6 & 7.

1.4.2.8.1 Bechtel Power Corporation

Bechtel Power Corporation prepared and published the COL application.

1.4.2.8.2 Contingency Management Consulting Group, LLC

Contingency Management Consulting Group, LLC, as a subcontractor to Bechtel Power Corporation, provided support for preparing the Emergency Plan and the Security Plan.

1.4.2.8.3 Environmental Consulting & Technology, Inc.

Environmental Consulting & Technology, Inc., as a subcontractor to Bechtel Power Corporation, performed investigations for the electrical transmission lines and corridors.

1.4.2.8.4 Golder Associates, Inc.

Golder Associates, Inc., as a subcontractor to Bechtel Power Corporation, performed environmental assessments for use in the Environmental Report.

1.4.2.8.5 KLD Associates, Inc.

The Evacuation Time Estimate Study, Revision 0 through Revision 3, in support of the COL application, was performed by KLD Engineering, P.C. under an assignment agreement with KLD Associates, Inc., a subcontractor to Bechtel Power Corporation.

1.4.2.8.6 MACTEC Engineering and Consulting, Inc.

MACTEC Engineering and Consulting, Inc., as a subcontractor to Bechtel Power Corporation, performed geotechnical field investigations and laboratory testing in support of the COL application.

1.4.2.8.7 McNabb Hydrogeologic Consulting, Inc.

McNabb Hydrogeologic Consulting, Inc., as a subcontractor to Bechtel Power Corporation, performed studies related to deep injection wells.

1.4.2.8.8 NuStart Energy, Inc.

NuStart Energy, Inc. prepared the Reference COL application (Bellefonte Units 3 and 4) used as a template for preparing the non-site-specific portions of the COL application.

1.4.2.8.9 Risk Engineering, Inc.

Risk Engineering, Inc., as a subcontractor to Bechtel Power Corporation, performed the probabilistic seismic hazard analyses for developing the site-specific ground motion response spectra.

1.4.2.8.10 Tetra Tech NUS, Inc.

Tetra Tech NUS, Inc., as a subcontractor to Bechtel Power Corporation, provided services for site investigations and preparing the Environmental Report and portions of the FSAR.

1.4.2.8.11 William Lettis & Associates, Inc.

William Lettis & Associates, Inc., as a subcontractor to Bechtel Power Corporation, provided technical services to include field and office studies for the identification and characterization of seismic source zones.

1.4.2.8.12 Westinghouse Electric Company LLC

Westinghouse Electric Company LLC provided information on the design and safety analysis of the AP1000 for use in preparing the site-specific portions of the COL application and to address technical issues identified with the certified design.

1.4.2.8.13 AMEC Foster Wheeler

AMEC Foster Wheeler, as a subcontractor to FPL, provided a third-party independent review of revised FSAR Section 2.5 RAI responses. AMEC Foster Wheeler also performed an analysis to evaluate the potential impacts of the newly released Central and Eastern United States Seismic Source Characterization for Nuclear Facilities (CEUS SSC) model on the seismic hazard curves and the site-specific ground motion response spectra (GMRS) foundation input response spectra (FIRS).

1.4.2.8.14 Paul C. Rizzo Associates, Inc.

Paul C. Rizzo Associates, Inc., as a subcontractor to FPL, performed a supplemental boring program to provide additional in situ and laboratory data to support RAI responses. The results of the additional field investigation augment the existing results and were used to improve the existing analyses or to develop new analyses.

1.4.2.8.15 Fugro Consultants, Inc.

Fugro Consultants, Inc., as a subcontractor to Bechtel Power Corporation, provided technical services to include field and office studies for identifying and characterizing seismic source zones.

1.4.2.8.16 KLD Engineering, P.C.

The Evacuation Time Estimate Study, Revision 4, in support of the COL application, was performed by KLD Engineering, P.C.

1.5 REQUIREMENTS FOR FURTHER TECHNICAL INFORMATION

This section of the referenced DCD is incorporated by reference with no departures or supplements.

1.6 MATERIAL REFERENCED

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

Add the following text to the end of DCD Section 1.6.

STD SUP 1.6-1 Table 1.6-201 provides a list of the various technical documents incorporated by reference in the FSAR in addition to those technical documents incorporated by reference in the AP1000 DCD.

PTN DEP 6.4-1

TABLE 1.6-1R
MATERIAL REFERENCED

DCD Section Number	Westinghouse Topical Report Number	Title
15.4	WCAP-7979-P-A (P) WCAP-8028-A	TWINKLE – A Multi-Dimensional Neutron Kinetics Computer Code, January 1975
	WCAP-7908-A	FACTRAN – A FORTRAN-IV Code for Thermal Transients in a UO2 Fuel Rod, December 1989
	WCAP-7907-P-A (P) WCAP-7907-A	LOFTRAN Code Description, April 1984
	WCAP-15806-P-A (P) WCAP-15807-NP-A	Westinghouse Control Rod Ejection Accident Analysis Methodology Using Multi-Dimensional Kinetics
	WCAP-10965-P-A (P) WCAP-10966-A	ANC: A Westinghouse Advanced Nodal Computer Code, September 1986
	WCAP-11397-P-A (P) WCAP-11397-A	Revised Thermal Design Procedure, April 1989
	WCAP-15644-P (P) WCAP-15644-NP	AP1000 Code Applicability Report, Revision 2, March 2004
	WCAP-11596-P-A (P) WCAP-11597-A	Qualification of the PHOENIX-P/ANC Nuclear Design System for Pressurized Water Reactor Cores, June 1988
	WCAP-16045-P-A (P) WCAP-16045-NP-A	Qualification of the Two-Dimensional Transport Code PARAGON, August 2004
	WCAP-10965-P-A, Addendum 1 (P) WCAP-10966-A Addendum 1	ANC – A Westinghouse Advanced Nodal Computer Code; Enhancements to ANC Rod Power Recovery, April 1989
	WCAP-14565-P-A (P) WCAP-15306-NP-A	VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis, October 1999
	WCAP-15063-P-A, Revision 1 with Errata (P) WCAP-15064-NP-A	Westinghouse Improved Performance Analysis and Design Model (PAD 4.0), July 2000
	WCAP-16045-P-A Addendum 1-A (P) WCAP-16045-NP-A Addendum 1-A	Qualification of the NEXUS Nuclear Data Methodology, August 2007
	WCAP-10965-P-A Addendum 2-A (P)	Qualification of the New Pin Power Recovery Methodology, September 2010
	WCAP-15025-P-A (P) WCAP-15026-NP-A	Modified WRB-2 Correlation, WRB-2M, for Predicting Critical Heat Flux in 17x17 Rod Bundles with Modified LPD Mixing Vane Grids, April 1999

(P) Denotes Document is Proprietary

Table 1.6-201
Additional Material Referenced

	Author/Report Number[(a)]	Title	Revision	FSAR Section	Document Transmittal	ADAMS Accession Number
STD SUP 1.6-1	Westinghouse/ APP-GW-GL-700	AP1000 Design Control Document	19	All	June 2011	ML11171A500
	NEI 07-08A	Generic FSAR Template Guidance for Ensuring That Occupational Radiation Exposures Are As Low As Is Reasonably Achievable (ALARA)	0	12.1	October 2009	ML093220164
	NEI 07-03A	Generic FSAR Template Guidance for Radiation Protection Program Description	0	Appendix 12AA	May 2009	ML091490684
	NEI 06-13A	Template for an Industry Training Program Description	2	13.2	March 2009	ML090910554
	NEI 07-02A	Generic FSAR Template Guidance for Maintenance Rule Program Description for Plants Licensed Under 10 CFR Part 52	0 (Corrected)	17.6	November 2010	ML103410542
	10 CFR Part 52 Appendix D	Design Certification Rule for the AP1000 Design	—	1.1	—	—
PTN SUP 1.6-2	QAPD	Florida Power and Light Company New Nuclear Projects Quality Assurance Program Description FPL-2	3	17.5	September 2012	—
	Emergency Plan	Florida Power & Light Company Turkey Point Plant Radiological Emergency Plan	7	13.3	October 2015	—
	Security Plan	Florida Power & Light Company Turkey Point Units 6 & 7 Physical Security Plan	3	13.6	December 2011	Not applicable (Safeguards)
	Cyber Security Plan	Florida Power & Light Company Turkey Point Units 6 & 7 Cyber Security Plan	1	13.6	August 2011	Not applicable (SUNSI)

(a) The NRC-accepted NEI documents identified by the A in the document number include the accepted template, the NRC safety evaluation, and corresponding responses to the NRC Requests for Additional Information. Only the accepted template is incorporated by reference. The remainder of the document is referenced but not incorporated into the FSAR. (A) Denotes NRC approved document.

1.7 DRAWINGS AND OTHER DETAILED INFORMATION

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

1.7.2 PIPING AND INSTRUMENTATION DIAGRAMS

Add the following text to the end of DCD Subsection 1.7.2.

PTN SUP 1.7-1 Table 1.7-201 contains a list of piping and instrumentation diagrams (P&IDs) or system diagrams and the corresponding FSAR figure numbers that supplement the DCD.

PTN SUP 1.7-1

Table 1.7-201
AP1000 System Designators and System Diagrams

Designator	System	FSAR Section	FSAR Figure
CWS	Circulating Water System	10.4.5	10.4-201
DIS	Deep Well Injection System	9.2.12	9.2-203
RWS	Raw Water System	9.2.11	9.2-201
ZBS	Offsite Power System One-Line Diagram	8.2.1	8.2-201
	Switchyard General Arrangement	8.2.1	8.2-202

1.8 INTERFACES FOR STANDARD DESIGN

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

Add the following paragraphs to the end of DCD Section 1.8.

PTN SUP 1.8-1 Departures from the referenced DCD are summarized in Table 1.8-201. Table 1.8-201 lists each departure and the FSAR section or subsection impacted.

PTN SUP 1.8-2 DCD Table 1.8-2 presents Combined License Information for the AP1000. Items requiring COL Applicant or COL Holder action are presented in Table 1.8-202. FSAR section(s) addressing these COL items are tabulated in this table. COL Holder items listed in Table 1.8-202 are regulatory commitments of the COL Holder and these actions are completed as specified in the appropriate section of the referenced DCD. Completion of these COL Holder items is the subject of a Combined License Condition as presented in a separate document submitted as part of this COL application.

PTN SUP 1.8-3 DCD Table 1.8-1 presents interface items for the AP1000. FSAR section(s) addressing these interface items are tabulated in Table 1.8-203.

PTN SUP 1.8-1

Table 1.8-201 (Sheet 1 of 6)
Summary of FSAR Departures from the DCD

Departure Number	Departure Description Summary	FSAR Section or Subsection
STD DEP 1.1-1	An administrative departure is established to identify instances where the renumbering of FSAR sections is necessary to effectively include content consistent with RG 1.206, as well as NUREG-0800.[a]	2.1.1 2.1.4 2.2.1 2.2.4 2.4.1 2.4.15 2.5 2.5.6 9.2.11 9.2.12 9.2.13 9.2.14 9.5.1.8 9.5.1.9 13.1 13.1.4 13.5 13.5.3 13.7 17.5 17.6 17.7 17.8
PTN DEP 1.8-1	Departure to correct error in DCD Table 1.8-1, Item 13.1, that incorrectly references Appendix O of 10 CFR 50.	Table 1.8-203
PTN DEP 2.0-1	The DCD site parameter value for operating basis wind speed in DCD Tier 2, Table 2-1 is 145 miles per hour. In DCD Appendix 3H, the operating design basis wind speed is a Tier 2* value. The corresponding site characteristic is the 50-year return period, 3-second gust wind speed of 150 miles per hour as reported in FSAR Subsection 2.3.1.3.1. This site characteristic exceeds the DCD site parameter by 5 miles per hour.	2.0 2.3.1.3.1 3.3.1.1 3.3.3 3H3.3
PTN DEP 2.0-2	The DCD site parameter value for the maximum normal air temperature wet bulb (noncoincident) in DCD Tier 2, Table 2-1 is 80.1°F. The corresponding site characteristic value is 81.5°F as reported in FSAR Subsection 2.3.1.5. This site characteristic exceeds the DCD site parameter by 1.4°F.	2.0 2.3.1.5 9.2.1.2 9.2.7.2
PTN DEP 2.0-3	The site parameter value provided in the DCD Tier 1, Table 5.0-1 for the air temperature maximum wet bulb (noncoincident) is 86.1°F. This site parameter value is listed as the maximum safety wet bulb (noncoincident) air temperature in DCD Tier 2, Table 2-1. The corresponding site characteristic value is 87.4°F as reported in FSAR Subsection 2.3.1.5. This site characteristic exceeds the DCD site parameter by 1.3°F.	2.0 2.3.1.5 5.4.7.1 6.2.1.1.3 6.2.2.3 6.4 6.4.1.1 9.1.3.1.3.1 9.2.2.1 9.2.7.2.4

PTN SUP 1.8-1

Table 1.8-201 (Sheet 2 of 6)
Summary of FSAR Departures from the DCD

Departure Number	Departure Description Summary	FSAR Section or Subsection
PTN DEP 2.0-4	DCD Table 2-1 lists a site parameter for the population distribution exclusion area (site) of 0.5 miles. The distance from the Units 6 & 7 source boundary to the exclusion area boundary (EAB) and the atmospheric dispersion value (X/Q) at the EAB are listed in Tables 2.3.4-201, 2.3.4-202, and 2.3.4-203. All sector distances, except for S, SSW, and SSE sectors, are less than the 0.5 mile site parameter, with the minimum being 0.27 miles in the northeast sector.	2.0 2.1.2 2.3.4.2
PTN DEP 2.5-1	DELETED	N/A
PTN DEP 3.2-1	The condensate return portion of the Passive Core Cooling System has been upgraded to add downspouts and plug fabrication holes in the Polar Crane Girder in order to maximize the return of condensate to the In-Containment Refueling Water Storage Tank and ensure long-term operation of the Passive Residual Heat Removal Heat Exchanger to meet design requirements. The following are the departures from the DCD: Tier 1 Table 2.2.3-1 and Table 2.2.3-2, Tier 2 Subsections 1.9.4.2.2, 1.9.5.1.5, Table 3.2-3 (Sheet 16 of 75), Figure 3.8.2-1 (Sheet 3), Subsections 5.4.5.2.1, 5.4.11.2 and 5.4.14.1, Chapter 6, Subsections 6.3.1.1.1, 6.3.1.1.4, 6.3.1.1.6, 6.3.1.2, 6.3.1.3, 6.3.2.1, 6.3.2.1.1, 6.3.2.2.5, 6.3.2.2.7, 6.3.2.8, 6.3.3, and 6.3.3.2.1.1, Figure 6.3-1 (Sheets 1 through 3), Figure 6.3-2 (Not Used), Section 7.4, Subsection 7.4.1.1, Table 14.3-2 (Sheets 7 and 8 of 17), Subsections 15.0.13 and 15.2, Chapter 16 (TS Surveillance Requirement 3.5.4.7, TS Bases B 3.3.3 and B 3.5.4), Subsections 19E.2.3.2.6 and 19E.4.10.2, Table 19E.4.10-1, and Figures 19E.4.10-1 through 19E.4.10-4.	1.9.4.2.2 1.9.5.1.5 Table 3.2-3R Figure 3.8.2-1R 5.4.5.2.1 5.4.11.2 5.4.14.1 6.3.1.1.1 6.3.1.1.4 6.3.1.1.6 6.3.1.2 6.3.1.3 6.3.2.1 6.3.2.1.1 6.3.2.2.5 6.3.2.2.7 6.3.2.8 6.3.3 6.3.3.2.1.1 Figure 6.3-1R 7.4 7.4.1.1 Table 14.3-2R 15.0.13 15.2 16 (TS Surveillance Requirement 3.5.4.7 TS Bases B 3.3.3 and B 3.5.4) 19E.2.3.2.6 19E.4.10.2 Table 19E.4.10-1R Figures 19E.4.10-1R through 19E.4.10-4R
PTN DEP 3.11-1	DCD Table 3.11-1 (Sheet 14 of 51) "Envir. Zone" numbers for Spent Fuel Pool Level Instruments SFS-JE-LT019A, SFS-JE-LT019B, and SFS-JE-LT019C are revised to be consistent with the location of the instruments.	3.11

PTN SUP 1.8-1

Table 1.8-201 (Sheet 3 of 6) Summary of FSAR Departures from the DCD

Departure Number	Departure Description Summary	FSAR Section or Subsection
PTN DEP 6.2-1	The ITAAC Acceptance Criteria for the in-containment PXS compartment vents are revised to reflect the current plant configuration. An analysis demonstrates a postulated hydrogen flame would not result in a failure of the containment shell. The following are the departures from the DCD: Tier 1 Table 2.3.9-3, and Tier 2 Subsections 6.2.4.5.1 and 19.41.7.	6.2.4.5.1 19.41.7
PTN DEP 6.3-1	The DCD states that the PRHR HX can maintain safe shutdown conditions for non-LOCA accidents "indefinitely." A quantitative duration of greater than 14 days has been adopted based on that time being long enough to minimize the need to switch to passive feed and bleed cooling except for very unlikely or extreme hazard events. The following are the departures from the DCD: Subsection 5.4.14.1, Subsections 6.3.1.1.1, 6.3.1.2, 6.3.1.3, 6.3.2.1.1, and 6.3.3.4.1, Subsection 7.4.1.1, Table 9.5.1-1 (Sheet 11), Subsection 15.2.6.1, Table 19.59-18 (Sheet 6), and Subsection 19E.4.10.2.	5.4.14.1 6.3.1.1.1 6.3.1.2 6.3.1.3 6.3.2.1.1 6.3.3.4.1 7.4.1.1 Table 9.5.1-1R 15.2.6.1 Table 19.59-18R 19E.4.10.2
PTN DEP 6.4-1	The main control room habitability system design and operator dose evaluation has been revised. Shielding was added to control room VES filter, VBS signals were added, VES actuation setpoints were adjusted to meet design requirements and allowable secondary iodine activity level was lowered. The following are the departures from the DCD: Tier 1 Subsection 2.2.5, Tier 1 Table 2.2.5-1, Tier 1 Table 2.2.5-5, Tier 1 Subsection 2.7.1, Tier 2 Table 1.6-1, Subsection 1.9.4.2.3, Appendix 1A, Subsection 3.1.2, Subsection 6.4, Subsection 6.4.2.6, Subsection 6.4.3.2, Subsection 6.4.4, Table 6.4-2, Subsection 7.3.1.2.17, Subsection 9.2.6.1.1, Subsection 9.4.1.1.1, Subsection 9.4.1.1.2, Subsection 9.4.1.2.1.1, Subsection 9.4.1.2.3.1, Figure 9.4.1-1 (Sheet 5 of 7), Table 11.1-4, Table 11.1-5, Table 11.1-6, Subsection 11.5.1.1, Subsection 11.5.2.3.1, Subsection 12.2.1.3.1, Subsection 12.2.1.3.2, Table 12.2-28, Table 12.2-29, Subsection 12.3.2.2.7, Figure 12.3-1 (Sheet 6 of 16), Table 14.3-7 (Sheet 2 of 3), Subsection 15.0.11.1, Subsection 15.0.11.6 (new), Table 15.0-2 (Sheet 4 of 5), Subsection 15.1.5.4.1, Subsection 15.1.5.4.6, Table 15.1.5-1, Subsection 15.3.3.3.1, Table 15.3-3 (Sheet 1 of 2), Subsection 15.4.8.1.1.3, Subsection 15.4.8.1.2, Subsection 15.4.8.2, Subsection 15.4.8.2.1,	Table 1.6-1R 1.9.4.2.3 Appendix 1AA 3.1.2 6.4 6.4.2.6 6.4.3.2 6.4.4 Table 6.4-2R 7.3.1.2.17 9.2.6.1.1 9.4.1.1.1 9.4.1.1.2 9.4.1.2.1.1 9.4.1.2.3.1 Figure 9.4.1-1R Table 11.1-4R Table 11.1-5R Table 11.1-6R 11.5.1.1 11.5.2.3.1 12.2.1.3.1 12.2.1.3.2 Table 12.2-201

PTN SUP 1.8-1

Table 1.8-201 (Sheet 4 of 6)
Summary of FSAR Departures from the DCD

Departure Number	Departure Description Summary	FSAR Section or Subsection
PTN DEP 6.4-1	Subsection 15.4.8.2.1.1, Subsection 15.4.8.2.1.2, Subsection 15.4.8.2.1.3, Subsection 15.4.8.2.1.4, Subsection 15.4.8.2.1.5, Subsection 15.4.8.2.1.7, Subsection 15.4.8.2.1.8, Subsection 15.4.8.2.1.9, Subsection 15.4.8.3, Subsection 15.4.8.3.1, Subsection 15.4.8.3.5, Subsection 15.4.8.3.6, Subsection 15.4.10, Table 15.4-1 (Sheets 2 and 3 of 3), Table 15.4-3 (Not Used), Table 15.4-4 (Sheets 1 and 2 of 2), Figure 15.4.8-1, Figure 15.4.8-2, Figure 15.4.8-3, Figure 15.4.8-4 (Not Used), Subsection 15.6.2.6, Subsection 15.6.3.3.1, Subsection 15.6.3.3.6, Subsection 15.6.5.3.2, Subsection 15.6.5.3.5, Subsection 15.6.5.3.8.1, Subsection 15.6.5.3.8.2, Subsection 15.6.6, Table 15.6.2-1, Table 15.6.3-3, Table 15.6.5-2 (Sheets 1-3 of 3), Table 15.6.5-3, Subsection 15.7.4.5, Table 15.7-1, Subsection 15A.3.1.2, Subsection 15B.1, Chapter 16 LCO 3.7.4, SR 3.7.4.1, Bases 3.4.10, Bases 3.7.4, Bases 3.7.6.	Table 12.2-202 12.3.2.2.7 Figure 12.3-1R Table 14.3-7R 15.0.11.1 15.0.11.6 Table 15.0-2R 15.1.5.4.1 15.1.5.4.6 Table 15.1.5-1R 15.3.3.3.1 Table 15.3-3R 15.4.8.1.1.3 15.4.8.1.2 15.4.8.2 15.4.8.2.1 15.4.8.2.1.1 15.4.8.2.1.2 15.4.8.2.1.3 15.4.8.2.1.4 15.4.8.2.1.5 15.4.8.2.1.7 15.4.8.2.1.8 15.4.8.2.1.9 15.4.8.3 15.4.8.3.1 15.4.8.3.5 15.4.8.3.6 15.4.10 Table 15.4-1R Table 15.4-4R Figure 15.4.8-1R Figure 15.4.8-2R Figure 15.4.8-3R Figure 15.4.8-4R 15.6.2.6 15.6.3.3.1 15.6.3.3.6 15.6.5.3.2 15.6.5.3.5 15.6.5.3.8.1 15.6.5.3.8.2

PTN SUP 1.8-1

Table 1.8-201 (Sheet 5 of 6)
Summary of FSAR Departures from the DCD

Departure Number	Departure Description Summary	FSAR Section or Subsection
PTN DEP 6.4-1		15.6.6 Table 15.6.2-1R Table 15.6.3-3R Table 15.6.5-2R Table 15.6.5-3R 15.7.4.5 Table 15.7-1R 15A.3.1.2 15B.1 16 LCO 3.7.4 16 SR 3.7.4.1 16 Bases 3.4.10 16 Bases 3.7.4 16 Bases 3.7.6
PTN DEP 6.4-2	Main Control Room Heatup. The following are the departures from the DCD: Tier 1 Tables 2.2.5-1, 2.2.5-4, 2.5.2-3 and 2.5.2-4, Tier 2 Table 3.7.3-1 (Sheets 1 and 2 of 3), Table 3.9-12 (Sheet 6 of 7), Table 3.9-16 (Sheet 23 of 26), Table 3.9-17, Table 3.11-1 (Sheets 17, 30 and 47 of 51). Figure 3D.5-1 (Sheet 1 of 3), Table 3I.6-2 (Sheet 11 of 28), Table 3I.6-3 (Sheets 10 and 28 of 32), Subsections 6.4.2.2, 6.4.2.3, 6.4.3.2, 6.4.4, 6.4.5.1, 6.4.5.3 and 6.4.8, Table 6.4-3, Figure 7.2-1 (Sheet 13 of 21), Subsection 7.3.1.2.17, Table 7.3-1 (Sheet 7 of 9), Table 7.3-3 (Sheet 2 of 2), Table 7.5-1 (Sheet 11 of 12), Table 7.5-7 (Sheet 4 of 4), Subsections 9.3.1.1.2, 9.4.1.1.2, 9.4.1.2.3.1 and 14.2.9.1.6, Table 14.3-7 (Sheet 1 of 3), Chapter 16 TS 3.3.2, TS 3.7.6, TS B 3.3.2, TS B 3.7.6, TS Figure B 3.7.6-2.	Table 3.7.3-1R Table 3.9-12R Table 3.9-16R Table 3.9-17R Table 3.11-1R (Sheets 2 to 4) Figure 3D.5-1R Table 3I.6-2R Table 3I.6-3R 6.4.2.2 6.4.2.3 6.4.3.2 6.4.4 6.4.5.1 6.4.5.3 6.4.8 Table 6.4-3R Figure 7.2-1R (Sheet 2 of 2) 7.3.1.2.17 Table 7.3-1R Table 7.3-3R Table 7.5-1R Table 7.5-7R 9.3.1.1.2 9.4.1.1.2 9.4.1.2.3.1 14.2.9.1.6 Table 14.3-7R 16 Technical Specifications TS 3.3.2 and TS 3.7.6, Bases B 3.3.2 and B 3.7.6

PTN SUP 1.8-1

Table 1.8-201 (Sheet 6 of 6)
Summary of FSAR Departures from the DCD

Departure Number	Departure Description Summary	FSAR Section or Subsection
PTN DEP 7.3-1	Source Range Flux Doubling Permissive The following are departures from the DCD: Tier 2 Subsections 7.3.1.2.14, 9.3.6.3.7, 9.3.6.4.5.1, 9.3.6.7 and 19E.2.7.2. Tables 7.3-1 (Sheets 6 and 7 of 9), 7.3-2 (Sheet 1 of 4) and 14.3-2 (Sheets 9 and 12 of 17). Figure 7.2-1 (Sheet 3 of 21), Chapter 16 Technical Specification Table 3.3.2-1 (Pages 9 and 10 of 13) and B 3.3.1 and B 3.3.2 Bases.	7.3.1.2.14 9.3.6.3.7 9.3.6.4.5.1 9.3.6.7 19E.2.7.2 Table 7.3-1R (Sheets 1 and 2 of 2) Table 7.3-2R (Sheet 1 of 1) Table 14.3-2R Figure 7.2-1R (Sheet 1 of 2) 16 Technical Specification Table 3.3.2-1 (Pages 9 and 10 of 13) B 3.3.1 and B 3.3.2 Bases
STD DEP 8.3-1	The Class 1E voltage regulating transformers do not have active components to limit current.	8.3.2.2
PTN DEP 9.3-1	DELETED	N/A
PTN DEP 18.8-1	The Operations Support Center (OSC) is being moved from the location identified in DCD Subsections 18.8.3.6, 12.5.2.2, and 12.5.3.2 and as identified on DCD figures in Subsections 1.2, 12.3, and Appendix 9A. There will be a single OSC for Units 6 & 7 located as described in the Emergency Plan.	1.2.3 9.4.2.2 9A 12.3.1.2 12.5.2.2 12.5.3.2 18.8.3.6
PTN DEP 18.8-2	The Technical Support Center (TSC) is not located in the control support area as identified in DCD Subsection 18.8.3.5. The TSC is common for Turkey Point Units 3, 4, 6, and 7 and is located as described in the Emergency Plan.	18.8.3.5
PTN DEP 19.58-1	As shown in Table 19.58-201, the initiating event frequency for high winds at Units 6 & 7 are higher than those in the DCD. Therefore, a site-specific analysis of high winds and tornadoes was conducted to determine core damage frequency (CDF). The analysis determined the total CDF for Case 1 (loss of offsite power) is 3.3E-09, the CDF for Case 2 (loss of offsite power with non-safety systems unavailable for select events) is 1.0E-08, and for Case 3 (loss of offsite power with non-safety systems unavailable for all events) the CDF is 2.0E-08 per year. These values are higher than the DCD CDF values listed in DCD Table 19.58-3.	19.58

(a) The Departure is standard for AP1000 COL applications but the applicable FSAR sections or subsections may vary in AP1000 subsequent COL applications.

PTN SUP 1.8-2

Table 1.8-202 (Sheet 1 of 9)
COL Item Tabulation

COL Item	Subject	DCD Subsection	FSAR Section(s)	COL Applicant (A), Holder (H), Or Both (B)
1.1-1	Construction and Startup Schedule	1.1.7	1.1.5 1.1.7	A
1.9-1	Regulatory Guide Conformance	1.9.1.5	1.9.1 1.9.1.1 1.9.1.2 1.9.1.3 1.9.1.4 1.9.1.5 Appendix 1A Appendix 1AA	A
1.9-2[a]	Bulletins and Generic Letters	1.9.5.5	1.9.5.5	A
1.9-3[a]	Unresolved Safety Issues and Generic Safety Issues	Table 1.9-2 1.9.4.1	1.9.4.1 1.9.4.2.3	A
2.1-1	Geography and Demography	2.1.1	1.1.1 1.2.2 2.1	A
2.2-1	Identification of Site-Specific Potential Hazards	2.2.1	2.2	A
2.3-1	Regional Climatology	2.3.6.1	2.3.1 2.3.6.1	A
2.3-2	Local Meteorology	2.3.6.2	2.3.2 2.3.6.2	A
2.3-3	Onsite Meteorological Measurements Program	2.3.6.3	2.3.3 2.3.6.3	A
2.3-4	Short-Term Diffusion Estimates	2.3.6.4	2.3.4 2.3.6.4 15.6.5.3.7.3 15A.3.3	A
2.3-5	Long-Term Diffusion Estimates	2.3.6.5	2.3.5 2.3.6.5	A
2.4-1	Hydrological Description	2.4.1.1	2.4.1 2.4.8 2.4.15.1	A
2.4-2	Floods	2.4.1.2	2.4.2 2.4.3 2.4.4 2.4.5 2.4.6 2.4.7 2.4.10 2.4.15.2	A
2.4-3	Cooling Water Supply	2.4.1.3	2.4.9 2.4.11 2.4.15.3	A
2.4-4	Groundwater	2.4.1.4	2.4.12.1 2.4.12.2 2.4.12.4 2.4.12.5 2.4.15.4	A

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Table 1.8-202 (Sheet 2 of 9) COL Item Tabulation

COL Item	Subject	DCD Subsection	FSAR Section(s)	COL Applicant (A), Holder (H), Or Both (B)
2.4-5	Accidental Release of Liquid Effluents into Ground and Surface Water	2.4.1.5	2.4.12.3 2.4.13 2.4.15.5	A
2.4-6	Flood Protection Emergency Operation Procedures	2.4.1.6	2.4.10 2.4.14 2.4.15.6	A
2.5-1	Basic Geologic and Seismic Information	2.5.1	2.5.1 2.5.2.1 2.5.4 2.5.4.1 2.5.6.1	A
2.5-2	Site Seismic and Tectonic Characteristics Information	2.5.2.1	2.5.2 2.5.4.7 2.5.4.9 2.5.6.2	A
2.5-3	Geoscience Parameters	2.5.2.3	2.5.2.6 2.5.4.1.1 2.5.6.3	A
2.5-4	Surface Faulting	2.5.3	2.5.3 2.5.6.4	A
2.5-5	Site and Structures	2.5.4.6.1	2.5.4 2.5.4.1 2.5.4.3 2.5.6.5	A
2.5-6	Properties of Underlying Materials	2.5.4.6.2	2.5.4.2 2.5.4.3 2.5.4.4 2.5.4.6 2.5.4.7 2.5.6.6	A
2.5-7	Excavation and Backfill	2.5.4.6.3	2.5.4.5 2.5.4.10.4 2.5.4.12 2.5.6.7	A
2.5-8	Groundwater Conditions	2.5.4.6.4	2.5.4.6 2.5.6.8	A
2.5-9	Liquefaction Potential	2.5.4.6.5	2.5.4.8 2.5.6.9	A
2.5-10	Bearing Capacity	2.5.4.6.6	2.5.4.10 2.5.6.10	A
2.5-11	Earth Pressures	2.5.4.6.7	2.5.4.10.4 2.5.6.11	A
2.5-12	Static and Dynamic Stability of Facilities	2.5.4.6.9	2.5.4.10.3 2.5.6.12	A
2.5-13	Subsurface Instrumentation	2.5.4.6.10	2.5.4.5 2.5.6.13	A
2.5-14	Stability of Slopes	2.5.5	2.5.5 2.5.6.14	A
2.5-15	Embankments and Dams	2.5.6	2.5.5.1.1 2.5.6.15	A
2.5-16	Settlement of Nuclear Island	2.5.4.6.11	2.5.4.10.3 2.5.6.16	A

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Table 1.8-202 (Sheet 3 of 9)
COL Item Tabulation

COL Item	Subject	DCD Subsection	FSAR Section(s)	COL Applicant (A), Holder (H), Or Both (B)
2.5-17	Waterproofing System	2.5.4.6.12	2.5.6.17 3.8.5.1 14.3.3.4	A
3.3-1	Wind and Tornado Site Interface Criteria	3.3.3	1.2.2 2.2.1 3.3.1.1 3.3.2.1 3.3.2.3 3.3.3 3.5.1.4 3.5.1.5 3.5.1.6	A
3.4-1	Site-Specific Flooding Hazards Protective Measures	3.4.3	3.4.1.3 3.4.3	A
3.5-1	External Missile Protection Requirements	3.5.4	1.2.2 2.2.1 3.3.1.1 3.3.2.1 3.3.2.3 3.5.1.4 3.5.1.5 3.5.1.6 3.5.2 3.5.4	A
3.6-1	Pipe Break Hazards Analysis	3.6.4.1	3.6.4.1 14.3.3.2	H
3.6-4	Primary System Inspection Program for Leak-Before-Break Piping	3.6.4.4	3.6.4.4	A
3.7-1	Seismic Analysis of Dams	3.7.5.1	3.7.2.12 3.7.5.1	A
3.7-2	Post-Earthquake Procedures	3.7.5.2	3.7.4.4 3.7.5.2	A
3.7-3	Seismic Interaction Review	3.7.5.3	3.7.5.3	H
3.7-4	Reconciliation of Seismic Analyses of Nuclear Island Structures	3.7.5.4	3.7.5.4	H
3.7-5	Location of Free-Field Acceleration Sensor	3.7.5.5	3.7.4.2.1 3.7.5.5	A
3.8-5	Structures Inspection Program	3.8.6.5	3.8.3.7 3.8.4.7 3.8.5.7 3.8.6.5 17.6	A
3.8-6	Construction Procedures Program	3.8.6.6	3.8.6.6	H
3.9-2	Design Specification and Reports	3.9.8.2	3.9.8.2	H
3.9-3	Snubber Operability Testing	3.9.8.3	3.9.3.4.4 3.9.8.3	A

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Table 1.8-202 (Sheet 4 of 9)
COL Item Tabulation

COL Item	Subject	DCD Subsection	FSAR Section(s)	COL Applicant (A), Holder (H), Or Both (B)
3.9-4	Valve Inservice Testing	3.9.8.4	3.9.6 3.9.6.2.2 3.9.6.2.3 3.9.6.2.4 3.9.6.2.5 3.9.6.3 3.9.8.4	A
3.9-5	Surge Line Thermal Monitoring	3.9.8.5	3.9.3.1.2 3.9.8.5 14.2.9.2.22	A
3.9-7	As-Designed Piping Analysis	3.9.8.7	3.9.8.7 14.3.3.3	H
3.11-1	Equipment Qualification File	3.11.5	3.11.5	H
4.4-2	Confirm Assumptions for Safety Analyses DNBR Limits	4.4.7.2	4.4.7	H
5.2-1	ASME Code and Addenda	5.2.6.1	5.2.1.1 5.2.6.1	A
5.2-2	Plant Specific Inspection Program	5.2.6.2	5.2.4 5.2.4.1 5.2.4.3.1 5.2.4.3.2 5.2.4.4 5.2.4.5 5.2.4.6 5.2.4.8 5.2.4.9 5.2.4.10 5.2.6.2	A
5.2-3	Response to Unidentified Reactor Coolant System Leakage Inside Containment	5.2.6.3	5.2.6.3 5.2.5.3.5	A
5.3-1	Reactor Vessel Pressure — Temperature Limit Curves	5.3.6.1	5.3.6.1	H
5.3-2	Reactor Vessel Materials Surveillance Program	5.3.6.2	5.3.2.6 5.3.2.6.3 5.3.6.2	A
5.3-4	Reactor Vessel Materials Properties Verification	5.3.6.4.1	5.3.6.4.1	H
5.3-7	Quickloc Weld Build-up ISI	5.3.6.6	5.2.4.1 5.3.6.6	A
5.4-1	Steam Generator Tube Integrity	5.4.15	5.4.2.5 5.4.15	A
6.1-1	Procedure Review for Austenitic Stainless Steels	6.1.3.1	6.1.1.2 6.1.3.1	A
6.1-2	Coating Program	6.1.3.2	6.1.2.1.6 6.1.3.2	A
6.2-1	Containment Leak Rate Testing	6.2.6	6.2.5.1 6.2.5.2.2 6.2.6	A
6.3-1	Containment Cleanliness Program	6.3.8.1	6.3.8.1	A
6.4-1	Local Hazardous Gas Services and Monitoring	6.4.7	6.4.4.2 6.4.7	A

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Table 1.8-202 (Sheet 5 of 9) COL Item Tabulation

COL Item	Subject	DCD Subsection	FSAR Section(s)	COL Applicant (A), Holder (H), Or Both (B)
6.4-2	Procedures for Training for Control Room Habitability	6.4.7	6.4.3 6.4.7	A
6.6-1	Inspection Programs	6.6.9.1	6.6 6.6.1 6.6.3.1 6.6.3.2 6.6.3.3 6.6.4 6.6.6 6.6.9.1	A
6.6-2	Construction Activities	6.6.9.2	6.6.2 6.6.9.2	A
7.1-1	Setpoint Calculations for Protective Functions	7.1.6.1	7.1.6.1	B
7.5-1	Post Accident Monitoring	7.5.5	7.5.2 7.5.3.5 7.5.5	A
8.2-1	Offsite Electrical Power	8.2.5	8.2.1 8.2.1.1 8.2.1.2 8.2.1.3 8.2.1.4 8.2.5	A
8.2-2	Technical Interfaces	8.2.5	8.2.1.2.1 8.2.2 8.2.5	A
8.3-1	Grounding and Lightning Protection	8.3.3	8.3.1.1.7 8.3.1.1.8 8.3.3	A
8.3-2	Onsite Electrical Power Plant Procedures	8.3.3	8.3.1.1.2.4 8.3.1.1.6 8.3.2.1.4 8.3.3	A
9.1-5	Inservice Inspection Program of Cranes	9.1.6.5	9.1.4.4 9.1.5.4 9.1.6.5	A
9.1-6	Radiation Monitor	9.1.6.6	9.1.4.3.8 9.1.5.3 9.1.6.6	A
9.1-7	Metamic Monitoring Program	9.1.6.7	9.1.6.7	H
9.2-1	Potable Water	9.2.11.1	9.2.5.2.1 9.2.5.3 9.2.13.1	A
9.2-2	Wastewater Retention Basins	9.2.11.2	9.2.9.2.2 9.2.9.5 9.2.13.2	A
9.3-1	Air Systems (NUREG-0933 Issue 43)	9.3.7	9.3.7	A
9.4-1	Ventilation Systems Operations	9.4.12	9.4.1.4 9.4.7.4 9.4.12	A

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Table 1.8-202 (Sheet 6 of 9)
COL Item Tabulation

COL Item	Subject	DCD Subsection	FSAR Section(s)	COL Applicant (A), Holder (H), Or Both (B)
9.5-1	Qualification Requirements for Fire Protection Program	9.5.1.8.1	9.5.1.6 9.5.1.8 9.5.1.8.1 9.5.1.8.1.2 9.5.1.8.2 9.5.1.8.3 9.5.1.8.4 9.5.1.8.5 9.5.1.8.6 9.5.1.8.7 9.5.1.9.1 13.1.1.2.10 13.1.2.1.3.9	A
9.5-2	Fire Protection Analysis Information	9.5.1.8.2	9.5.1.9.2 9A.3.3	A
9.5-3	Regulatory Conformance	9.5.1.8.3	9.5.1.8.1.1 9.5.1.8.8 9.5.1.8.9 9.5.1.9.3 9A.3.3	A
9.5-4	NFPA Exceptions	9.5.1.8.4	9.5.1.8.1.1 9.5.1.9.4	A
9.5-6	Verification of Field Installed Fire Barriers	9.5.1.8.6	9.5.1.8.6 9.5.1.9.6	H
9.5-8	Establishment of Procedures to Minimize Risk for Fire Areas Breached During Maintenance	9.5.1.8.7	9.5.1.8.1.2 9.5.1.9.7	A
9.5-9	Offsite Interfaces	9.5.2.5.1	9.5.2.2.5 9.5.2.5.1	A
9.5-10	Emergency Offsite Communications	9.5.2.5.2	9.5.2.2.5 9.5.2.5.2	A
9.5-11	Security Communications	9.5.2.5.3	9.5.2.5.3	A
9.5-13	Fuel Degradation Protection	9.5.4.7.2	9.5.4.5.2 9.5.4.7.2	A
10.1-1	Erosion-Corrosion Monitoring	10.1.3	10.1.3	H
10.2-1	Turbine Maintenance and Inspection	10.2.6	10.2.6	H
10.4-1	Circulating Water Supply	10.4.12.1	10.4.5.2.1 10.4.5.2.2 10.4.5.5 10.4.12.1	A
10.4-2	Condensate, Feedwater and Auxiliary Steam System Chemistry Control	10.4.12.2	10.4.7.2.1 10.4.12.2	A
10.4-3	Potable Water	10.4.12.3	10.4.12.3	A
11.2-1	Liquid Radwaste Processing by Mobile Equipment	11.2.5.1	11.2.1.2.5.2 11.2.5.1	A
11.2-2	Cost Benefit Analysis of Population Doses	11.2.5.2	11.2.3.5.2.5.2 11.2.5.2	A
11.3-1	Cost Benefit Analysis of Population Doses	11.3.5.1	11.3.3.4.3 11.3.3.4.4 11.3.5.1	A

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Table 1.8-202 (Sheet 7 of 9)
COL Item Tabulation

COL Item	Subject	DCD Subsection	FSAR Section(s)	COL Applicant (A), Holder (H), Or Both (B)
11.4-1	Solid Waste Management System Process Control Program	11.4.6	11.4.6	A
11.5-1	Plant Offsite Dose Calculation Manual (ODCM)	11.5.8	11.5.8	A
11.5-2	Effluent Monitoring and Sampling	11.5.8	11.5.1.2 11.5.2.4 11.5.3 11.5.4 11.5.4.1 11.5.4.2 11.5.6.5 11.5.8	A
11.5-3	10 CFR 50, Appendix I	11.5.8	11.2.3.5 11.3.3.4 11.5.8	A
12.1-1	ALARA and Operational Policies	12.1.3	12.1 12.1.3 Appendix 12AA	A
12.2-1	Additional Contained Radiation Sources	12.2.3	12.2.1.1.10 12.2.3	A
12.3-1	Administrative Controls for Radiological Protection	12.3.5.1	12.3.5.1 Appendix 12AA	A
12.3-2	Criteria and Methods for Radiological Protection	12.3.5.2	12.3.4 12.3.5.2	A
12.3-3	Groundwater Monitoring Program	12.3.5.3	12.3.5.3 12AA.5.4.14	A
12.3-4	Record of Operational Events of Interest for Decommissioning	12.3.5.4	12.3.5.4 12AA.5.4.15	A
12.5-1	Radiological Protection Organization and Procedures	12.5.5	12.5.5 Appendix 12AA	A
13.1-1	Organizational Structure of Combined License Applicant	13.1.1	13.1 13.1.4 Appendix 13AA	A
13.2-1	Training Program for Plant Personnel	13.2.1	13.2 13.2.1	A
13.3-1	Emergency Planning and Communications	13.3.1	13.3 13.3.1	A
13.3-2	Activation of Emergency Operations Facility	13.3.1	13.3 13.3.1	A
13.4-1	Operational Review	13.4.1	13.4 13.4.1	A
13.5-1	Plant Procedures	13.5.1	13.5 13.5.2 13.5.3	A
13.6-1	Security	13.6	13.6 13.6.1 13.6.2 14.3.2.3.2	A
13.6-5	Cyber Security Program	13.6.1	13.6 13.6.1	H

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Table 1.8-202 (Sheet 8 of 9)
COL Item Tabulation

COL Item	Subject	DCD Subsection	FSAR Section(s)	COL Applicant (A), Holder (H), Or Both (B)
14.4-1	Organization and Staffing	14.4.1	14.2.2 14.4.1	A
14.4-2	Test Specifics and Procedures	14.4.2	14.4.2	H
14.4-3	Conduct of Test Program	14.4.3	14.4.3	H
14.4-4	Review and Evaluation of Test Results	14.4.4	14.2.3.2 14.4.4	H
14.4-5	Testing Interface Requirements	14.4.5	14.2.9.4.15 14.2.9.4.22 to 14.2.9.4.28 14.2.10.4.29 14.4.5	A
14.4-6	First-Plant-Only and Three-Plant-Only Tests	14.4.6	14.4.6	B
15.0-1	Documentation of Plant Calorimetric Uncertainty Methodology	15.0.15.1	15.0.15 15.0.3.2	H
15.7-1	Consequences of Tank Failure	15.7.6	2.4.13 15.7.6	A
16.1-1	Technical Specification Preliminary Information	16.1	16.1.1	A
16.3-1	Procedure to Control Operability of Investment Protection Systems, Structures, and Components	16.3.2	16.3.1 16.3.2	A
17.5-1	Quality Assurance Design Phase	17.5.1	17.1 17.5 17.7	A
17.5-2	Quality Assurance for Procurement, Fabrication, Installation, Construction, and Testing	17.5.2	17.5 17.7	A
17.5-4	Quality Assurance Program for Operations	17.5.4	17.5 17.7	A
17.5-8	Operational Reliability Assurance Program Integration with Quality Assurance Program	17.5.8	17.5 17.7	A
18.2-2	Design of the Emergency Operations Facility	18.2.6.2	18.2.1.3 18.2.6.2	A
18.6-1	Plant Staffing	18.6.1	13.1.1.4 13.1.3.1 13.1.3.2 18.6 18.6.1	A
18.10-1	Training Program Development	18.10.1	13.1.1.3.2.5 13.2 18.10 18.10.1	A
18.14-1	Human Performance Monitoring	18.14	18.14	A
19.59.10-1	As-Built SSC HCLPF Comparison to Seismic Margin Evaluation	19.59.10.5	19.59.10.5	H
19.59.10-2	Evaluation of As-Built Plant Versus Design in AP1000 PRA and Site-Specific PRA External Events	19.59.10.5	19.59.10.5	B

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Table 1.8-202 (Sheet 9 of 9)
COL Item Tabulation

COL Item	Subject	DCD Subsection	FSAR Section(s)	COL Applicant (A), Holder (H), Or Both (B)
19.59.10-3	Internal Fire and Internal Flood Analyses	19.59.10.5	19.59.10.5	H
19.59.10-4	Implement Severe Accident Management Guidance	19.59.10.5	19.59.10.5	H
19.59.10-5	Equipment Survivability	19.59.10.5	19.59.10.5	H
19.59.10-6	Confirm that the Seismic Margin Assessment analysis is applicable to the COL site	19.59.10.5	19.55.6.3 19.59.10.5	A

(a) COL Items 1.9-2 and 1.9-3 are not numbered in the DCD.

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Table 1.8-203 (Sheet 1 of 6)
Summary of FSAR Discussions of AP1000 Plant Interfaces

Item No.	Interface	Interface Type	Matching Interface Item	Section[a] or Subsection
2.1	Envelope of AP1000 plant site related parameters	Site Interface	Site specific parameters	Table 2.0-201
2.2	External missiles from man-made hazards and accidents	Site Interface	Site specific parameters	2.2.2.2, 2.2.3.1, 3.5
2.3	Maximum loads from man-made hazards and accidents	Site Interface	Site specific parameters	Table 2.0-201
2.4	Limiting meteorological parameters (X/Q) for design basis accidents and for routine releases and other extreme meteorological conditions for the design of systems and components exposed to the environment.	Site Interface	Site specific parameters	Table 2.0-201
2.5	Tornado and operating basis wind loadings	Site Interface	Site specific parameters	Table 2.0-201
2.6	External missiles generated by natural phenomena	Site Interface	Site specific parameters	Table 2.0-201
2.7	Snow, ice and rain loads	Site Interface	Site specific parameters	2.3.1.3
2.8	Ambient air temperatures	Site Interface	Site specific parameters	Table 2.0-201
2.9	Onsite meteorological measurement program	Requirement of AP1000	Combined License applicant program	2.3.3
2.10	Flood and ground water elevations	Site Interface	Site specific parameters	Table 2.0-201
2.11	Hydrostatic loads on systems, components and structures	Site Interface	Site specific parameters	Table 2.0-201
2.12	Seismic parameters peak ground acceleration response spectra shear wave velocity	Site Interface	Site specific parameters	Table 2.0-201

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Table 1.8-203 (Sheet 2 of 6)
Summary of FSAR Discussions of AP1000 Plant Interfaces

Item No.	Interface	Interface Type	Matching Interface Item	Section[a] or Subsection
2.13	Required bearing capacity of foundation materials	Site Interface	Site specific parameters	Table 2.0-201
3.1	Deleted	N/A	N/A	N/A
3.2	Operating procedures to minimize water hammer	Requirement of AP1000	Combined License applicant procedure	10.3.2.2.1, 10.4.7.2.1
3.3	Site seismic sensor location and “trigger” value	Requirement of AP1000	Onsite implementation	3.7.4.2.1
3.4	Depth of overburden	Requirement of AP1000	Onsite implementation	3.8.5.1, 2.5.4
3.5	Depth of embedment	Requirement of AP1000	Onsite implementation	3.8.5.1, 2.5.4
3.6	Specific depth of waterproofing	Requirement of AP1000	Onsite implementation	2.5.4.1
3.7	Foundation Settlement Monitoring	Requirement of AP1000	Combined License applicant procedure	2.5.4.10.3
3.8	Lateral earth pressure loads	Not an Interface	N/A	N/A
3.9	Preoperational piping vibration test parameters	Not an Interface	N/A	N/A
3.10	Inservice Inspection requirements and locations	Requirement of AP1000	Combined License applicant procedure	3.9.6, 5.2.4, 6.6
3.11	Maintenance of preservice and reference test data for inservice testing of pumps and valves	Requirement of AP1000	Combined License applicant procedure	3.9.6
3.12	Earthquake response procedures	Requirement of AP1000	Combined License applicant procedure	3.7.4.4
5.1	Steam Generator Tube Surveillance Requirements	Requirement of AP1000	Combined License applicant procedure	5.4.2.5
6.1	Inservice Inspection requirements for the containment	Requirement of AP1000	Combined License applicant procedure	6.6

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Table 1.8-203 (Sheet 3 of 6) Summary of FSAR Discussions of AP1000 Plant Interfaces

Item No.	Interface	Interface Type	Matching Interface Item	Section[a] or Subsection
6.2	Off site environmental conditions assumed for Main Control Room and control support area habitability design	AP1000 Interface	Site specific parameter	2.2.3, 6.4
7.1	Listing of all design criteria applied to the design of the I&C systems	Not an Interface	N/A	N/A
7.2	Power required for site service water instrumentation	NNS and Not an Interface	N/A	N/A
7.3	Other provisions for site service water instrumentation	NNS and Not an Interface	N/A	N/A
7.4	Post Accident Monitoring System	NNS	Combined License applicant coordination	7.5.5
8.1	Listing of design criteria applied to the design of the offsite power system	NNS	Combined License applicant coordination	8.1.4.3
8.2	Offsite ac requirements: • Steady-state load; • Inrush kVA for motors; • Nominal voltage; • Allowable voltage regulation; • Nominal frequency; • Allowable frequency fluctuation; • Maximum frequency decay rate; • Limiting under frequency value for RCP	NNS	Combined License applicant coordination	8.2.2

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Table 1.8-203 (Sheet 4 of 6)
Summary of FSAR Discussions of AP1000 Plant Interfaces

Item No.	Interface	Interface Type	Matching Interface Item	Section[a] or Subsection
8.3	Offsite transmission system analysis: • Loss of AP1000 or largest unit; • Voltage operating range; • Transient stability must be maintained and the RCP bus voltage must remain above the voltage required to maintain the flow assumed in Chapter 15 analyses for a minimum of three (3) seconds following a turbine trip.; • The protective devices controlling the switchyard breakers are set with consideration given to preserving the plant grid connection following a turbine trip.	NNS	Combined License applicant analysis	8.2.2, 8.2.1.2.1
8.4	Listing of design criteria applied to the design of onsite ac power systems	NNS and Not an Interface	N/A	N/A
8.5	Onsite ac requirements	NNS and Not an Interface	N/A	N/A
8.6	Diesel generator room coordination	NNS and Not an Interface	N/A	N/A
8.7	Listing of design criteria applied to the design of onsite dc power systems	Not an Interface	N/A	N/A
8.8	Provisions of dc power systems to accommodate the site service water system	NNS and Not an Interface	N/A	N/A
9.1	Listing of design criteria applied to the design of portions of the site service water within AP1000	NNS and Not an Interface	N/A	N/A
9.2	Integrated heat load to site service water system	NNS and Not an Interface	N/A	N/A
9.3	Plant cooling water systems parameters	NNS and Not an Interface	N/A	N/A
9.4	Plant makeup water quality limits	NNS	Site specific parameter	9.2.11

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Table 1.8-203 (Sheet 5 of 6)
Summary of FSAR Discussions of AP1000 Plant Interfaces

Item No.	Interface	Interface Type	Matching Interface Item	Section(a) or Subsection
9.5	Requirements for location and arrangement of raw and sanitary water systems	NNS	Site implementation	9.2.5, 9.2.6, 9.2.11
9.6	Ventilation requirements for diesel-generator room	NNS and Not an Interface	N/A	N/A
9.7	Requirements to satisfy fire protection program	AP1000 Interface	Combined License applicant program	9.5.1
11.1	Expected release rates of radioactive material from the Liquid Waste System including: • Location of release points • Effluent temperature • Effluent flow rate • Size and shape of flow orifices	Site Interface	Site specific parameters	11.2
11.2	Expected release rates of radioactive materials from the Gaseous Waste System including: • Location of release points • Height above grade • Height relative to adjacent buildings • Effluent temperature • Effluent flow rate • Effluent velocity • Size and shape of flow orifices	Site Interface	Site specific parameters	11.3
11.3	Expected release rates of radioactive material from the Solid Waste System including: • Location of release points • Material types • Material qualities • Size and shape of material containers	Site Interface	Site specific parameters	11.4.6
11.4	Requirements for offsite sampling and monitoring of effluent concentrations	AP1000 Interface	Combined License applicant program	11.5.3, 11.5.8
12.1	Identification of miscellaneous radioactive sources	AP1000 Interface	Combined License applicant program	12.2.1

PTN SUP 1.8-3

Table 1.8-203 (Sheet 6 of 6)
Summary of FSAR Discussions of AP1000 Plant Interfaces

PTN DEP 1.8-1

Item No.	Interface	Interface Type	Matching Interface Item	Section[a] or Subsection
13.1	The information pertaining to design features that affect plans for coping with emergencies in the operation of the reactor facility or a major portion thereof as specified in 10 CFR 52.137(a)(11)	AP1000 Interface	Combined License applicant program	13.3
13.2	Physical Security Plan consistent with AP1000 plant	AP1000 Interface	Combined License applicant program	13.6
14.1	Identification of special features to be considered in development of the initial test program	Requirement of AP1000	Combined License applicant program	14
14.2	Maintenance of preoperational test data and inservice inspection baseline data	AP1000 Interface	Combined License applicant program	14
16.1	Administrative requirements associated with reliability information maintenance	AP1000 Interface	Combined License applicant program	16
16.2	Administrative requirements associated with the Technical Specifications	Requirement of AP1000	Combined License applicant program	16
16.3	Site and operator related information associated with the Reliability Assurance Program (D-RAP)	Requirement of AP1000	Combined License applicant program	16.2
18.1	Operating staff consistent with Human Factors evaluations	AP1000 Interfaces	Combined License applicant program	18.6
18.2	Operator training consistent with Human Factors evaluations	AP1000 Interface	Combined License applicant program	18.8, 18.10
18.3	Operating Procedures consistent with Human Factors evaluations	AP1000 Interface	Combined License applicant program	18.8, 18.10

(a) This table supplements DCD Table 1.8-1 by providing additional information in the Section or Subsection column.

1.9 COMPLIANCE WITH REGULATORY CRITERIA

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

1.9.1 REGULATORY GUIDES

Add the following paragraphs to the end of DCD Subsection 1.9.1:

STD COL 1.9-1 Divisions 2, 3, 6, 7, 9, and 10 of the regulatory guides do not apply to the construction or operational safety considerations and are not addressed in the FSAR.

PTN COL 1.9-1 Division 4 of the regulatory guides applies to the Environmental Report and the topics are addressed in the Environmental Report. Two Division 4 Regulatory Guides are addressed in Appendix 1AA.

PTN COL 1.9-1 Division 5 of the regulatory guides applies to materials and plant protection. As appropriate, the Division 5 regulatory guide topics are addressed in the DCD and plant-specific security plans (i.e., Physical Security Plan, Training and Qualification Plan, Safeguards Contingency Plan, and Cyber Security Plan).

Applicable Division 8 Regulatory Guides are addressed in Appendix 1AA.

Appendix 1AA provides a discussion of plant specific regulatory guide conformance, addressing new Regulatory Guides and new revisions not addressed by the referenced DCD. Regulatory Guides that are completely addressed by the DCD are not listed.

The following subsections provide a summary discussion of Divisions 1, 4, 5 and 8 of the regulatory guides as applicable to the content of this FSAR, or to the construction and/or operations phases.

1.9.1.1 Division 1 Regulatory Guides — Power Reactors

Add the following paragraphs to the end of DCD Subsection 1.9.1.1:

STD COL 1.9-1 Appendix 1AA provides an evaluation of the degree of compliance with Division 1 regulatory guides as applicable to the content of this FSAR, or to the site-specific design, construction and/or operational aspects. The revisions of the regulatory guides against which the degree of compliance is evaluated are indicated. Any exceptions or alternatives to the provisions of the regulatory guides are identified and justification is provided. One such general alternative is the use of previous revisions of the Regulatory Guide for design aspects as stated in the DCD in order to preserve the finality of the certified design (see Notes at the end of Appendix 1AA). Table 1.9-201 identifies the appropriate regulatory guide to FSAR cross-references. The cross-referenced sections contain descriptive information applicable to the regulatory guide positions found in Appendix 1AA.

Superseded or canceled regulatory guides are not considered in Appendix 1AA or Table 1.9-201.

1.9.1.2 Division 4 Regulatory Guides — Environmental and Siting

Add the following as the first paragraph in DCD Subsection 1.9.1.2:

STD COL 1.9-1 Division 4 of the regulatory guides applies to the Environmental Report and the topics are addressed in the Environmental Report. Appendix 1AA provides an evaluation of the degree of compliance with Division 4 regulatory guides as applicable to the content of this FSAR, or to the site-specific design, construction and/or operational aspects. The revisions of the regulatory guides against which the plant is evaluated are indicated. Any exceptions or alternatives to the provisions of the regulatory guides are identified and justification is provided. One such general alternative is the use of previous revisions of the Regulatory Guide for design aspects as stated in the DCD in order to preserve the finality of the certified design (see Notes at the end of Appendix 1AA). For those regulatory guides applicable, Table 1.9-201 identifies the appropriate FSAR cross-references. The cross-referenced sections contain descriptive information applicable to the regulatory guide positions found in Appendix 1AA.

1.9.1.3 Division 5 Regulatory Guides — Materials and Plant Protection

Add the following as the first paragraph in DCD Subsection 1.9.1.3:

STD COL 1.9-1 Division 5 of the regulatory guides applies to materials and plant protection. Appendix 1AA provides an evaluation of the degree of conformance with Division 5 regulatory guides as applicable to the content of the AP1000 DCD and the plant-specific Cyber Security Plan. The plant-specific physical security plans (i.e., Physical Security Plan, Training and Qualification Plan, and Safeguards Contingency Plan) were developed using the template in NEI 03-12, Revision 6, “Template for the Security Plan, Training and Qualification Plan, Safeguards Contingency Plan [and Independent Spent Fuel Storage Installation Security Program],” which was endorsed for use by NRC letter dated April 9, 2009. The plant-specific physical security plans include no substantive deviations from the NRC-endorsed template in NEI 03-12, Revision 6. Therefore, the degree of conformance with Division 5 regulatory guides for the plant-specific physical security plans is consistent with the degree of conformance of NEI 03-12, Revision 6.

1.9.1.4 Division 8 Regulatory Guides — Occupational Health

Add the following paragraphs to the end of DCD Subsection 1.9.1.4:

STD COL 1.9-1 Appendix 1AA provides an evaluation of the degree of compliance with Division 8 regulatory guides as applicable to the content of this FSAR, or to the site-specific design, construction and/or operational aspects. The revisions of the regulatory guides against which the plant is evaluated are indicated. Any exceptions or alternatives to the provisions of the regulatory guides are identified and justification is provided. One such general alternative is the use of previous revisions of the Regulatory Guide for design aspects as stated in the DCD in order to preserve the finality of the certified design (see Notes at the end of Appendix 1AA). For those regulatory guides applicable, Table 1.9-201 identifies the appropriate FSAR cross-references. The cross-referenced sections contain descriptive information applicable to the regulatory guide positions found in Appendix 1AA.

Superseded or canceled regulatory guides are not considered in Appendix 1AA or Table 1.9-201.

1.9.1.5 Combined License Information

Add the following as the first paragraph in DCD Subsection 1.9.1.5:

STD COL 1.9-1 Division 1, 4, 5 and 8 Regulatory Guides applicable to the content of this FSAR, or to the site-specific design, construction and/or operational aspects are listed in Table 1.9-201 and Appendix 1AA.

1.9.2 COMPLIANCE WITH STANDARD REVIEW PLAN (NUREG-0800)

Add the following paragraph to the end of DCD Subsection 1.9.2:

STD SUP 1.9-1 Table 1.9-202 provides the required assessment of conformance with the applicable acceptance criteria and the associated FSAR cross-references.

The design related SRP acceptance criteria addressed by the certified design are identified as such in Table 1.9-202.

1.9.4.1 Review of NRC List of Unresolved Safety Issues and Generic Safety Issues

Add the following paragraphs to the end of DCD Subsection 1.9.4.1:

STD COL 1.9-3 Table 1.9-203 addresses the second un-numbered COL Information Item identified at the end of DCD Table 1.8-2 and listed in Table 1.8-202 as COL Information Item 1.9-3, “Unresolved Safety Issues and Generic Safety Issues.” As such, Table 1.9-203 lists those issues on DCD Table 1.9-2 identified by Note “d,” which apply to other than design issues, Note “f,” which apply either to resolution of Combined License (COL) Information Items or to nuclear power plant operations issues, Note “h,” which apply to issues unresolved pending generic resolution at the time of submittal of the AP1000 DCD, and any new Unresolved Safety Issues and Generic Safety Issues that have been included in NUREG-0933 (through Supplement 30) since the DCD was developed. Many of these have since been resolved and incorporated into the applicable licensing regulations or guidance (e.g., the standard review plans). These resolved items

(as indicated by NUREG-0933) are identified only as “Resolved per NUREG-0933.” Many others are not in the list of items in NUREG-0933 Appendix B identified as applicable to new plants. These items are identified only as “Not applicable to new plants.” For the remaining items, the table provides the FSAR sections that address the topic.

1.9.4.2.2 Task Action Plan Items

A-31 Residual Heat Removal Requirements

Replace the first and second paragraphs of DCD Subsection 1.9.4.2.2, Action Plan Item A-31, AP1000 Response, with the following:

PTN DEP 3.2-1 The AP1000 employs safety-related core decay heat removal systems that establish and maintain the plant in a safe, stable condition following design basis events. It is not necessary that these passive systems achieve cold shutdown as defined by Regulatory Guide 1.139.

The AP1000 complies with General Design Criteria 34 by using a more reliable and simplified system design. The passive core cooling system is employed for both hot-standby and long-term cooling modes. Hot-standby conditions are achieved immediately and a temperature of 420°F is reached within 36 hours as discussed in Subsection 19E.4.10.2. Reactor pressure is controlled and can be reduced to about 250 psig. The passive residual heat removal system provides a closed cooling system to maintain long-term core cooling. Passive feed and bleed cooling, using the passive injection features for the feed and the automatic depressurization system for bleed, provides safety-related cooling capability. See Section 7.4 for a discussion of safe shutdown and Section 6.3 for a description of the passive core cooling system.

1.9.4.2.3 New Generic Issues

Revise the second sentence in the first paragraph of the AP1000 Response for Issue 83 in DCD Subsection 1.9.4.2.3 as follows:

PTN DEP 6.4-1 If ac power is unavailable for more than 10 minutes or if "High-2" particulate or iodine radioactivity is detected in the main control room supply air duct, which

would lead to exceeding General Design Criteria 19 operator dose limits, the protection and safety monitoring system automatically isolates the main control room and operator habitability requirements are then met by the main control room emergency habitability system (VES).

Add the following text in DCD Subsection 1.9.4.2.3, following the AP1000 Position for Issue 185.

STD COL 1.9-3

Issue 186 Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants

Discussion:

This issue concerns licensees operating within the regulatory guidelines of Generic Letter 85-11 that may not have taken adequate measures to assess and mitigate the consequences of dropped heavy loads.

FSAR Position:

There are no planned heavy load lifts outside those already described in the DCD. However, over the plant life there may be occasions when heavy loads not presently addressed need to be lifted (i.e. in support of special maintenance/repairs). For these occasions, special procedures are generated that address to the activity. Further discussion is provided in Subsection 9.1.5.3.

Issue 189 Susceptibility of Ice Condenser and Mark III Containments to Early Failure From Hydrogen Combustion During a Severe Accident Description

Discussion:

This issue concerns the early containment failure probability for ice condenser and BWR MARK III containments given the relatively low containment free volume and low containment strength in these designs.

FSAR Position:

The AP1000 design does not have an ice condenser containment or a Mark III containment. Therefore, this issue is not addressed in this FSAR.

Add the following text in DCD Subsection 1.9.4.2.3, following the AP1000 Position for Issue 191.

STD COL 1.9-3 Issue 191 Assessment of Debris Accumulation on PWR Sump Performance (REV. 1)

Discussion:

Results of research on BWR ECCS suction strainer blockage identified new phenomena and failure modes that were not considered in the resolution of Issue A-43. In addition, operating experience identified new contributors to debris and possible blockage of PWR sumps, such as degraded or failed containment paint coatings.

FSAR Position:

The design aspects of this issue are addressed by the DCD. The protective coatings program controls the procurement, application, inspection, and monitoring of Service Level I and Service Level III coatings with the quality assurance features discussed above. The protective coatings program complies with Regulatory Guide 1.54, and is controlled and implemented by administrative procedures. The program is discussed in Subsection 6.1.2.1.6.

Administrative procedures implement the containment cleanliness program. Implementation of the program minimizes the amount of debris that might be left in containment following refueling and maintenance outages. The program is consistent with the containment cleanliness program used in the evaluation discussed in DCD Subsection 6.3.8.2. The program is discussed in Subsection 6.3.8.1.

Issue 196 Boral Degradation

Discussion:

The issue specifically addresses the use of Boral in long-term dry storage casks for spent reactor fuel.

FSAR Position:

Long-term dry storage casks for spent reactor fuel are not used and therefore this issue is not addressed in this FSAR.

1.9.5.1.5 Station Blackout

Replace the third paragraph of DCD Subsection 1.9.5.1.5, AP1000 Response, with the following:

PTN DEP 3.2-1

The AP1000 safety-related passive systems automatically establish and maintain safe, stable conditions for the plant following design basis events, including an extended loss of ac power sources. The passive systems can maintain these safe, stable conditions after design basis events for at least 72 hours, without operator action, following a loss of both onsite and offsite ac power sources. DCD Subsection 1.9.5.4 provides additional information on long-term actions following an extended station blackout beyond 72 hours.

Add the following text to the end of DCD Subsection 1.9.5.1.5.

STD SUP 1.9-3

Training and procedures to mitigate a 10 CFR 50.63 “loss of all alternating current power” (or station blackout (SBO)) event are implemented in accordance with Sections 13.2 and 13.5, respectively. As recommended by NUMARC 87-00 (Reference 201), the SBO event mitigation procedures address response (e.g., restoration of onsite power sources), ac power restoration (e.g., coordination with transmission system load dispatcher), and severe weather guidance (e.g., identification of actions to prepare for the onset of severe weather such as an impending tornado), as applicable. The AP1000 is a passive design and does not rely on offsite or onsite ac sources of power for at least 72 hours after an SBO event, as described above.

Restoration from an SBO event will be contingent upon ac power being made available from any one of the transmission lines described in Section 8.2 or any one of the standby diesel generators.

1.9.5.2.15 Severe Accident Mitigation Design Alternatives

Add the following text to the end of DCD Subsection 1.9.5.2.15.

PTN SUP 1.9-2 FSAR Position:

The severe accident mitigation design alternatives (SAMDA) evaluation for AP1000 contained in DCD Appendix 1B is not incorporated into this FSAR, but is addressed in the COL application Environmental Report.

1.9.5.5 Operational Experience

Add the following paragraph to the end of DCD Subsection 1.9.5.5.

STD COL 1.9-2 Table 1.9-204 lists the Bulletins and Generic Letters addressed by topical discussion in this FSAR. Table 1.9-204 also lists Bulletins and Generic Letters categorized as part of the first un-numbered COL Information Item identified at the end of DCD Table 1.8-2 and listed in Table 1.8-202 as COL Information Item 1.9-2. Table 1.9-204 provides the appropriate FSAR cross-references for the discussion of the topics addressed by those Bulletins and Generic Letters. Bulletins or Generic Letters issued after those listed in the DCD are also included in Table 1.9-204. Issues identified as “procurement” or “maintenance” or “surveillance” in WCAP-15800 are addressed as part of the scope of the certified design and are not specifically identified in Table 1.9-204. Issues identified as “procedural” in WCAP-15800 are addressed by the procedures discussed in DCD Section 13.5 and are not specifically identified in Table 1.9-204. Other items in WCAP-15800, including the Circulars and Information Notices, are considered to have been adequately addressed based on the guidance identified in Regulatory Guide 1.206 and the NRC Standard Review Plans.

1.9.6 REFERENCES

Add the following text to the end of DCD Subsection 1.9.6.

201. Nuclear Management and Resources Council 87-00, *Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors*, Rev. 1, August 1991.

Table 1.9-201 (Sheet 1 of 9)
Regulatory Guide/FSAR Section Cross-References

		Regulatory Guides	FSAR Chapter, Section, or Subsection[a]
STD COL 1.9-1	**Division 1 Regulatory Guides**		
	1.6	Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems (Rev. 0, March 1971)	16 (TS Bases 3.8.1)
	1.7	Control of Combustible Gas Concentrations in Containment (Rev. 3, March 2007)	DCD discussion only; see DCD Table 1.9-1
PTN COL 1.9-1	1.8	Qualification and Training of Personnel for Nuclear Power Plants (Rev. 3, May 2000)	12.1 (NEI 07-08A) Appendix 12AA (NEI 07-03A) 13.1.1.4 13.1.3.1 13.2 (NEI 06-13A) 16 (TS 5.3.1) 17.5 (QAPD, IV)
STD COL 1.9-1	1.11	Instrument Lines Penetrating the Primary Reactor Containment (Rev. 1, March 2010)	DCD discussion only; see DCD Table 1.9-1
	1.12	Nuclear Power Plant Instrumentation for Earthquakes (Rev. 2, March 1997)	3.7.4.1
	1.13	Spent Fuel Storage Facility Design Basis (Rev. 2, March 2007)	16 (TS Bases 3.7.11) 16 (TS Bases 3.7.12)
	1.20	Comprehensive Vibration Assessment Program for Reactor Internals During Preoperational and Initial Startup Testing (Rev. 3, March 2007)	DCD discussion only; see DCD Table 1.9-1
PTN COL 1.9-1	1.21	Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents From Light-Water-Cooled Nuclear Power Plants (Rev.1, June 1974)	2.3.3.1 11.5.1.2 11.5.4.1 11.5.4.2 12.3.4
	1.23	Meteorological Monitoring Programs for Nuclear Power Plants (Rev. 1, March 2007)	2.3.2.1 2.3.3 2.3.3.1 2.3.4.1
STD COL 1.9-1	1.26	Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants (Rev. 4, March 2007)	5.2.4.1 17.5 (QAPD IV)
	1.27	Ultimate Heat Sink for Nuclear Power Plants (Rev. 2, January 1976)	2.4.11.6
PTN COL 1.9-1	1.28	Quality Assurance Program Requirements (Design and Construction) (Rev. 3, August 1985)	14.2.2.2 17.1 17.5 (QAPD, II, 17.1) 17.5 (QAPD, IV)
STD COL 1.9-1	1.29	Seismic Design Classification (Rev. 4, March 2007)	17.5 (QAPD IV)
	1.30	Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electric Equipment (Rev. 0, August 1972)	Not referenced; see Appendix 1AA
	1.31	Control of Ferrite Content in Stainless Steel Weld Metal (Rev. 3, April 1978)	6.1.1.2
	1.32	Criteria for Power Systems for Nuclear Power Plants (Rev. 3, March 2004)	16 (TS Bases 3.8.1)

Table 1.9-201 (Sheet 2 of 9)
Regulatory Guide/FSAR Section Cross-References

	Regulatory Guides		FSAR Chapter, Section, or Subsection[a]
PTN COL 1.9-1	1.33	Quality Assurance Program Requirements (Operation) (Rev. 2, February 1978)	16 (TS 5.4.1) 12.1 (NEI 07-08A) 17.5 (QAPD, IV)
STD COL 1.9-1	1.37	Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants (Rev. 1, March 2007)	17.5 (QAPD IV) 17.5 (QAPD, II, 13.2)
	1.38	Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage and Handling of Items for Water- Cooled Nuclear Power Plants (Rev. 2, May 1977)	DCD discussion only; see DCD Table 1.9-1
	1.39	Housekeeping Requirements for Water- Cooled Nuclear Power Plants (Rev. 2, September 1977)	DCD discussion only; see DCD Table 1.9-1
	1.44	Control of the Use of Sensitized Stainless Steel (Rev. 0, May 1973)	6.1.1.2
	1.45	Reactor Coolant Pressure Boundary Leakage Detection Systems (Rev. 0, May 1973)	16 (TS Bases 3.4.7) 16 (TS Bases 3.4.9)
	1.52	Design, Inspection and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants (Rev. 3, June 2001)	16 (TS 3.7.6)
	1.53	Application of the Single-Failure Criterion to Safety Systems (Rev. 2, November 2003)	DCD discussion only; see DCD Table 1.9-1
	1.54	Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants (Rev. 1, July 2000)	1.9.4.2.3 6.1.2.1.6
	1.57	Design Limits and Loading Combinations for Metal Primary Reactor Containment System Components (Rev. 1, March 2007)	DCD discussion only; see DCD Table 1.9-1
PTN COL 1.9-1	1.59	Design Basis Floods for Nuclear Power Plants (Rev. 2, August 1977)	2.4.5.2.2 2.4.6.5
	1.60	Design Response Spectra for Seismic Design of Nuclear Power Plants (Rev. 1, December 1973)	2.5.2.6.2 Table 2.0-201 Appendix 3JJ.2
STD COL 1.9-1	1.61	Damping Values for Seismic Design of Nuclear Power Plants (Rev. 1, March 2007)	DCD discussion only; see DCD Table 1.9-1
	1.68	Initial Test Program for Water-Cooled Nuclear Power Plants (Rev. 3, March 2007)	14.2.1 14.2.3 14.2.8 14.2.5.2 16 (TS Bases 3.1.8)
PTN COL 1.9-1	1.70	Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition) (Rev. 3, November 1978)	1.1.6.1 2.2.2.7
STD COL 1.9-1	1.71	Welder Qualification for Areas of Limited Accessibility (Rev 1, March 2007)	DCD discussion only; see DCD Table 1.9-1
	1.75	Criteria for Independence of Electrical Safety Systems (Rev 3, February 2005)	DCD discussion only; see DCD Table 1.9-1
PTN COL 1.9-1	1.76	Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants (Rev. 1, March 2007)	Table 2.0-201 2.3.1.3.2
STD COL 1.9-1	1.77	Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized Water Reactors (Rev 0, May 1974)	16 (TS Bases 3.2.1) 16 (TS Bases 3.2.2) 16 (TS Bases 3.2.4) 16 (TS Bases 3.2.5)

Table 1.9-201 (Sheet 3 of 9)
Regulatory Guide/FSAR Section Cross-References

	Regulatory Guides		FSAR Chapter, Section, or Subsection[a]
PTN COL 1.9-1	1.78	Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release (Rev. 1, December 2001)	2.2.3 2.2.3.1.3 2.3.4.4 6.4.3 6.4.4.2 16 (TS Bases 3.7.6)
STD COL 1.9-1	1.82	Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident (Rev. 3, November 2003)	DCD discussion only; see DCD Table 1.9-1
	1.83	Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes (Rev. 1, July 1975)	DCD discussion only; see DCD Table 1.9-1
	1.84	Design, Fabrication, and Materials Code Case Acceptability, ASME Section III (Rev. 33, August 2005)	DCD discussion only; see DCD Table 1.9-1
	1.86	Termination of Operating Licenses for Nuclear Reactors (Rev. 0, June 1974)	Not referenced; see Appendix 1AA
PTN COL 1.9-1	1.91	Evaluations of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plants (Rev. 1, February 1978)	2.2.1 2.2.3 2.2.3.1.1 3.5.1.5
STD COL 1.9-1	1.92	Combining Modal Responses and Spatial Components in Seismic Response Analysis (Rev. 2, July 2006)	DCD discussion only; see DCD Table 1.9-1
	1.93	Availability of Electric Power Sources (Rev. 0, December 1974)	16 (TS Bases 3.8.1) 16 (TS Bases 3.8.5)
	1.94	Quality Assurance Requirements for Installation, Inspection and Testing of Structural Concrete and Structural Steel During the Construction Phase of Nuclear Power Plants (Rev. 1, April 1976)	Not referenced; see Appendix 1AA
	1.97	Criteria For Accident Monitoring Instrumentation For Nuclear Power Plants (Rev. 4, June 2006)	Not referenced; see Appendix 1AA
	1.97	Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Environs Conditions During and Following an Accident (Rev. 3, May 1983)	Table 7.5-201 Appendix 12AA 16 (TS Bases 3.3.3)
	1.99	Radiation Embrittlement of Reactor Vessel Materials (Rev. 2, May 1988)	16 (TS Bases 3.4.3)
	1.101	Emergency Response Planning and Preparedness for Nuclear Power Reactors (Rev. 5, June 2005)	Not referenced; see Appendix 1AA
	1.101	Emergency Planning and Preparedness for Nuclear Power Reactors (Rev. 4, July 2003)	Not referenced; see Appendix 1AA
PTN COL 1.9-1	1.101	Emergency Planning and Preparedness for Nuclear Power Reactors (Rev. 3, August 1992)	9.5.1.8.2.2 Table 9.5-201 13.3 (Emergency Plan App I)
	1.109	Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I (Rev. 1, October 1977)	11.2.3.5 11.3.3.2 11.3.3.4.1 12.4.1.9.3
	1.110	Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors (Draft Rev. 0, March 1976)	11.2.3.5 11.3.3.4.3 11.3.3.4.4
	1.111	Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors (Rev. 1, July 1977)	2.3.3.1.8 2.3.4.2 2.3.5.1

Table 1.9-201 (Sheet 4 of 9)
Regulatory Guide/FSAR Section Cross-References

	Regulatory Guides		FSAR Chapter, Section, or Subsection[(a)]
STD COL 1.9-1	1.112	Calculation of Releases of Radioactive Materials in Gaseous or Liquid Effluents from Light-Water-Cooled Nuclear Power Reactors (Rev. 1, March 2007)	DCD discussion only; see DCD Table 1.9-1
PTN COL 1.9-1	1.113	Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I (Rev. 1, April 1977)	Not referenced; see Appendix 1AA
	1.114	Guidance to Operators at the Controls and to Senior Operators in the Control Room of a Nuclear Power Unit (Rev. 3, October 2008)	13.1.2.1.3.6 13.1.2.1.4
STD COL 1.9-1	1.115	Protection Against Low-Trajectory Turbine Missiles (Rev. 1, July 1977)	3.5.1.3
	1.116	Quality Assurance Requirements for Installation, Inspection, and Testing of Mechanical Equipment and Systems (Rev. 0-R, May 1977)	Not referenced; see Appendix 1AA
	1.121	Bases for Plugging Degraded PWR Steam Generator Tubes (Rev. 0, August 1976)	16 (TS Bases 3.4.18)
	1.124	Service Limits and Loading Combinations for Class 1 Linear-Type Supports (Rev. 2, February 2007)	DCD discussion only; see DCD Table 1.9-1
	1.128	Installation Design and Installation of Vented Lead-Acid Storage Batteries for Nuclear Power Plants (Rev. 2, February 2007)	DCD discussion only; see DCD Table 1.9-1
	1.129	Maintenance, Testing, and Replacement of Vented Lead-Acid Storage Batteries for Nuclear Power Plants (Rev. 2, February 2007)	Table 8.1-201 8.3.2.1.4 16 (TS Bases 3.8.1)
	1.130	Service Limits and Loading Combinations for Class 1 Plate-And-Shell-Type Supports (Rev. 2, March 2007)	DCD discussion only; see DCD Table 1.9-1
PTN COL 1.9-1	1.132	Site Investigations for Foundations of Nuclear Power Plants (Rev. 2, October 2003)	2.5.4.2.2 2.5.4.10.1
STD COL 1.9-1	1.133	Loose-Part Detection Program for the Primary System of Light-Water-Cooled Reactors (Rev. 1, May 1981)	Not referenced; see Appendix 1AA
	1.134	Medical Evaluation of Licensed Personnel at Nuclear Power Plants (Rev. 3, March 1998)	Not referenced; see Appendix 1AA
	1.135	Normal Water Level and Discharge at Nuclear Power Plants (Rev. 0, September 1977)	DCD discussion only; see DCD Table 1.9-1
PTN COL 1.9-1	1.138	Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants (Rev. 2, December 2003)	2.5.4.2.2
STD COL 1.9-1	1.139	Guidance for Residual Heat Removal (Rev. 0, May 1978)	DCD discussion only; see DCD Table 1.9-1
	1.140	Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants (Rev. 2, June 2001)	9.4.1.4 9.4.7.4 16 (TS Bases 3.9.6)
	1.143	Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants (Rev. 2, November 2001)	11.2.1.2.5.2 11.2.3.6 11.3.3.6 11.4.5 11.4.6.2 13.5.2.2.5
PTN COL 1.9-1	1.145	Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants (Rev. 1, November 1982)	2.3.4.2 2.3.5.1

Table 1.9-201 (Sheet 5 of 9)
Regulatory Guide/FSAR Section Cross-References

	Regulatory Guides		FSAR Chapter, Section, or Subsection[(a)]
STD COL 1.9-1	1.147	Inservice Inspection Code Case Acceptability, ASME section XI, Division 1 (Rev. 15, October 2007)	5.2.4 6.6
	1.149	Nuclear Power Plant Simulation Facilities for Use in Operator Training and License Examinations (Rev. 3, October 2001)	13.2 (NEI 06-13A)
	1.150	Ultrasonic Testing of Reactor Vessel Welds During Preservice and Inservice Examinations (Rev. 1, February 1983)	DCD discussion only; see DCD Table 1.9-1
	1.152	Criteria for Use of Computers in Safety Systems of Nuclear Power Plants (Rev. 2, January 2006)	Not referenced; see Appendix 1AA
	1.154	Format and Content of Plant-Specific Pressurized Thermal Shock Safety Analysis Reports for Pressurized Water Reactors (Rev. 0, January 1987)	Not referenced; see Appendix 1AA
PTN COL 1.9-1	1.155	Station Blackout (Rev. 0, August 1998)	Table 8.1-201 17.5 (QAPD III.2)
STD COL 1.9-1	1.159	Assuring the Availability of Funds for Decommissioning Nuclear Reactors (Rev. 1, October 2003)	Not referenced; see Appendix 1AA
	1.160	Monitoring the Effectiveness of Maintenance at Nuclear Power Plants (Rev. 2, March 1997)	3.8.3.7 3.8.4.7 3.8.5.7 17.6 (NEI 07-02A)
	1.162	Format and Content of Report for Thermal Annealing of Reactor Pressure Vessels (Rev. 0, February 1996)	Not referenced; see Appendix 1AA
	1.163	Performance-Based Containment Leak-Test Program (Rev. 0, September 1995)	6.2.5.1 6.2.5.2.2 16 (TS 5.5.8)
PTN COL 1.9-1	1.165	Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion (Rev. 0, March 1997)	2.5.3
STD COL 1.9-1	1.166	Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post Earthquake Actions (Rev. 0, March 1997)	3.7.4.4
	1.167	Restart of a Nuclear Power Plant Shut Down by a Seismic Event (Rev. 0, March 1997)	3.7.4.4
	1.168	Verification, Validation, Reviews, and Audits for Digital Computer Software Used in Safety Systems of Nuclear Power Plants (Rev. 1, February 2004)	DCD discussion only; see DCD Table 1.9-1
	1.174	An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis (Rev. 1, November 2002)	Not referenced; see Appendix 1AA
	1.175	An Approach for Plant-Specific, Risk- Informed Decisionmaking: Inservice Testing (Rev. 0, August 1998)	Not referenced; see Appendix 1AA
	1.177	An Approach for Plant-Specific, Risk- Informed Decisionmaking: Technical Specifications (Rev. 0, August 1998)	16 (TS Bases 3.5.1) 16 (TS Bases 3.7.10)
	1.178	An Approach for Plant-Specific Risk- Informed Decisionmaking for Inservice Inspection of Piping (Rev. 1, September 2003)	Not referenced; see Appendix 1AA
	1.179	Standard Format and Content of License Termination Plans for Nuclear Power Reactors (Rev. 0, January 1999)	Not referenced; see Appendix 1AA

Table 1.9-201 (Sheet 6 of 9) Regulatory Guide/FSAR Section Cross-References

	Regulatory Guides		FSAR Chapter, Section, or Subsection[a]
STD COL 1.9-1	1.180	Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems (Rev. 1, October 2003)	DCD discussion only; see DCD Table 1.9-1
	1.181	Content of Updated Final Safety Analysis Report in Accordance with 10 CFR 50.71(e) (Rev. 0, September 1999)	Not referenced; see Appendix 1AA
	1.182	Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants (Rev. 0, May 2000)	16 (TS Bases SR 3.0.3) 17.6 (NEI 07-02A)
	1.183	Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors (Rev. 0, July 2000)	16 (TS Bases 3.7.5) 16 (TS Bases 3.9.4) 16 (TS Bases 3.9.7)
	1.184	Decommissioning of Nuclear Power Reactors (Rev. 0, July 2000)	Not referenced; see Appendix 1AA
	1.185	Standard Format and Content for Post- shutdown Decommissioning Activities Report (Rev. 0, July 2000)	Not referenced; see Appendix 1AA
	1.186	Guidance and Examples for Identifying 10 CFR 50.2 Design Bases (Rev. 0, December 2000)	Not referenced; see Appendix 1AA
	1.187	Guidance for Implementation of 10 CFR 50.59, Changes, Tests, and Experiment (Rev. 0, November 2000)	Not referenced; see Appendix 1AA
	1.188	Standard Format and Content for Applications To Renew Nuclear Power Plant Operating Licenses (Rev. 1, September 2005)	Not referenced; see Appendix 1AA
PTN COL 1.9-1	1.189	Fire Protection for Nuclear Power Plants (Rev. 1, March 2007)	9.5.1.8.1.1 9.5.1.8.2.2 13.1.2.1.3.9 17.5 (QAPD III.2)
STD COL 1.9-1	1.191	Fire Protection Program for Nuclear Power Plants During Decommissioning and Permanent Shutdown (Rev. 0, May 2001)	Not referenced; see Appendix 1AA
	1.192	Operation and Maintenance Code Case Acceptability, ASME OM Code (Rev. 0, June 2003)	3.9.6.3
	1.193	ASME Code Cases Not Approved for Use (Rev 1, August 2005)	Not referenced; see Appendix 1AA
	1.194	Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants (Rev. 0, June 2003)	2.3.4.3
	1.195	Methods and Assumptions for Evaluating Radiological Consequences of Design Basis Accidents at Light-Water Nuclear Power Reactors (Rev. 0, May 2003)	Not referenced; see Appendix 1AA
	1.196	Control Room Habitability at Light-Water Nuclear Power Reactors (Rev. 1, January 2007)	6.4.3
	1.197	Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors (Rev. 0, May 2003)	DCD discussion only; see DCD Table 1.9-1
PTN COL 1.9-1	1.198	Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites (Rev. 0, November 2003)	2.5.4.8 2.5.4.1.1
STD COL 1.9-1	1.199	Anchoring Components and Structural Supports in Concrete (Rev. 0, November 2003)	DCD discussion only; see DCD Table 1.9-1
	1.200	An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities (Rev. 1, January 2007)	19.59.10.6

Table 1.9-201 (Sheet 7 of 9)
Regulatory Guide/FSAR Section Cross-References

	Regulatory Guides		FSAR Chapter, Section, or Subsection[(a)]
STD COL 1.9-1	1.201	Guidelines for Categorizing Structures, Systems, and Components in Nuclear Power Plants According to Their Safety Significance (Rev. 1, May 2006)	Not referenced; see Appendix 1AA
	1.202	Standard Format and Content of Decommissioning Cost Estimates for Nuclear Power Reactors (Rev. 0, February 2005)	Not referenced; see Appendix 1AA
	1.203	Transient and Accident Analysis Methods (Rev. 0, December 2005)	Not referenced; see Appendix 1AA
	1.204	Guidelines for Lightning Protection of Nuclear Power Plants (Rev. 0, November 2005)	Table 8.1-201
	1.205	Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants (Rev. 0, May 2006)	Not referenced; see Appendix 1AA
PTN COL 1.9-1	1.206	Combined License Applications for Nuclear Power Plants (LWR Edition) (Rev. 0, June 2007)	See Appendix 1AA 1.1.6.1 1.9.5.5 2.1 2.1.3.6 2.2 2.2.1 2.2.2 2.2.2.1 2.2.2.2 2.2.2.7 2.2.3 2.2.3.1 2.2.3.1.4 2.3.5.1 2.4 2.5 2.5.0.1 2.5.1 2.5.2.1.2 2.5.4 2.5.5 3.5.1.6 Table 8.1-201 12.1 (NEI 07-08A) Appendix 12AA (NEI 07-03A) 14.3.2.3.1 14.3.2.3.2 17.6 (NEI 07-02A)
STD COL 1.9-1	1.207	Guidelines for Evaluating Fatigue Analyses Incorporating the Life Reduction of Metal Components Due to the Effects of the Light-Water Reactor Environment for New Reactors (Rev. 0, March 2007)	Not referenced; see Appendix 1AA
PTN COL 1.9-1	1.208	A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion (Rev. 0, March 2007)	2.0 2.5 2.5.1 2.5.2 2.5.3 3.7.1.1.1 Appendix 3JJ.2

Table 1.9-201 (Sheet 8 of 9)
Regulatory Guide/FSAR Section Cross-References

	Regulatory Guides		FSAR Chapter, Section, or Subsection[a]
STD COL 1.9-1	1.209	Guidelines for Environmental Qualification of Safety-Related Computer-Based Instrumentation and Control Systems in Nuclear Power Plants (Rev. 0, March 2007)	Not referenced; see Appendix 1AA
PTN COL 1.9-1	1.210	Qualification of Safety-Related Battery Chargers and Inverters for Nuclear Power Plants (Rev. 0, June 2008)	Not referenced; see Appendix 1AA
	1.212	Sizing of Large Lead-Acid Storage Batteries (Rev. 0, November 2008)	Not referenced; see Appendix 1AA
	1.221	Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants (Rev. 0, October 2011)	2.3.1.3.1 3.3.2.1 3.5.1.4 3.5.2
	Division 4 Regulatory Guides		
	4.7	General Site Suitability Criteria for Nuclear Power Stations (Rev. 2, April 1998)	2.1.3.6 2.2.1 2.2.2.7 2.2.3
	4.15	Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) - Effluent Streams and the Environment (Rev. 2, July 2007)	11.5.1.2 11.5.3 11.5.4 11.5.6.5
	4.21	Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning (Rev. 0, June 2008)	2.4.12.4
STD COL 1.9-1	**Division 5 Regulatory Guides**		Note[b]
	Division 8 Regulatory Guides		
	8.2	Guide for Administrative Practices in Radiation Monitoring (Rev. 0, February 1973)	12.1 (NEI 07-08A) 12.3.4 Appendix 12AA (NEI 07-03A)
	8.4	Direct-Reading and Indirect-Reading Pocket Dosimeters (Rev. 0, February 1973)	Appendix 12AA (NEI 07-03A)
	8.5	Criticality and Other Interior Evacuation Signals (Rev. 1, March 1981)	Appendix 12AA (NEI 07-03A)
	8.6	Standard Test Procedure for Geiger-Muller Counters (Rev. 0, May 1973)	Appendix 12AA (NEI 07-03A)
	8.7	Instructions for Recording and Reporting Occupational Radiation Exposure Data (Rev. 2, November 2005)	12.1 (NEI 07-08A) Appendix 12AA (NEI 07-03A)
PTN COL 1.9-1	8.8	Information Relevant to Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable (Rev. 3, June 1978)	12.1 (NEI 07-08A) 12.3.4 Appendix 12AA Appendix 12AA (NEI 07-03A) 13.1.2.1.2.6
STD COL 1.9-1	8.9	Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program (Rev. 1, July 1993)	12.1 (NEI 07-08A) Appendix 12AA (NEI 07-03A)

Table 1.9-201 (Sheet 9 of 9)
Regulatory Guide/FSAR Section Cross-References

	Regulatory Guides		FSAR Chapter, Section, or Subsection(a)
PTN COL 1.9-1	8.10	Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable (Rev. 1-R, May 1977)	12.1 (NEI 07-08A) 12.3.4 Appendix 12AA Appendix 12AA (NEI 07-03A) 13.1.2.1.2.6
	8.13	Instruction Concerning Prenatal Radiation Exposure (Rev. 3, June 1999)	12.1 (NEI 07-08A) Appendix 12AA (NEI 07-03A) 13.2 (NEI 06-13A)
STD COL 1.9-1	8.15	Acceptable Programs for Respiratory Protection (Rev. 1, October 1999)	12.1 (NEI 07-08A) Appendix 12AA (NEI 07-03A)
	8.27	Radiation Protection Training for Personnel at Light-Water-Cooled Nuclear Power Plants (Rev. 0, March 1981)	12.1 (NEI 07-08A) Appendix 12AA (NEI 07-03A)
	8.28	Audible-Alarm Dosimeters (Rev. 0, August 1981)	12.1 (NEI 07-08A) Appendix 12AA (NEI 07-03A)
	8.29	Instruction Concerning Risks from Occupational Radiation Exposure (Rev. 1, February 1996)	12.1 (NEI 07-08A) Appendix 12AA (NEI 07-03A)
	8.34	Monitoring Criteria and Methods To Calculate Occupational Radiation Doses (Rev. 0, July 1992)	12.1 (NEI 07-08A) Appendix 12AA (NEI 07-03A)
	8.35	Planned Special Exposures (Rev. 0, June 1992)	12.1 (NEI 07-08A) Appendix 12AA (NEI 07-03A)
	8.36	Radiation Dose to the Embryo/Fetus (Rev. 0, July 1992)	12.1 (NEI 07-08A) Appendix 12AA (NEI 07-03A)
	8.38	Control of Access to High and Very High Radiation Areas of Nuclear Plants (Rev. 1, May 2006)	12.1 (NEI 07-08A) Appendix 12AA Table 12AA-201 Appendix 12AA (NEI 07-03A)

(a) NEI templates are incorporated by reference. See Table 1.6-201.
(b) Division 5 of the regulatory guides applies to materials and plant protection. As appropriate, the Division 5 regulatory guide topics are addressed in the DCD and plant-specific security plans (i.e., Physical Security Plan, Training and Qualification Plan, Safeguards Contingency Plan, and Cyber Security Plan).

Table 1.9-202 (Sheet 1 of 19)[a]
Conformance with SRP Acceptance Criteria

		Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
PTN SUP 1.9-1	1	Introduction and Interfaces, Rev. 1, 11/2007		N/A	No specific acceptance criteria associated with these general requirements.
STD SUP 1.9-1	2.0	Site Characteristics and Site Parameters, Initial Issuance, 03/2007		N/A	No specific acceptance criteria are identified.
	2.1.1	Site Location and Description		Acceptable	
	2.1.2	Exclusion Area Authority and Control		Acceptable	
PTN SUP 1.9-1	2.1.3	Population Distribution		Acceptable	
STD SUP 1.9-1	2.2.1–2.2.2	Identification of Potential Hazards in Site Vicinity		Acceptable	
	2.2.3	Evaluation of Potential Accidents		Acceptable	
	2.3.1	Regional Climatology		Acceptable	
	2.3.2	Local Meteorology		Acceptable	
PTN SUP 1.9-1	2.3.3	Onsite Meteorological Measurements Programs		Exception	Atmospheric moisture measurements are presently not taken for Units 3 & 4.
STD SUP 1.9-1	2.3.4	Short-Term Atmospheric Dispersion Estimates for Accident Releases		Acceptable	
	2.3.5	Long-Term Atmospheric Dispersion Estimates for Routine Releases		Acceptable	
	2.4.1	Hydrologic Description		Acceptable	
	2.4.2	Floods, Rev. 4, 03/2007		Acceptable	
PTN SUP 1.9-1	2.4.3	Probable Maximum Flood (PMF) on Streams and Rivers, Rev. 4, 03/2007		Exception	There are no streams and rivers near Units 6 & 7.
	2.4.4	Potential Dam Failures		Exception	There are no upstream or downstream dams that could affect Units 6 & 7.
STD SUP 1.9-1	2.4.5	Probable Maximum Surge and Seiche Flooding		Acceptable	

Table 1.9-202 (Sheet 2 of 19)[a]
Conformance with SRP Acceptance Criteria

		Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
STD SUP 1.9-1	2.4.6	Probable Maximum Tsunami Hazards		Acceptable	
	2.4.7	Ice Effects		Acceptable	
	2.4.8	Cooling Water Canals and Reservoirs		Acceptable	
	2.4.9	Channel Diversions		Acceptable	
	2.4.10	Flooding Protection Requirements		Acceptable	
	2.4.11	Low Water Considerations		Acceptable	
	2.4.12	Groundwater		Acceptable	
	2.4.13	Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters		Acceptable	
	2.4.14	Technical Specifications and Emergency Operation Requirements		Acceptable	
	2.5.1	Basic Geologic and Seismic Information, Rev. 4, 03/2007		Acceptable	
PTN SUP 1.9-1	2.5.2	Vibratory Ground Motion, Rev. 4, 03/2007		Acceptable	
STD SUP 1.9-1	2.5.3	Surface Faulting, Rev. 4, 03/2007		Acceptable	
	2.5.4	Stability of Subsurface Materials and Foundations		Acceptable	
	2.5.5	Stability of Slopes System		Acceptable	
	3.2.1	Seismic Classification, Rev. 2, 03/2007			See Notes [d] and [e].
	3.2.2	System Quality Group Classification, Rev. 2, 03/2007			See Notes [d] and [e].
	3.3.1	Wind Loadings		Acceptable	See Notes [d], [e], and [f].
	3.3.2	Tornado Loadings		Acceptable	See Notes [d], [e], and [f].
	3.4.1	Internal Flood Protection for Onsite Equipment Failures		Acceptable	See Notes [d], [e], and [f].
	3.4.2	Analysis Procedures			See Notes [d] and [e].

Table 1.9-202 (Sheet 3 of 19)[a]
Conformance with SRP Acceptance Criteria

STD SUP 1.9-1

	Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
3.5.1.1	Internally Generated Missiles (Outside Containment)			See Notes [d] and [e].
3.5.1.2	Internally Generated Missiles (Inside Containment)			See Notes [d] and [e].
3.5.1.3	Turbine Missiles		Acceptable	See Notes [d], [e], and [f].
3.5.1.4	Missiles Generated by Tornadoes and Extreme Winds			See Notes [d] and [e].
3.5.1.5	Site Proximity Missiles (Except Aircraft), Rev. 4, 03/2007		Acceptable	See Notes [d], [e], and [f].
3.5.1.6	Aircraft Hazards		Acceptable	See Notes [d], [e], and [f]. Aircraft hazard event probability is consistent with SRP 2.2.3, Rev. 3, Technical Rationale 2.
3.5.2	Structures, Systems, and Components to be Protected from Externally-Generated Missiles			See Notes [d] and [e].
3.5.3	Barrier Design Procedures			See Notes [d] and [e].
3.6.1	Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment			See Notes [d] and [e].
3.6.2	Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping, Rev. 2, 03/2007		Acceptable	See Notes [d], [e], and [f].
3.6.3	Leak-Before-Break Evaluation Procedures, Rev. 1, 03/2007		Acceptable	See Notes [d], [e], and [f].
3.7.1	Seismic Design Parameters			See Notes [d] and [e].
3.7.2	Seismic System Analysis		Acceptable	See Notes [d], [e], and [f].
3.7.3	Seismic Subsystem Analysis			See Notes [d] and [e].
3.7.4	Seismic Instrumentation, Rev. 2, 03/2007		Acceptable	See Notes [d], [e], and [f].
3.8.1	Concrete Containment, Rev. 2, 03/2007			See Notes [d] and [e].
3.8.2	Steel Containment, Rev. 2, 03/2007			See Notes [d] and [e].

Table 1.9-202 (Sheet 4 of 19)[a]
Conformance with SRP Acceptance Criteria

STD SUP 1.9-1

	Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
3.8.3	Concrete and Steel Internal Structures of Steel or Concrete Containments, Rev. 2, 03/2007			See Notes [d] and [e].
3.8.4	Other Seismic Category I Structures, Rev. 2, 03/2007			See Notes [d] and [e].
3.8.5	Foundations, Rev. 2, 03/2007		Acceptable	See Notes [d], [e], and [f].
3.9.1	Special Topics for Mechanical Components			See Notes [d] and [e].
3.9.2	Dynamic Testing and Analysis of Systems, Structures, and Components			See Notes [d] and [e].
3.9.3	ASME Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures, Rev. 2, 03/2007		Acceptable	See Notes [d], [e], and [f].
3.9.4	Control Rod Drive Systems			See Notes [d] and [e].
3.9.5	Reactor Pressure Vessel Internals			See Notes [d] and [e].
3.9.6	Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints		Acceptable	See Notes [d], [e], and [f].
3.9.7	Risk-Informed Inservice Testing, Rev. 0, 08/1998		N/A	
3.9.8	Risk-Informed Inservice Inspection of Piping, Rev. 0, 09/2003		N/A	
3.10	Seismic and Dynamic Qualification of Mechanical and Electrical Equipment			See Notes [d] and [e].
3.11	Environmental Qualification of Mechanical and Electrical Equipment		Acceptable	See Notes [d], [e], and [f].
3.12	ASME Code Class 1, 2, and 3 Piping Systems, Piping Components and their Associated Supports, Initial Issuance, 03/2007			See Note [g].
3.13	Threaded Fasteners - ASME Code Class 1, 2, and 3, Initial Issuance, 03/2007			See Note [g].
4.2	Fuel System Design			See Notes [d] and [e].

Table 1.9-202 (Sheet 5 of 19)[a]
Conformance with SRP Acceptance Criteria

STD SUP 1.9-1

	Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
4.3	Nuclear Design			See Notes [d] and [e].
4.4	Thermal and Hydraulic Design, Rev. 2, 03/2007		Acceptable	See Notes [d], [e], and [f].
4.5.1	Control Rod Drive Structural Materials			See Notes [d] and [e].
4.5.2	Reactor Internal and Core Support Structure Materials			See Notes [d] and [e].
4.6	Functional Design of Control Rod Drive System, Rev. 2, 03/2007			See Notes [d] and [e].
5.2.1.1	Compliance with the Codes and Standards Rule, 10 CFR 50.55a		Acceptable	See Notes [d], [e], and [f].
5.2.1.2	Applicable Code Cases			See Notes [d] and [e].
5.2.2	Overpressure Protection			See Notes [d] and [e].
5.2.3	Reactor Coolant Pressure Boundary Materials		Acceptable	See Notes [d], [e], and [f].
5.2.4	Reactor Coolant Pressure Boundary Inservice Inspection and Testing, Rev. 2, 03/2007		Acceptable	See Notes [d], [e], and [f].
5.2.5	Reactor Coolant Pressure Boundary Leakage Detection, Rev. 2, 03/2007			See Notes [d] and [e].
5.3.1	Reactor Vessel Materials, Rev. 2, 03/2007			See Notes [d] and [e].
5.3.2	Pressure-Temperature Limits, Upper-Shelf Energy, and Pressurized Thermal Shock, Rev. 2, 03/2007		Acceptable	See Notes [d], [e], and [f].
5.3.3	Reactor Vessel Integrity, Rev. 2, 03/2007		Acceptable	See Notes [d], [e], and [f].
5.4	Reactor Coolant System Component and Subsystem Design, Rev. 2, 03/2007		N/A	No specific acceptance criteria associated with these general requirements.
5.4.1.1	Pump Flywheel Integrity (PWR), Rev. 2, 03/2007			See Notes [d] and [e].
5.4.2.1	Steam Generator Materials			See Notes [d] and [e].
5.4.2.2	Steam Generator Program, Rev. 2, 03/2007		Acceptable	See Notes [d], [e], and [f].

Table 1.9-202 (Sheet 6 of 19)[a]
Conformance with SRP Acceptance Criteria

STD SUP 1.9-1

	Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
5.4.6	Reactor Core Isolation Cooling System (BWR), Rev. 4, 03/2007		N/A	
5.4.7	Residual Heat Removal (RHR) System, Rev. 4, 03/2007			See Notes [d] and [e].
5.4.8	Reactor Water Cleanup System (BWR)		N/A	
5.4.11	Pressurizer Relief Tank			See Notes [d] and [e].
5.4.12	Reactor Coolant System High Point Vents, Rev. 1, 03/2007			See Notes [d] and [e].
5.4.13	Isolation Condenser System (BWR), Initial Issuance, 03/2007		N/A	
6.1.1	Engineered Safety Features Materials, Rev. 2, 03/2007		Acceptable	See Notes [d], [e], and [f].
6.1.2	Protective Coating Systems (Paints) - Organic Materials		Acceptable	See Notes [d], [e], and [f].
6.2.1	Containment Functional Design			See Notes [d] and [e].
6.2.1.1.A	PWR Dry Containments, Including Subatmospheric Containments			See Notes [d] and [e].
6.2.1.1.B	Ice Condenser Containments, Rev. 2, 07/1981		N/A	
6.2.1.1.C	Pressure-Suppression Type BWR Containments, Rev. 7, 03/2007		N/A	
6.2.1.2	Subcompartment Analysis			See Notes [d] and [e].
6.2.1.3	Mass and Energy Release Analysis for Postulated Loss-of-Coolant Accidents (LOCAs)			See Notes [d] and [e].
6.2.1.4	Mass and Energy Release Analysis for Postulated Secondary System Pipe Ruptures, Rev. 2, 03/2007			See Notes [d] and [e].
6.2.1.5	Minimum Containment Pressure Analysis for Emergency Core Cooling System Performance Capability Studies			See Notes [d] and [e].

Table 1.9-202 (Sheet 7 of 19)[a]
Conformance with SRP Acceptance Criteria

STD SUP 1.9-1

	Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
6.2.2	Containment Heat Removal Systems, Rev. 5, 03/2007			See Notes [d] and [e].
6.2.3	Secondary Containment Functional Design			See Notes [d] and [e].
6.2.4	Containment Isolation System			See Notes [d] and [e].
6.2.5	Combustible Gas Control in Containment		Acceptable	See Notes [d], [e], and [f].
6.2.6	Containment Leakage Testing		Acceptable	See Notes [d], [e], and [f].
6.2.7	Fracture Prevention of Containment Pressure Boundary, Rev. 1, 03/2007			See Notes [d] and [e].
6.3	Emergency Core Cooling System		Acceptable	See Notes [d], [e], and [f].
6.4	Control Room Habitability System		Acceptable	See Notes [d], [e], and [f].
6.5.1	ESF Atmosphere Cleanup Systems			See Notes [d] and [e].
6.5.2	Containment Spray as a Fission Product Cleanup System, Rev. 4, 03/2007			See Notes [d] and [e].
6.5.3	Fission Product Control Systems and Structures			See Notes [d] and [e].
6.5.4	Ice Condenser as a Fission Product Cleanup System, Rev. 3, 12/1988		N/A	
6.5.5	Pressure Suppression Pool as a Fission Product Cleanup System, Rev. 1, 03/2007		N/A	
6.6	Inservice Inspection and Testing of Class 2 and 3 Components, Rev. 2, 03/2007		Acceptable	See Notes [d], [e], and [f].
6.7	Main Steam Isolation Valve Leakage Control System (BWR), Rev. 2, 07/1981		N/A	
7	Instrumentation and Controls — Overview of Review Process, Rev. 5, 03/2007			See Notes [d] and [e].
Appendix 7.0-A	Review Process for Digital Instrumentation and Control Systems, Rev. 5, 03/2007			See Notes [d] and [e].

Table 1.9-202 (Sheet 8 of 19)[a]
Conformance with SRP Acceptance Criteria

STD SUP 1.9-1

	Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
7.1	Instrumentation and Controls — Introduction, Rev. 5, 03/2007			See Notes [d] and [e].
7.1-T Table 7-1	Regulatory Requirements, Acceptance Criteria, and Guidelines for Instrumentation and Control Systems Important to Safety, Rev. 5, 03/2007			See Notes [d] and [e].
Appendix 7.1-A	Acceptance Criteria and Guidelines for Instrumentation and Controls Systems Important to Safety, Rev. 5, 03/2007			See Notes [d] and [e].
Appendix 7.1-B	Guidance for Evaluation of Conformance to IEEE Std 279, Rev. 5, 03/2007			See Notes [d] and [e].
Appendix 7.1-C	Guidance for Evaluation of Conformance to IEEE Std 603, Rev. 5, 03/2007			See Notes [d] and [e].
Appendix 7.1-D	Guidance for Evaluation of the Application of IEEE Std 7-4.3.2 Initial Issuance 03/2007			See Notes [d] and [e].
7.2	Reactor Trip System, Rev. 5, 03/2007			See Notes [d] and [e].
7.3	Engineered Safety Features Systems, Rev. 5, 03/2007			See Notes [d] and [e].
7.4	Safe Shutdown Systems, Rev. 5, 03/2007			See Notes [d] and [e].
7.5	Information Systems Important to Safety, Rev. 5, 03/2007			See Notes [d] and [e].
7.6	Interlock Systems Important to Safety, Rev. 5, 03/2007			See Notes [d] and [e].
7.7	Control Systems, Rev. 5, 03/2007			See Notes [d] and [e].
7.8	Diverse Instrumentation and Control Systems, Rev. 5, 03/2007			See Notes [d] and [e].
7.9	Data Communication Systems, Rev. 5, 03/2007			See Notes [d] and [e].
8.1	Electric Power — Introduction		N/A	No specific acceptance criteria associated with these general requirements.

Table 1.9-202 (Sheet 9 of 19)[a]
Conformance with SRP Acceptance Criteria

STD SUP 1.9-1

	Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
8.2	Offsite Power System, Rev. 4, 03/2007		Acceptable	See Notes [d], [e], and [f].
8.3.1	A-C Power Systems (Onsite)		Acceptable	See Notes [d], [e], and [f].
8.3.2	D-C Power Systems (Onsite)		Acceptable	See Notes [d], [e], and [f].
8.4	Station Blackout, Initial Issuance, 03/2007			See Note [g].
9.1.1	Criticality Safety of Fresh and Spent Fuel Storage and Handling			See Notes [d] and [e].
9.1.2	New and Spent Fuel Storage, Rev. 4, 03/2007			See Notes [d] and [e].
9.1.3	Spent Fuel Pool Cooling and Cleanup System, Rev. 2, 03/2007			See Notes [d] and [e].
9.1.4	Light Load Handling System (Related to Refueling)		Acceptable	See Notes [d], [e], and [f].
9.1.5	Overhead Heavy Load Handling Systems, Rev. 1, 03/2007		Acceptable	See Notes [d], [e], and [f].
9.2.1	Station Service Water System, Rev. 5, 03/2007		Acceptable	See Notes [d], [e], and [f].
9.2.2	Reactor Auxiliary Cooling Water Systems, Rev. 4, 03/2007			See Notes [d] and [e].
9.2.4	Potable and Sanitary Water Systems			See Notes [d] and [e].
9.2.5	Ultimate Heat Sink		Acceptable	See Notes [d], [e], and [f].
9.2.6	Condensate Storage Facilities		Acceptable	See Notes [d], [e], and [f].
9.3.1	Compressed Air System, Rev. 2, 03/2007		Acceptable	See Notes [d], [e], and [f].
9.3.2	Process and Post-accident Sampling Systems			See Notes [d] and [e].
9.3.3	Equipment and Floor Drainage System			See Notes [d] and [e].
9.3.4	Chemical and Volume Control System (PWR) (Including Boron Recovery System)			See Notes [d] and [e].
9.3.5	Standby Liquid Control System (BWR)		N/A	
9.4.1	Control Room Area Ventilation System		Acceptable	See Notes [d], [e], and [f].

Table 1.9-202 (Sheet 10 of 19)[a]
Conformance with SRP Acceptance Criteria

STD SUP 1.9-1

	Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
9.4.2	Spent Fuel Pool Area Ventilation System			See Notes (d) and (e).
9.4.3	Auxiliary and Radwaste Area Ventilation System			See Notes (d) and (e).
9.4.4	Turbine Area Ventilation System			See Notes (d) and (e).
9.4.5	Engineered Safety Feature Ventilation System			See Notes (d) and (e).
9.5.1	Fire Protection Program, Rev. 5, 03/2007		Acceptable	See Notes (d), (e), and (f).
9.5.2	Communications Systems		Acceptable	See Notes (d), (e), and (f).
9.5.3	Lighting Systems			See Notes (d) and (e).
9.5.4	Emergency Diesel Engine Fuel Oil Storage and Transfer System		Acceptable	See Notes (d), (e), and (f).
9.5.5	Emergency Diesel Engine Cooling Water System			See Notes (d) and (e).
9.5.6	Emergency Diesel Engine Starting System			See Notes (d) and (e).
9.5.7	Emergency Diesel Engine Lubrication System			See Notes (d) and (e).
9.5.8	Emergency Diesel Engine Combustion Air Intake and Exhaust System			See Notes (d) and (e).
10.2	Turbine Generator		Acceptable	See Notes (d), (e), and (f).
10.2.3	Turbine Rotor Integrity, Rev. 2, 03/2007		Acceptable	See Notes (d), (e), and (f).
10.3	Main Steam Supply System, Rev. 4, 03/2007		Acceptable	See Notes (d), (e), and (f).
10.3.6	Steam and Feedwater System Materials		Acceptable	See Notes (d), (e), and (f).
10.4.1	Main Condensers			See Notes (d) and (e).
10.4.2	Main Condenser Evacuation System		Acceptable	See Notes (d), (e), and (f).
10.4.3	Turbine Gland Sealing System			See Notes (d) and (e).
10.4.4	Turbine Bypass System			See Notes (d) and (e).
10.4.5	Circulating Water System		Acceptable	See Notes (d), (e), and (f).

Table 1.9-202 (Sheet 11 of 19)[a]
Conformance with SRP Acceptance Criteria

STD SUP 1.9-1

	Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
10.4.6	Condensate Cleanup System			See Notes [d] and [e].
10.4.7	Condensate and Feedwater System, Rev. 4, 03/2007		Acceptable	See Notes [d], [e], and [f].
10.4.8	Steam Generator Blowdown System (PWR)			See Notes [d] and [e].
10.4.9	Auxiliary Feedwater System (PWR)			See Notes [d] and [e].
11.1	Source Terms			See Notes [d] and [e].
11.2	Liquid Waste Management System		Acceptable	See Notes [d], [e], and [f].
11.3	Gaseous Waste Management System		Acceptable	See Notes [d], [e], and [f].
11.4	Solid Waste Management System		Acceptable	See Notes [d], [e], and [f].
11.5	Process and Effluent Radiological Monitoring Instrumentation and Sampling Systems, Rev. 4, 03/2007		Acceptable	See Notes [d], [e], and [f].
12.1	Assuring that Occupational Radiation Exposures Are As Low As Is Reasonably Achievable		Exception	See Notes [d], [e], and [f]. An exception is taken to following the guidance of RG 1.206 to address RG 8.20, 8.25, and RG 8.26. NUREG-1736, Final Report (published 2001) lists RG 8.20 and RG 8.26 as “outdated” and recommends the methods of RG 8.9 R1. RG 8.25 states it is not applicable to nuclear facilities licensed under 10 CFR Part 50, and, by extension, to 10 CFR Part 52. An exception is taken to RG 8.8, C.3.b. RG 1.16, C.1.b (3) data is no longer reported. Reporting per C.1.b (2) is also no longer required.

Table 1.9-202 (Sheet 12 of 19)[a]
Conformance with SRP Acceptance Criteria

		Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
STD SUP 1.9-1	12.2	Radiation Sources		Exception	See Notes [d], [e], and [f]. A general description of miscellaneous sealed sources related to radiography is provided in FSAR text. Other requested details are maintained on-site for NRC review and audit upon their procurement.
	12.3–12.4	Radiation Protection Design Features		Acceptable	See Notes [d], [e], and [f].
	12.5	Operational Radiation Protection Program		Acceptable	See Notes [d], [e], and [f].
PTN SUP 1.9-1	13.1.1	Management and Technical Support Organization, Rev. 5, 03/2007		Exception	See Notes [d], [e], and [f]. Design and construction responsibilities are not defined in numbers. The experience requirements of corporate staff are set by corporate policy and not provided here in detail, however the experience level of the corporate staff, as discussed in Subsections 13.1.1, 13.1.1.1, and Appendix 13AA, in the area of nuclear plant development, construction, and management establishes that the applicant has the necessary capability and staff to ensure that design and construction of the facility will be performed in an acceptable manner. Resumes and/or other documentation of qualification and experience of initial appointees to appropriate management and supervisory positions are available for NRC after position vacancies are filled.

Table 1.9-202 (Sheet 13 of 19)[a] Conformance with SRP Acceptance Criteria

		Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
STD SUP 1.9-1	13.1.2–13.1.3	Operating Organization, Rev. 6, 03/2007		Exception	See Notes [d], [e], and [f]. The SRP requires resumes of personnel holding plant managerial and supervisory positions to be included in the FSAR. Current industry practice is to have the resumes available for review by the regulator when requested but not be kept in the FSAR. Additionally, at time of COLA, most positions are unfilled.
	13.2.1	Reactor Operator Requalification Program; Reactor Operator Training		Exception	See Notes [d], [e], and [f]. SRP requires meeting the guidance of NUREG-0711. NEI 06-13A, Technical Report on a Template for an Industry Training Program Description, which is incorporated by reference in FSAR Section 13.2, does not address meeting the guidance of NUREG-0711. NEI 06-13A, is approved by NRC to meet the regulatory requirements for the FSAR description of the Training Program. SRP requires meeting the guidance of Regulatory Guide 1.149, “Nuclear Power Plant Simulation Facilities for Use in Operator Training and License Examinations” RG 1.149 is not addressed in NEI 06-13A. Level of detail is consistent with NEI 06-13A.
	13.2.2	Non-Licensed Plant Staff Training		Exception	See Notes [d], [e], and [f]. Level of detail is consistent with NEI 06-13A.
	13.3	Emergency Planning		Acceptable	See Notes [d], [e], and [f].

Table 1.9-202 (Sheet 14 of 19)[a]
Conformance with SRP Acceptance Criteria

		Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
STD SUP 1.9-1	13.4	Operational Programs		Acceptable	See Notes [d], [e], and [f].
	13.5.1.1	Administrative Procedures — General, Initial Issuance, 03/2007		Exception	The procedure development schedule is addressed in the COL application (not in the SAR as requested by this SRP).
	13.5.2.1	Operating and Emergency Operating Procedures, Rev. 2, 03/2007		Exception	See Notes [d], [e], and [f]. Procedures are generally identified in this section by topic, type, or classification in lieu of the specific title and represent general areas of procedural coverage.
	13.6	Physical Security		Acceptable	See Security Plan developed in accordance with NEI 03-12.
	13.6.1	Physical Security — Combined License Review Responsibilities, Initial Issuance, 03/2007		Acceptable	See Security Plan developed in accordance with NEI 03-12.
	13.6.2	Physical Security — Design Certification, Initial Issuance, 03/2007			See Notes [d] and [e].
	13.6.3	Physical Security — Early Site Permit, Initial Issuance, 03/2007		N/A	
	14.2	Initial Plant Test Program — Design Certification and New License Applicants		Exception	See Notes [d], [e], and [f]. The level of detail is consistent with DCD section content addressing nonsafety-related systems.
	14.2.1	Generic Guidelines for Extended Power Uprate Testing Programs, Initial Issuance, 08/2006		N/A	No power uprate is sought.
	14.3	Inspections, Tests, Analyses, and Acceptance Criteria, Initial Issuance, 03/2007		Acceptable	
	14.3.1	[Reserved]			

Table 1.9-202 (Sheet 15 of 19)[a]
Conformance with SRP Acceptance Criteria

STD SUP 1.9-1

	Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
14.3.2	Structural and Systems Engineering — Inspections, Tests, Analyses, and Acceptance Criteria, Initial Issuance, 03/2007			See Notes [d] and [e].
14.3.3	Piping Systems and Components — Inspections, Tests, Analyses, and Acceptance Criteria, Initial Issuance, 03/2007			See Notes [d] and [e].
14.3.4	Reactor Systems — Inspections, Tests, Analyses, and Acceptance Criteria, Initial Issuance, 03/2007			See Notes [d] and [e].
14.3.5	Instrumentation and Controls — Inspections, Tests, Analyses, and Acceptance Criteria, Initial Issuance, 03/2007			See Notes [d] and [e].
14.3.6	Electrical Systems — Inspections, Tests, Analyses, and Acceptance Criteria, Initial Issuance, 03/2007			See Notes [d] and [e].
14.3.7	Plant Systems — Inspections, Tests, Analyses, and Acceptance Criteria, Initial Issuance, 03/2007		Acceptable	See Notes [d], [e], and [f].
14.3.8	Radiation Protection — Inspections, Tests, Analyses, and Acceptance Criteria, Initial Issuance, 03/2007			See Notes [d] and [e].
14.3.9	Human Factors Engineering - Inspections, Tests, Analyses, and Acceptance Criteria, Initial Issuance, 03/2007			See Notes [d] and [e].
14.3.10	Emergency Planning — Inspections, Tests, Analyses, and Acceptance Criteria, Initial Issuance, 03/2007		Acceptable	See Notes [d], [e], and [f].
14.3.11	Containment Systems — Inspections, Tests, Analyses, and Acceptance Criteria, Initial Issuance, 03/2007			See Notes [d] and [e].
14.3.12	Physical Security Hardware — Inspections, Tests, Analyses, and Acceptance Criteria, Initial Issuance, 03/2007		Acceptable	See Notes [d], [e], and [f].
15	Introduction — Transient and Accident Analysis			See Notes [d] and [e].

Table 1.9-202 (Sheet 16 of 19)[a]
Conformance with SRP Acceptance Criteria

STD SUP 1.9-1

	Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
15.0.1	Radiological Consequence Analyses Using Alternative Source Terms, Rev. 0, 07/2000			See Notes [d] and [e].
15.0.2	Review of Transient and Accident Analysis Method, Rev. 0, 12/2005			See Notes [d] and [e].
15.0.3	Design Basis Accident Radiological Consequences of Analyses for Advanced Light Water Reactors, Initial Issuance, 03/2007			See Notes [d] and [e].
15.1.1–15.1.4	Decrease in Feedwater Temperature, Increase in Feedwater Flow, Increase in Steam Flow, and Inadvertent Opening of a Steam Generator Relief or Safety Valve, Rev. 2, 03/2007			See Notes [d] and [e].
15.1.5	Steam System Piping Failures Inside and Outside of Containment (PWR)			See Notes [d] and [e].
15.2.1–15.2.5	Loss of External Load; Turbine Trip; Loss of Condenser Vacuum; Closure of Main Steam Isolation Valve (BWR); and Steam Pressure Regulator Failure (Closed), Rev. 2, 03/2007			See Notes [d] and [e].
15.2.6	Loss of Nonemergency AC Power to the Station Auxiliaries, Rev. 2, 03/2007			See Notes [d] and [e].
15.2.7	Loss of Normal Feedwater Flow, Rev. 2, 03/2007			See Notes [d] and [e].
15.2.8	Feedwater System Pipe Breaks Inside and Outside Containment (PWR), Rev. 2, 03/2007			See Notes [d] and [e].
15.3.1–15.3.2	Loss of Forced Reactor Coolant Flow Including Trip of Pump Motor and Flow Controller Malfunctions, Rev. 2, 03/2007			See Notes [d] and [e].
15.3.3–15.3.4	Reactor Coolant Pump Rotor Seizure and Reactor Coolant Pump Shaft Break			See Notes [d] and [e].
15.4.1	Uncontrolled Control Rod Assembly Withdrawal from a Subcritical or Low Power Startup Condition			See Notes [d] and [e].

Table 1.9-202 (Sheet 17 of 19)[a]
Conformance with SRP Acceptance Criteria

STD SUP 1.9-1

	Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
15.4.2	Uncontrolled Control Rod Assembly Withdrawal at Power			See Notes (d) and (e).
15.4.3	Control Rod Misoperation (System Malfunction or Operator Error)			See Notes (d) and (e).
15.4.4 –15.4.5	Startup of an Inactive Loop or Recirculation Loop at an Incorrect Temperature, and Flow Controller Malfunction Causing an Increase in BWR Core Flow Rate, Rev. 2, 03/2007			See Notes (d) and (e).
15.4.6	Inadvertent Decrease in Boron Concentration in the Reactor Coolant System (PWR), Rev. 2, 03/2007			See Notes (d) and (e).
15.4.7	Inadvertent Loading and Operation of a Fuel Assembly in an Improper Position, Rev. 2, 03/2007			See Notes (d) and (e).
15.4.8	Spectrum of Rod Ejection Accidents (PWR)			See Notes (d) and (e).
15.4.8.A	Radiological Consequences of a Control Rod Ejection Accident (PWR), Rev. 1, 07/1981			See Notes (d) and (e).
15.4.9	Spectrum of Rod Drop Accidents (BWR)		N/A	
15.5.1–15.5.2	Inadvertent Operation of ECCS and Chemical and Volume Control System Malfunction that Increases Reactor Coolant Inventory, Rev. 2, 03/2007			See Notes (d) and (e).
15.6.1	Inadvertent Opening of a PWR Pressurizer Pressure Relief Valve or a BWR Pressure Relief Valve, Rev. 2, 03/2007			See Notes (d) and (e).
15.6.5	Loss-of-Coolant Accidents Resulting From Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary			See Notes (d) and (e).
15.8	Anticipated Transients Without Scram, Rev. 2, 03/2007			See Notes (d) and (e).
15.9	Boiling Water Reactor Stability, Initial Issuance, 03/2007		N/A	
16	Technical Specifications, Rev. 2, 03/2007		Acceptable	See Notes (d), (e), and (f).

Table 1.9-202 (Sheet 18 of 19)[a]
Conformance with SRP Acceptance Criteria

		Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
STD SUP 1.9-1	16.1	Risk-informed Decision Making: Technical Specifications, Rev. 1, 03/2007		N/A	This SRP applies to the Technical Specifications change process.
PTN SUP 1.9-1	17.1	Quality Assurance During the Design and Construction Phases, Rev. 2, 07/1981		Acceptable	See Notes [d], [e], and [f]. This section covers the requirements of SRP Section 17.1 through reference to quality assurance plan which is maintained separately as described in FSAR Sections 17.1 and 17.5.
STD SUP 1.9-1	17.2	Quality Assurance During the Operations Phase, Rev. 2, 07/1981			See Notes [d] and [e].
	17.3	Quality Assurance Program Description, Rev. 0, 08/1990			See Notes [d] and [e].
	17.4	Reliability Assurance Program (RAP), Initial Issuance, 03/2007			See Notes [d] and [e].
	17.5	Quality Assurance Program Description — Design Certification, Early Site Permit and New License Applicants, Initial Issuance, 03/2007		Acceptable	See Notes [d], [e], and [f]. This section covers the requirements of SRP Section 17.5 through reference to Quality Assurance Program Description which is maintained separately and developed in accordance with NEI 06-14A.
PTN SUP 1.9-1	17.6	Maintenance Rule, Rev. 1, 08/2007		Acceptable	Content developed in accordance with NEI 07-02A
STD SUP 1.9-1	18.0	Human Factors Engineering, Rev. 2, 03/2007		Acceptable	See Notes [d], [e], and [f].
	19.0	Probabilistic Risk Assessment and Severe Accident Evaluation for New Reactors, Rev. 2, 06/2007		Acceptable	See Notes [d], [e], and [f].
	19.1	Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities, Rev. 2, 06/2007		Acceptable	See Notes [d], [e], and [f].

Table 1.9-202 (Sheet 19 of 19)[a]
Conformance with SRP Acceptance Criteria

		Criteria Section[b]	Reference Criteria	FSAR Position[c]	Comments/Summary of Exceptions
STD SUP 1.9-1	19.2	Review of Risk Information Used to Support Permanent Plant-Specific Changes to the Licensing Basis: General Guidance, Initial Issuance, 06/2007			See Note [g].

(a) This table is provided as a one-time aid to facilitate NRC review. This table becomes historical information and need not be updated.
(b) If no revision or date is specified, it is Rev. 3, 03/2007.
(c) Consult the AP1000 Design Control Document (DCD) Appendix 1A and Appendix 1AA to determine extent of conformance with Regulatory Guides (except Regulatory Guide 1.206).
(d) Conformance with a previous revision of this SRP is documented in AP1000 Design Control Document (Section 1.9.2 and WCAP-15799).
(e) Conformance with the design aspects of this SRP is as stated in the AP1000 DCD.
(f) Conformance with the plant or site-specific aspects of this SRP is as stated under “FSAR Position.”
(g) This SRP is not applicable to the AP1000 certified design.

Table 1.9-203 (Sheet 1 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

STD COL 1.9-3

Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
TMI Action Plan Items			
I.A.1.1	Shift Technical Advisor	f	Resolved per NUREG-0933
I.A.1.2	Shift Supervisor Administrative Duties	f	Resolved per NUREG-0933
I.A.1.3	Shift Manning	f	Resolved per NUREG-0933
I.A.1.4	Long-Term Upgrading	f	Resolved per NUREG-0933
I.A.2.1(1)	Qualifications — Experience	f	Resolved per NUREG-0933
I.A.2.1(2)	Immediate Upgrading of RO & SRO Training and Qualifications, Training	f	Resolved per NUREG-0933
I.A.2.1(3)	Facility Certification of Competence and Fitness of Applicants for Operator and Senior Operator Licenses	f	Resolved per NUREG-0933
I.A.2.3	Administration of Training Programs	f	Resolved per NUREG-0933
I.A.2.4	NRR Participation in Inspector Training	d	Not applicable to new plants
I.A.2.6(1)	Revise Regulatory Guide 1.8	f	Resolved per NUREG-0933
I.A.3.1	Revise Scope of Criteria for Licensing Examinations	f	Resolved per NUREG-0933
I.A.3.5	Establish Statement of Understanding with INPO and DOE	d	Not applicable to new plants
I.A.4.1(2)	Interim Changes in Training Simulators	f	Resolved per NUREG-0933
I.A.4.2(1)	Research on Training Simulators	f	Resolved per NUREG-0933

Table 1.9-203 (Sheet 2 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

STD COL 1.9-3

Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
TMI Action Plan Items (Continued)			
I.A.4.2(2)	Upgrade Training Simulator Standards	f	Resolved per NUREG-0933
I.A.4.2(3)	Regulatory Guide on Training Simulators	f	Resolved per NUREG-0933
I.A.4.2(4)	Review Simulators for Conformance to Criteria	f	Resolved per NUREG-0933
I.A.4.3	Feasibility Study of Procurement of NRC Training Simulator	d	Not applicable to new plants
I.A.4.4	Feasibility Study of NRC Engineering Computer	d	Not applicable to new plants
I.B.1.3(1)	Require Licensees to Place Plant in Safest Shutdown Cooling Following a Loss of Safety Function Due to Personnel Error	d	Not applicable to new plants
I.B.1.3(2)	Use Existing Enforcement Options to Accomplish Safest Shutdown Cooling	d	Not applicable to new plants
I.B.1.3(3)	Use Non-Fiscal Approaches to Accomplish Safest Shutdown Cooling	d	Not applicable to new plants
I.B.2.1(1)	Verify the Adequacy of Management and Procedural Controls and Staff Discipline	d	Not applicable to new plants
I.B.2.1(2)	Verify that Systems Required to Be Operable Are Properly Aligned	d	Not applicable to new plants
I.B.2.1(3)	Follow-up on Completed Maintenance Work Orders to Ensure Proper Testing and Return to Service	d	Not applicable to new plants
I.B.2.1(4)	Observe Surveillance Tests to Determine Whether Test Instruments Are Properly Calibrated	d	Not applicable to new plants
I.B.2.1(5)	Verify that Licensees Are Complying with Technical Specifications	d	Not applicable to new plants
I.B.2.1(6)	Observe Routine Maintenance	d	Not applicable to new plants

Table 1.9-203 (Sheet 3 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

STD COL 1.9-3

Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
TMI Action Plan Items (Continued)			
I.B.2.1(7)	Inspect Terminal Boards, Panels, and Instrument Racks for Unauthorized Jumpers and Bypasses	d	Not applicable to new plants
I.B.2.2	Resident Inspector at Operating Reactors	d	Not applicable to new plants
I.B.2.3	Regional Evaluations	d	Not applicable to new plants
I.B.2.4	Overview of Licensee Performance	d	Not applicable to new plants
I.C.1(1)	Small Break LOCAs	f	Resolved per NUREG-0933
I.C.1(2)	Inadequate Core Cooling	f	Resolved per NUREG-0933
I.C.1(3)	Transients and Accidents	f	Resolved per NUREG-0933
I.C.2	Shift and Relief Turnover Procedures	f	Resolved per NUREG-0933
I.C.3	Shift Supervisor Responsibilities	f	Resolved per NUREG-0933
I.C.4	Control Room Access	f	Resolved per NUREG-0933
I.C.6	Procedures for Verification of Correct Performance of Operating Activities	f	Resolved per NUREG-0933
I.C.7	NSSS Vendor Review of Procedures	f	Resolved per NUREG-0933
I.C.8	Pilot Monitoring of Selected Emergency Procedures for Near-Term Operating License Applicants	f	Resolved per NUREG-0933
I.D.5(5)	Disturbance Analysis Systems	d	Not applicable to new plants
I.D.6	Technology Transfer Conference	d	Not applicable to new plants

Table 1.9-203 (Sheet 4 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

STD COL 1.9-3

Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
TMI Action Plan Items (Continued)			
I.E.1	Office for Analysis and Evaluation of Operational Data	d	Not applicable to new plants
I.E.2	Program Office Operational Data Evaluation	d	Not applicable to new plants
I.E.3	Operational Safety Data Analysis	d	Not applicable to new plants
I.E.4	Coordination of Licensee, Industry, and Regulatory Programs	d	Not applicable to new plants
I.E.5	Nuclear Plant Reliability Data Systems	d	Not applicable to new plants
I.E.6	Reporting Requirements	d	Not applicable to new plants
I.E.7	Foreign Sources	d	Not applicable to new plants
I.E.8	Human Error Rate Analysis	d	Not applicable to new plants
I.F.2(6)	Increase the Size of Licensees' QA Staff	f	Resolved per NUREG-0933
I.F.2(9)	Clarify Organizational Reporting Levels for the QA Organization	f	Resolved per NUREG-0933
I.G.1	Training Requirements	f	Resolved per NUREG-0933
I.G.2	Scope of Test Program	f	Resolved per NUREG-0933
II.B.4	Training for Mitigating Core Damage	f	Resolved per NUREG-0933
II.B.5(1)	Behavior of Severely Damaged Fuel	d	Not applicable to new plants
II.B.5(2)	Behavior of Core Melt	d	Not applicable to new plants

Table 1.9-203 (Sheet 5 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

STD COL 1.9-3

Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
TMI Action Plan Items (Continued)			
II.B.5(3)	Effect of Hydrogen Burning and Explosions on Containment Structures	d	Not applicable to new plants
II.B.6	Risk Reduction for Operating Reactors at Sites with High Population Densities	f	Resolved per NUREG-0933
II.E.1.3	Update Standard Review Plan and Develop Regulatory Guide	d	Resolved per NUREG-0933
II.E.6.1	Test Adequacy Study	d	Resolved per NUREG-0933
II.F.5	Classification of Instrumentation, Control, and Electrical Equipment	d	Not applicable to new plants
II.H.4	Determine Impact of TMI on Socioeconomic and Real Property Values	d	Not applicable to new plants
II.J.1.1	Establish a Priority System for Conducting Vendor Inspections	d	Not applicable to new plants
II.J.1.2	Modify Existing Vendor Inspection Program	d	Not applicable to new plants
II.J.1.3	Increase Regulatory Control Over Present Non-Licensees	d	Not applicable to new plants
II.J.1.4	Assign Resident Inspectors to Reactor Vendors and Architect-Engineers	d	Not applicable to new plants
II.J.2.1	Reorient Construction Inspection Program	d	Not applicable to new plants
II.J.2.2	Increase Emphasis on Independent Measurement in Construction Inspection Program	d	Not applicable to new plants
II.J.2.3	Assign Resident Inspectors to All Construction Sites	d	Not applicable to new plants
II.J.3.1	Organization and Staffing to Oversee Design and Construction	f	Not applicable to new plants
II.J.4.1	Revise Deficiency Reporting Requirements	f	Resolved per NUREG-0933

Table 1.9-203 (Sheet 6 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

STD COL 1.9-3

Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
TMI Action Plan Items (Continued)			
II.K.1(1)	Review TMI-2 PNs and Detailed Chronology of the TMI-2 Accident	f	Resolved per NUREG-0933
II.K.1(3)	Review Operating Procedures for Recognizing, Preventing, and Mitigating Void Formation in Transients and Accidents	f	Resolved per NUREG-0933
II.K.1(4)	Review Operating Procedures and Training Instructions	f	Resolved per NUREG-0933
II.K.1(5)	Safety-Related Valve Position Description	f	Resolved per NUREG-0933
II.K.1(6)	Review Containment Isolation Initiation Design and Procedures	f	Resolved per NUREG-0933
II.K.1(9)	Review Procedures to Assure That Radioactive Liquids and Gases Are Not Transferred out of Containment Inadvertently	f	Resolved per NUREG-0933
II.K.1(10)	Review and Modify Procedures for Removing Safety-Related Systems from Service	f	Resolved per NUREG-0933
II.K.1(11)	Make All Operating and Maintenance Personnel Aware of the Seriousness and Consequences of the Erroneous Actions Leading up to, and in Early Phases of, the TMI-2 Accident	f	Resolved per NUREG-0933
II.K.1(12)	One Hour Notification Requirement and Continuous Communications Channels	f	Resolved per NUREG-0933
II.K.1(13)	Propose Technical Specification Changes Reflecting Implementation of All Bulletin Items	f	Resolved per NUREG-0933
II.K.1(14)	Review Operating Modes and Procedures to Deal with Significant Amounts of Hydrogen	f	Resolved per NUREG-0933
II.K.1(15)	For Facilities with Non-Automatic AFW Initiation, Provide Dedicated Operator in Continuous Communication with CR to Operate AFW	f	Resolved per NUREG-0933
II.K.1(16)	Implement Procedures That Identify PZR PORV "Open" Indications and That Direct Operator to Close Manually at "Reset" Setpoint	f	Resolved per NUREG-0933
II.K.1(17)	Trip PZR Level Bistable so That PZR Low Pressure Will Initiate Safety Injection	f	Resolved per NUREG-0933

Table 1.9-203 (Sheet 7 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

STD COL 1.9-3

Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
TMI Action Plan Items (Continued)			
II.K.1(26)	Revise Emergency Procedures and Train ROs and SROs	f	Resolved per NUREG-0933
II.K.3(3)	Report Safety and Relief Valve Failures Promptly and Challenges Annually	f	Resolved per NUREG-0933
II.K.3(5)	Automatic Trip of Reactor Coolant Pumps	f	Resolved per NUREG-0933
II.K.3(10)	Anticipatory Trip Modification Proposed by Some Licensees to Confine Range of Use to High Power Levels	f	Resolved per NUREG-0933
II.K.3(11)	Control Use of PORV Supplied by Control Components, Inc. Until Further Review Complete	f	Resolved per NUREG-0933
II.K.3(12)	Confirm Existence of Anticipatory Trip Upon Turbine Trip	f	Resolved per NUREG-0933
II.K.3(30)	Revised Small-Break LOCA Methods to Show Compliance with 10 CFR Part 50, Appendix K	f	Resolved per NUREG-0933
II.K.3(31)	Plant-Specific Calculations to Show Compliance with 10 CFR 50.46	f	Resolved per NUREG-0933
III.A.1.1(1)	Implement Action Plan Requirements for Promptly Improving Licensee Emergency Preparedness	f	Resolved per NUREG-0933
III.A.1.1(2)	Perform an Integrated Assessment of the Implementation	f	Not applicable to new plants
III.A.2.1(1)	Publish Proposed Amendments to the Rules	d	Resolved per NUREG-0933
III.A.2.1(2)	Conduct Public Regional Meetings	d	Not applicable to new plants
III.A.2.1(3)	Prepare Final Commission Paper Recommending Adoption of Rules	d	Not applicable to new plants
III.A.2.1(4)	Revise Inspection Program to Cover Upgraded Requirements	d	Resolved per NUREG-0933
III.A.2.2	Development of Guidance and Criteria	d	Resolved per NUREG-0933

Table 1.9-203 (Sheet 8 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

STD COL 1.9-3

Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
TMI Action Plan Items (Continued)			
III.A.3.3	Communications	d	Resolved per NUREG-0933
III.C.1(1)	Review Publicly Available Documents	d	Not applicable to new plants
III.C.1(2)	Recommend Publication of Additional Information	d	Not applicable to new plants
III.C.1(3)	Program of Seminars for News Media Personnel	d	Not applicable to new plants
III.C.2(1)	Develop Policy and Procedures for Dealing With Briefing Requests	d	Not applicable to new plants
III.C.2(2)	Provide Training for Members of the Technical Staff	d	Not applicable to new plants
III.D.2.4(2)	Place 50 TLDs Around Each Site	d	Not applicable to new plants
III.D.2.6	Independent Radiological Measurements	d	Not applicable to new plants
III.D.3.2(1)	Amend 10 CFR Part 20	d	Not applicable to new plants
III.D.3.2(2)	Issue a Regulatory Guide	d	Not applicable to new plants
III.D.3.2(3)	Develop Standard Performance Criteria	d	Not applicable to new plants
III.D.3.2(4)	Develop Method for Testing and Certifying Air-Purifying Respirators	d	Not applicable to new plants
III.D.3.3	In-Plant Radiation Monitoring	COL Item 12.3-2	12.3.4, Appendix 12AA
III.D.3.5(1)	Develop Format for Data To Be Collected by Utilities Regarding Total Radiation Exposure to Workers	d	Not applicable to new plants
III.D.3.5(2)	Investigate Methods of Obtaining Employee Health Data by Nonlegislative Means	d	Not applicable to new plants

Table 1.9-203 (Sheet 9 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

	Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
	TMI Action Plan Items (Continued)			
STD COL 1.9-3	III.D.3.5(3)	Revise 10 CFR Part 20	d	Not applicable to new plants
	IV.A.1	Seek Legislative Authority	d	Not applicable to new plants
	IV.A.2	Revise Enforcement Policy	d	Not applicable to new plants
	IV.B.1	Revise Practices for Issuance of Instructions and Information to Licensees	d	Not applicable to new plants
	IV.D.1	NRC Staff Training	d	Not applicable to new plants
	IV.E.1	Expand Research on Quantification of Safety Decision-Making	d	Not applicable to new plants
	IV.E.2	Plan for Early Resolution of Safety Issues	d	Not applicable to new plants
	IV.E.3	Plan for Resolving Issues at the CP Stage	d	Not applicable to new plants
	IV.E.4	Resolve Generic Issues by Rulemaking	d	Not applicable to new plants
	IV.G.1	Develop a Public Agenda for Rulemaking	d	Not applicable to new plants
	IV.G.2	Periodic and Systematic Reevaluation of Existing Rules	d	Not applicable to new plants
	IV.G.3	Improve Rulemaking Procedures	d	Not applicable to new plants
	IV.G.4	Study Alternatives for Improved Rulemaking Process	d	Not applicable to new plants
	IV.H.1	NRC Participation in the Radiation Policy Council	d	Not applicable to new plants
	V.A.1	Develop NRC Policy Statement on Safety	d	Not applicable to new plants

Table 1.9-203 (Sheet 10 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

STD COL 1.9-3

Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
TMI Action Plan Items (Continued)			
V.B.1	Study and Recommend, as Appropriate, Elimination of Nonsafety Responsibilities	d	Not applicable to new plants
V.C.1	Strengthen the Role of Advisory Committee on Reactor Safeguards	d	Not applicable to new plants
V.C.2	Study Need for Additional Advisory Committees	d	Not applicable to new plants
V.C.3	Study the Need to Establish an Independent Nuclear Safety Board	d	Not applicable to new plants
V.D.1	Improve Public and Intervenor Participation in the Hearing Process	d	Not applicable to new plants
V.D.2	Study Construction-During-Adjudication Rules	d	Not applicable to new plants
V.D.3	Reexamine Commission Role in Adjudication	d	Not applicable to new plants
V.D.4	Study the Reform of the Licensing Process	d	Not applicable to new plants
V.E.1	Study the Need for TMI-Related Legislation	d	Not applicable to new plants
V.F.1	Study NRC Top Management Structure and Process	d	Not applicable to new plants
V.F.2	Reexamine Organization and Functions of the NRC Offices	d	Not applicable to new plants
V.F.3	Revise Delegations of Authority to Staff	d	Not applicable to new plants
V.F.4	Clarify and Strengthen the Respective Roles of Chairman, Commission, and Executive Director for Operations	d	Not applicable to new plants
V.F.5	Authority to Delegate Emergency Response Functions to a Single Commissioner	d	Not applicable to new plants
V.G.1	Achieve Single Location, Long-Term	d	Not applicable to new plants

Table 1.9-203 (Sheet 11 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

	Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
	TMI Action Plan Items (Continued)			
STD COL 1.9-3	V.G.2	Achieve Single Location, Interim	d	Not applicable to new plants
	Task Action Plan Items			
STD COL 1.9-3	A-3	Westinghouse Steam Generator Tube Integrity (former USI)	COL Item 5.4-1	5.4.2.5
	A-19	Digital Computer Protection System	d	Not applicable to new plants
	A-20	Impacts of the Coal Fuel Cycle	d	Not applicable to new plants
	A-23	Containment Leak Testing	COL Item 6.2-1	6.2.5.1
	A-27	Reload Applications	d	Not applicable to new plants
	B-1	Environmental Technical Specifications	d	Not applicable to new plants
	B-2	Forecasting Electricity Demand	d	Not applicable to new plants
	B-11	Subcompartment Standard Problems	d	Not applicable to new plants
	B-13	Marviken Test Data Evaluation	d	Not applicable to new plants
	B-20	Standard Problem Analysis	d	Not applicable to new plants
	B-25	Piping Benchmark Problems	d	Not applicable to new plants
	B-27	Implementation and Use of Subsection NF	d	Not applicable to new plants
	B-28	Radionuclide/Sediment Transport Program	d	Not applicable to new plants

Table 1.9-203 (Sheet 12 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

STD COL 1.9-3

Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
Task Action Plan Items (Continued)			
B-29	Effectiveness of Ultimate Heat Sinks	d	Not applicable to new plants
B-30	Design Basis Floods and Probability	d	Not applicable to new plants
B-33	Dose Assessment Methodology	d	Not applicable to new plants
B-35	Confirmation of Appendix I Models for Calculations of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light Water Cooled Power Reactors	d	Not applicable to new plants
B-37	Chemical Discharges to Receiving Waters	d	Not applicable to new plants
B-42	Socioeconomic Environmental Impacts	d	Not applicable to new plants
B-43	Value of Aerial Photographs for Site Evaluation	d	Not applicable to new plants
B-44	Forecasts of Generating Costs of Coal and Nuclear Plants	d	Not applicable to new plants
B-49	Inservice Inspection Criteria and Corrosion Prevention Criteria for Containments	d	Not applicable to new plants
B-59	(N-1) Loop Operation in BWRs and PWRs	d	Not applicable to new plants
B-64	Decommissioning of Reactors	f	Resolved per NUREG-0933.
B-72	Health Effects and Life Shortening from Uranium and Coal Fuel Cycles	d	Not applicable to new plants
C-4	Statistical Methods for ECCS Analysis	d	Not applicable to new plants
C-5	Decay Heat Update	d	Not applicable to new plants
C-6	LOCA Heat Sources	d	Not applicable to new plants

Table 1.9-203 (Sheet 13 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

STD COL 1.9-3

Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
New Generic Issues			
43.	Reliability of Air Systems	f, j	Resolved per NUREG-0933.
59.	Technical Specification Requirements for Plant Shutdown when Equipment for Safe Shutdown is Degraded or Inoperable	d	Not applicable to new plants
67.2.1	Integrity of Steam Generator Tube Sleeves	d	Not applicable to new plants
67.5.1	Reassessment of Radiological Consequences	d	Not applicable to new plants
67.5.2	Reevaluation of SGTR Design Basis	d	Not applicable to new plants
67.10.0	Supplement Tube Inspections	d	Not applicable to new plants
99.	RCS/RHR Suction Line Valve Interlock on PWRs	f	Resolved per NUREG-0933
111.	Stress Corrosion Cracking of Pressure Boundary Ferritic Steels in Selected Environments	d	Not applicable to new plants
112.	Westinghouse RPS Surveillance Frequencies and Out-of-Service Times	d	Not applicable to new plants
118.	Tendon Anchorage Failure	f	Resolved per NUREG-0933.
119.1	Piping Rupture Requirements and Decoupling of Seismic and LOCA Loads	d	Not applicable to new plants
119.3	Decoupling the OBE from the SSE	d	Not applicable to new plants
119.4	BWR Piping Materials	d	Not applicable to new plants
119.5	Leak Detection Requirements	d	Not applicable to new plants
128.	Electrical Power Reliability	h (High)	Resolved per NUREG-0933.

Table 1.9-203 (Sheet 14 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

STD COL 1.9-3

Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
130.	Essential Service Water Pump Failures at Multiplant Sites	f	See DCD Subsection 1.9.4, item 130
133.	Update Policy Statement on Nuclear Plant Staff Working Hours	d	Not applicable to new plants
136.	Storage and Use of Large Quantities of Cryogenic Combustibles On Site	d	Not applicable to new plants
139.	Thinning of Carbon Steel Piping in LWRs	d	Not applicable to new plants
146.	Support Flexibility of Equipment and Components	d	Not applicable to new plants
147.	Fire-Induced Alternate Shutdown Control Room Panel Interactions	d	Not applicable to new plants
148.	Smoke Control and Manual Fire-Fighting Effectiveness	d	Not applicable to new plants
155.2	Establish Licensing Requirements For Non-Operating Facilities	d	Not applicable to new plants
156	Systematic Evaluation Program	f	Not applicable to new plants
156.6.1	Pipe Break Effects on Systems and Components	High	The AP1000 is a new plant that takes the effects of a pipe break into account and therefore issue 156.6.1 is not applicable.
163	Multiple Steam Generator Tube Leakage	h (High)	See DCD Subsection 1.9.4.2.3, item 163
168	Environmental Qualification Of Electrical Equipment	f	Not applicable to new plants
178	Effect Of Hurricane Andrew On Turkey Point	d	Not applicable to new plants

Table 1.9-203 (Sheet 15 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

	Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
	New Generic Issues (Continued)			
STD COL 1.9-3	180	Notice Of Enforcement Discretion	d	Not applicable to new plants
	181	Fire Protection	d	Not applicable to new plants
	183	Cycle-Specific Parameter Limits In Technical Specifications	d	Not applicable to new plants
	184	Endangered Species	d	Not applicable to new plants
	185	Control of Recriticality following Small-Break LOCA in PWRs	h	Not applicable to new plants
	186	Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants	Continue	1.9.4.2.3, 9.1.5.3
	189	Susceptibility of Ice Condenser and Mark III Containments to Early Failure from Hydrogen Combustion During a Severe Accident	Continue	Not applicable to the AP1000.
	191	Assessment Of Debris Accumulation On PWR Sump Performance	h (High)	See DCD Subsections 6.3.2.2.7 and 1.9.4.2.3, Item 191
	199	Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States	Issue to be Prioritized by NRC in the Future	2.5
	Human Factors Issues			
STD COL 1.9-3	HF1.1	Shift Staffing	f	13.1.2.1.4 18.6
	HF2.1	Evaluate Industry Training	d	Not applicable to new plants
	HF2.2	Evaluate INPO Accreditation	d	Not applicable to new plants

Table 1.9-203 (Sheet 16 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

	Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
	Human Factors Issues (Continued)			
STD COL 1.9-3	HF2.3	Revise SRP Section 13.2	d	Not applicable to new plants
	HF3.1	Develop Job Knowledge Catalog	d	Not applicable to new plants
	HF3.2	Develop License Examination Handbook	d	Not applicable to new plants
	HF3.5	Develop Computerized Exam System	d	Not applicable to new plants
	HF4.2	Procedures Generation Package Effectiveness Evaluation	d	Not applicable to new plants
	HF7.1	Human Error Data Acquisition	d	Not applicable to new plants
	HF7.2	Human Error Data Storage and Retrieval	d	Not applicable to new plants
	HF7.3	Reliability Evaluation Specialist Aids	d	Not applicable to new plants
	HF7.4	Safety Event Analysis Results Applications	d	Not applicable to new plants
	Chernobyl Issues			
STD COL 1.9-3	CH1.1A	Symptom-Based EOPs	d	Not applicable to new plants
	CH1.1B	Procedure Violations	d	Not applicable to new plants
	CH1.2A	Test, Change, and Experiment Review Guidelines	d	Not applicable to new plants
	CH1.2B	NRC Testing Requirements	d	Not applicable to new plants
	CH1.3A	Revise Regulatory Guide 1.47	d	Not applicable to new plants

Table 1.9-203 (Sheet 17 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

	Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
	Chernobyl Issues (Continued)			
STD COL 1.9-3	CH1.4A	Engineered Safety Feature Availability	d	Not applicable to new plants
	CH1.4B	Technical Specification Bases	d	Not applicable to new plants
	CH1.4C	Low Power and Shutdown	d	Not applicable to new plants
	CH1.5	Operating Staff Attitudes Toward Safety	d	Not applicable to new plants
	CH1.6A	Assessment of NRC Requirements on Management	d	Not applicable to new plants
	CH1.7A	Accident Management	d	Not applicable to new plants
	CH2.1A	Reactivity Transients	d	Not applicable to new plants
	CH2.3B	Contamination Outside Control Room	d	Not applicable to new plants
	CH2.3C	Smoke Control	d	Not applicable to new plants
	CH2.3D	Shared Shutdown Systems	d	Not applicable to new plants
	CH2.4A	Firefighting With Radiation Present	d	Not applicable to new plants
	CH3.1A	Containment Performance	d	Not applicable to new plants
	CH3.2A	Filtered Venting	d	Not applicable to new plants
	CH4.3A	Ingestion Pathway Protective Measures	d	Not applicable to new plants
	CH4.4A	Decontamination	d	Not applicable to new plants

Table 1.9-203 (Sheet 18 of 18)
Listing of Unresolved Safety Issues and Generic Safety Issues

	Action Plan Item/Issue No.	Title	Applicable Screening Criteria	Notes
	Chernobyl Issues (Continued)			
STD COL 1.9-3	CH4.4B	Relocation	d	Not applicable to new plants
	CH5.1A	Mechanical Dispersal in Fission Product Release	d	Not applicable to new plants
	CH5.1B	Stripping in Fission Product Release	d	Not applicable to new plants
	CH5.2A	Steam Explosions	d	Not applicable to new plants
	CH6.1B	Structural Graphite Experiments	d	Not applicable to new plants
	CH6.2	Assessment	d	Not applicable to new plants

Notes (from DCD Table 1.9-2):
(d) Issue is not a design issue (Environmental, Licensing, or Regulatory Impact Issue; or covered in an existing NRC program).
(f) Issue is not an AP1000 design certification issue. Issue is applicable to current operating plants or is programmatic in nature.
(h) Issue is unresolved pending generic resolution (for example, prioritized as High, Medium, or possible resolution identified).
(j) The AP600 DSER (Draft NUREG-0612) identified this item as required to be discussed.

Table 1.9-204 (Sheet 1 of 4)
Generic Communications Assessment

	Number	Title	Comment
	Bulletin		
STD COL 1.9-2	80-06	Engineered Safety Feature (ESF) Reset Controls (3/80)	See Note [(a)].
	80-10	Contamination of Nonradioactive System and Resulting Potential for Unmonitored, Uncontrolled Release of Radioactivity to Environment (5/80)	Appendix 12AA
PTN COL 1.9-2	80-15	Possible Loss of Emergency Notification System (ENS) with Loss of Offsite Power (6/80)	9.5.2.2.5 9.5.2.5.1
STD COL 1.9-2	88-11	Pressurizer Surge Line Thermal Stratification	3.9.3.1.2
	02-01	Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity	5.2.4 See Note [(a)].
	02-02	Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs	5.2.4 See Note [(a)].
	03-01	Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors	6.3 See Note [(a)].
	03-02	Leakage from Reactor Pressure Vessel Lower Head Penetrations and Reactor Coolant Pressure Boundary Integrity	5.2.4.3 See Note [(a)].
	03-03	Potentially Defective 1-inch Valves for Uranium Hexafluoride Cylinders	N/A
	03-04	Rebaselining of Data in the Nuclear Materials Management and Safeguards System	N/A One time report.
	04-01	Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized-Water Reactors	See Note [(a)].
	05-01	Material Control and Accounting at Reactors and Wet Spent Fuel Storage Facilities	13.5.2.2.9
	05-02	Emergency Preparedness and Response Actions for Security-Based Events	13.3
PTN COL 1.9-2	07-01	Security Officer Attentiveness	Administrative
	Generic Letters		
STD COL 1.9-2	80-22	Transmittal of NUREG-0654 “Criteria for Preparation and Evaluation of Radiological Emergency Response Plans” (3/80)	13.3
	80-26	Qualifications of Reactor Operators (3/80)	13.2 18.10
	80-51	On-Site Storage of Low-Level Waste (6/90)	11.4.6
	80-55	Possible Loss of Hotline With Loss of Off-Site Power	See Bulletin 80-15.

Table 1.9-204 (Sheet 2 of 4)
Generic Communications Assessment

	Number	Title	Comment
	Generic Letters (Continued)		
STD COL 1.9-2	80-77	Refueling Water Level (8/80)	16.1 See Note [a].
	80-094	Emergency Plan (11/80)	13.3
	80-099	Technical Specification Revisions for Snubber Surveillance (11/80)	Snubbers no longer in generic Tech Specs See Note [a].
	80-108	Emergency Planning (12/80)	13.3
	81-02	Analysis, Conclusions and Recommendations Concerning Operator Licensing (1/81)	13.2
	81-10	Post-TMI Requirements for the Emergency Operations Facility (2/81)	13.3
	81-38	Storage of Low-Level Radioactive Waste at Power Reactor Sites (11/81)	11.4.6
	81-40	Qualifications of Reactor Operators (12/81)	13.1 13.2
	82-02	Commission Policy on Overtime (2/82)	16.1
	82-04	Use of INPO See-in Program (3/82)	13.1 13.5
PTN COL 1.9-2	82-12	Nuclear Power Plant Staff Working Hours (6/82)	13.1.2.1.3 13.1.2.1.4 13.1.2.1.5
STD COL 1.9-2	82-13	Reactor Operator and Senior Reactor Operator Examinations (6/82)	For information only.
	82-18	Reactor Operator and Senior Reactor Operator Requalification Examinations (10/82)	13.2
	83-06	Certificates and Revised Format for Reactor Operator and Senior Reactor Operator Licenses (1/83)	13.2
	83-11	Licensee Qualification for Performing Safety Analyses in Support of Licensing Actions (2/83)	13.1 See Note [a].
	83-12	Issuance of NRC FORM 398 — Personal Qualifications Statement — Licensee (2/83)	13.2
	83-17	Integrity of the Requalification Examinations for Renewal of Reactor Operator and Senior Reactor Operator Licenses (4/83)	13.1
	83-22	Safety Evaluation of “Emergency Response Guidelines” (6/83)	18.9
	83-40	Operator Licensing Examination (12/83)	13.2
	84-10	Administration of Operating Tests Prior to Initial Criticality (10 CFR 55.25) (4/84)	13.2
	84-14	Replacement and Requalification Training Program (5/84)	13.2

Table 1.9-204 (Sheet 3 of 4)
Generic Communications Assessment

STD COL 1.9-2

Number	Title	Comment
Generic Letters (Continued)		
84-17	Annual Meeting to Discuss Recent Developments Regarding Operator Training, Qualifications, and Examinations (7/84)	Administrative
84-20	Scheduling Guidance for Licensee Submittals of Reloads That Involve Unreviewed Safety Questions (8/84)	13.5
85-04	Operating Licensing Examinations (1/85)	Administrative
85-05	Inadvertent Boron Dilution Events (1/85)	13.5
85-14	Commercial Storage At Power Reactor Sites Of Low Level Radioactive Waste Not Generated By The Utility (8/85)	Administrative
85-18	Operator Licensing Examinations (9/85)	Administrative
85-19	Reporting Requirements On Primary Coolant Iodine Spikes (9/85)	16.1
86-14	Operator Licensing Examinations (8/86)	Administrative
87-14	Operator Licensing Examinations (8/87)	Administrative
88-05	Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants (3/88)	5.2.4 See Note [a].
88-14	Instrument Air Supply System Problems Affecting Safety-Related Equipment (8/88)	9.3.7
88-18	Plant Record Storage on Optical Disk (10/88)	17
89-07	Power Reactors Safeguards Contingency Planning for Surface Vehicle Bombs (4/89)	13.6
89-07 S1	Power Reactor Safeguards Contingency Planning for Surface Vehicle Bombs	13.6
89-08	Erosion/Corrosion-Induced Pipe Wall Thinning (5/89)	10.1.3.1
89-12	Operator Licensing Examinations (7/89)	13.2
89-15	Emergency Response Data System (8/89)	9.5.2.5.3 13.3
89-17	Planned Administrative Changes to the NRC Operator Licensing Written Examination Process (9/89)	N/A
91-14	Emergency Telecommunications (9/91)	9.5.2.5.3 13.3
91-16	Licensed Operators and Other Nuclear Facility Personnel Fitness for Duty (10/91)	13.7
92-01	Reactor Vessel Structural Integrity (1/92)	5.3.2.6.3
93-01	Emergency Response Data System Test Program	13.3
93-03	Verification of Plant Records	17

Table 1.9-204 (Sheet 4 of 4)
Generic Communications Assessment

	Number	Title	Comment
	Generic Letters (Continued)		
STD COL 1.9-2	96-02	Reconsideration of Nuclear Power Plant Security Requirements Associated with an Internal Threat (2/96)	13.6
	03-01	Control Room Habitability	6.4 See Note (a).
	04-01	Requirements for Steam Generator Tube Inspections	5.4.2.5 16.1 See Note (a).
	04-02	Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors	6.3.8.1 See Note (a).
	06-01	Steam Generator Tube Integrity and Associated Technical Specifications	5.4.2.5 16.1 See Note (a).
	06-02	Grid Reliability and the Impact on Plant Risk and the Operability of Offsite Power	8.2.1.1 8.2.2 See Note (a).
	06-03	Potentially Nonconforming Hemyc and MT Fire Barrier Configurations	9.5.1.8 See Note (a).
	07-01	Inaccessible or Underground Power Cable Failures that Disable Accident Mitigation Systems or Cause Plant Transients.	17.6 See Note (a).
PTN COL 1.9-2	08-01	Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems	5.4 6.2 6.3 See Note (a).

(a) The design aspects of this topic are as stated in the AP1000 DCD.

Add the following section after DCD Section 1.9.

1.10 NUCLEAR POWER PLANTS TO BE OPERATED ON MULTI-UNIT SITES

STD SUP 1.10-1 The certification for the AP1000 is for a single unit. Dual siting of AP1000 is achievable, provided that the centerlines of the units are sufficiently separated. The primary consideration in setting this separation distance is the space needed to support plant construction via the use of a heavy-lift crane.

PTN SUP 1.10-1 Security controls for operation of the first unit during construction of the second unit will be addressed in the Turkey Point Units 6 & 7 Physical Security Plan, Appendix E, before fuel load of the first unit.

STD SUP 1.10-1 Management and administrative controls are established to identify potential hazards to structures, systems, and components (SSCs) of an operating unit as a result of construction activities at a unit under construction. Controls within this section are not required unless there is an operating unit on the site, i.e., a unit with fuel loaded into the reactor vessel. Advance notification, scheduling and planning allow site management to implement interim controls to reduce the potential for impact to SSCs.

This section presents an assessment of the potential impacts of construction of one unit on SSCs important to safety for an operating unit, in accordance with 10 CFR 52.79(a)(31). This assessment includes:

- Identification of potential construction activity hazards.
- Identification of SSCs important to safety and limiting conditions for operation (LCOs) for the operating unit.
- Identification of potentially impacted SSCs and LCOs.
- Identification of applicable managerial and administrative controls.

1.10.1 POTENTIAL CONSTRUCTION ACTIVITY HAZARDS

PTN SUP 1.10-1 The power blocks for Units 6 and 7 have a separation of 850 feet between plant centerlines.

STD SUP 1.10-1

Construction activities may include site exploration, grading, clearing, and installation of drainage and erosion-control measures; boring, drilling, dredging, pile driving and excavating; transportation, storage and warehousing of equipment; and construction, erection, and fabrication of new facilities.

Construction activities and their representative hazards to an operating unit are shown in Table 1.10-201.

1.10.2 POTENTIALLY IMPACTED SSCS AND LIMITING CONDITIONS FOR OPERATION

The construction activities described above were reviewed for possible impact to operating unit SSCs important to safety.

PTN SUP 1.10-1

- Turkey Point Units 3 & 4 SSCs important to safety are described in the Units 3 & 4 Updated Final Safety Analysis Report (UFSAR).
- Turkey Point Units 3 & 4 LCOs are located in Appendix A of the Turkey Point Units 3 & 4 Operating Licenses (Technical Specifications).
- New unit SSCs important to safety are described in FSAR Chapter 3.
- As indicated in Chapter 16, the LCOs for Units 6 & 7 are located in Part 4 of the COL Application.

STD SUP 1.10-1

The initial assessment consisted of a review of individual SSCs and LCOs to determine whether an item is applicable, or may be eliminated due to either examination or being internal and specific to an operating unit. The assessment identified the SSCs that could reasonably be expected to be impacted by construction activities unless administrative and managerial controls are established. The results of the assessment are presented in Table 1.10-202.

Periodic assessment during construction is addressed in Appendix 13AA, Subsection 13AA.1.1.1.1.8.

1.10.3 MANAGERIAL AND ADMINISTRATIVE CONTROLS

To eliminate or mitigate construction hazards that could potentially impact operating unit SSCs important to safety, specific managerial and administrative controls have been identified as shown in Table 1.10-203.

Although not all of the managerial and administrative construction controls are necessary to protect the operating unit, the identified controls are applied to any operating unit as a conservative measure. This conservative approach provides reasonable assurance of protecting the identified SSCs from potential construction hazards and preventing the associated LCOs specified in the operating unit Technical Specifications from being exceeded as a result of construction activities, as discussed below.

The majority of the operating unit SSCs important to safety are contained and protected within safety-related structures. The managerial controls protect these internal SSCs from postulated construction hazards by maintaining the integrity and design basis of the safety-related structures and foundations. Heavy load drop controls, crane boom failure standoff requirements, ground vibration controls and construction generated missile(s) control are examples of managerial controls that provide this protection.

Other managerial controls support maintaining offsite power, control of hazardous materials and gases, and protection of cooling water supplies and safety system instrumentation. These managerial controls prevent or mitigate external construction impacts that could affect SSCs important to safety. These controls also prevent or mitigate unnecessary challenges to safety systems caused by plant construction hazards, such as disruption of offsite transmission lines or impact to plant cooling water supplies.

The above discussed controls to eliminate or mitigate construction hazards that could potentially impact operating unit SSCs important to safety are in place when there is an operating nuclear unit on the site. Additional controls may be established during construction as addressed in Appendix 13AA, Subsection 13AA.1.1.1.1.8.

STD SUP 1.10-1

Table 1.10-201 (Sheet 1 of 2)
Potential Hazards From Construction Activities

Construction Activity Hazard	Potential Impact
Site Exploration, Grading, Clearing, Installation of Drainage and Erosion Control Measures	• Overhead Power Lines • Transmission Towers • Underground Conduits, Piping, Tunnels, Etc. • Site Access and Egress • Drainage Facilities and Structures • Onsite Transportation Routes • Slope Stability • Soil Erosion and Local Flooding • Construction-Generated Dust and Equipment Exhausts • Encroachment on Plant Control Boundaries • Encroachment on Structures and Facilities
Boring, Drilling, Pile Driving, Dredging, Demolition, Excavation	• Underground Conduits, Piping, Tunnels, Etc. • Foundation Integrity • Structural Integrity • Slope Stability • Erosion and Turbidity Control • Groundwater and Groundwater Monitoring Facilities • Dewatering Structures, Systems and Components • Nearby Structures, Systems and Components • Vibratory Ground Motion

STD SUP 1.10-1

Table 1.10-201 (Sheet 2 of 2)
Potential Hazards From Construction Activities

Construction Activity Hazard	Potential Impact
Equipment Movement, Material Delivery, Vehicle Traffic	• Overhead Power Lines • Transmission Towers • Underground Conduits, Piping, Tunnels • Crane Load Drops • Crane or Crane Boom Failures • Vehicle Accidents • Rail Car Derailments
Equipment and Material Laydown, Storage, Warehousing	• Releases of Flammable, Hazardous or Toxic Materials • Wind-Generated, Construction- Related Debris and Missiles
General Construction, Erection, Fabrication	• Physical Integrity of Structures, Systems and Components • Adjacent or Nearby Structures, Systems and Components • Instrumentation and Control Systems and Components • Electrical Systems and Components • Cooling Water Systems and Components • Waste Heat Environmental Controls and Parameters • Radioactive Waste Release Points and Parameters • Abandonment of Structures, Systems or Components • Relocation of Structures, Systems or Components • Removal of Structures, Systems or Components
Connection, Integration, Testing	• Instrumentation and Control Systems and Components • Electrical and Power Systems and Components • Cooling Water Systems and Components

STD SUP 1.10-1

Table 1.10-202
Hazards During Construction Activities

Construction Hazard	Impacted SSCs
Impact on Overhead Power Lines	• Offsite Power System
Impact on Transmission Towers	• Offsite Power Systems
Impact on Utilities, Underground Conduits, Piping, Tunnels, Tanks	• Fire Protection System • Service Water System[1]
Impact of Construction-Generated Dust and Equipment Exhausts	• Control Room Emergency HVAC Systems[1] • Diesel Generators
Impact of Vibratory Ground Motion	• Offsite Power System • Onsite Power Systems • Instrumentation and Seismic Monitors
Impact of Crane or Crane Boom Failures	• Safety-Related Structures
Impact of Releases of Flammable, Hazardous or Toxic Materials	• Control Room Emergency HVAC Systems[1]
Impact of Wind-Generated, Construction-Related Debris and Missiles	• Safety-Related Structures • Control Room Emergency HVAC Systems[1]
Impact on Electrical Systems and Components	• Offsite Power System • Onsite Power Systems
Impact on Cooling Water Systems and Components	• Service Water System[1] • Ultimate Heat Sink[1]
Impact on Radioactive Waste Release Points and Parameters	• Gaseous and Liquid Radioactive Waste Management Systems
Impact of Relocation of Structures, Systems or Components	• Fire Protection System • Service Water System[1]
Impact of Site Groundwater Depression and Dewatering	• Safety-Related Structures and Foundations
Impact of Equipment Delivery and Heavy Equipment Delivery	• Safety-Related Structures and Foundations
Impact of Local Flooding	• Safety-related structures, systems, and components (SSCs)

1 Not applicable to AP1000 operating units.

STD SUP 1.10-1

Table 1.10-203 (Sheet 1 of 2)
Managerial and Administrative Construction Controls

Construction Hazards to SSCs	Managerial Control
Impact on Transmission Power Lines and Offsite Power Lines	• Safe standoff clearance distances are established for transmission power lines, including verification of standoff distance for modules, the reactor vessel and other equipment to be transported beneath energized electric lines to meet minimum standoff clearance requirements. • Physical warning or caution barriers and signage are erected along transport routes.
Impact on Transmission Towers	• Establish controls or physical barriers to avoid equipment collisions with electric transmission support towers
Impact on Utilities, Underground Conduits, Piping, Tunnels, Tanks	• Grading, excavation, and pile driving require location and identification of equipment or underground structures that must be relocated, removed, or left in place and protected prior to the work activity.
Impact of Construction-Generated Dust and Equipment Exhausts	• Fugitive dust and dust generation is controlled. Potentially affected system air intakes and filters are periodically monitored.
Impact of Vibratory Ground Motion	• Construction administrative procedures, methods, and controls are implemented to prevent exceeding ground vibration and instrumentation limit settings.
Impact of Crane or Crane Boom Failures	• Construction standoff distance controls prevent heavy load impacts from crane boom failures and crane load drops. Drop analyses may be substituted if minimum standoff distances are not practical.
Impact of Releases of Flammable, Hazardous or Toxic Materials and Missile Generation	• Environmental, safety and health controls limit transport, storage, quantities, type and use of flammable, hazardous, toxic materials and compressed gasses. Construction safety and storage controls maintain potential missile generation events from compressed gasses within the operating unit design basis.
Impact of Wind-Generated, Construction-Related Debris and Missiles	• Administrative controls address equipment, material storage and transport during high winds or high wind warnings. • Plant procedures are followed during severe weather conditions which may call for power reduction or shut down.
Impact on Electrical Systems and Components	• Affected operating unit electrical systems and components within the construction area are identified and isolated or relocated or otherwise protected.
Impact on Cooling Water Systems and Components	• Transport of heavy load equipment over buried cooling water piping is prohibited without evaluation.

STD SUP 1.10-1

Table 1.10-203 (Sheet 2 of 2)
Managerial and Administrative Construction Controls

Construction Hazards to SSCs	Managerial Control
Impact on Radioactive Waste Release Points and Parameters	• Engineering evaluation and managerial controls are implemented, as necessary, to prevent radioactive releases beyond the established limits due to construction activity.
Impact of Relocation of Structures, Systems or Components	• Administrative controls identify SSCs that require relocation. Temporary or permanent design changes are implemented if necessary.
Impact of Equipment Delivery and Heavy Equipment Delivery	• Rail transport speed limits and maximum rail loading weights onsite are established. • General equipment and heavy equipment movement controls and limitations are established.
Impact of Local Flooding	• Site grading and drainage provisions consider potential flooding impacts from local intense precipitation
Impact of Site Groundwater Dewatering	• Administrative controls address groundwater level monitoring

APPENDIX 1A CONFORMANCE WITH REGULATORY GUIDES

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

STD COL 1.9-1 Appendix 1AA is provided to supplement the information in DCD Appendix 1A.

APPENDIX 1B SEVERE ACCIDENT MITIGATION DESIGN ALTERNATIVES

STD SUP 1B-1 DCD Appendix 1B is not incorporated into this FSAR. Rather, the severe accident mitigation design alternatives are addressed in the Environmental Report. As indicated in 10 CFR Part 52, Appendix D, Section III.B, "...the evaluation of severe accident mitigation design alternatives in appendix 1B of the generic DCD are not part of this appendix."

APPENDIX 1AA CONFORMANCE WITH REGULATORY GUIDES

Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
DIVISION 1 - Power Reactors			

STD COL 1.9-1

Regulatory Guide 1.7, Rev. 3, 3/07 – Control of Combustible Gas Concentrations in Containment

Conformance of the design aspects with Revision 2 of the Regulatory Guide is as stated in the DCD. Conformance with Revision 3 of this Regulatory Guide for programmatic and/or operational aspects is documented below.

C.2		Conforms	
C.4		Conforms	

Regulatory Guide 1.8, Rev. 3, 5/00 – Qualification and Training of Personnel for Nuclear Power Plants

C.1		Conforms	
C.2	Section 4 of ANSI/ANS-3.1-1993	Exception	Not able to meet Regulatory Guide 1.8, Rev. 3 qualification requirements for licensed personnel prior to operations.

Regulatory Guide 1.11, Rev. 1, 3/10 – Instrument Lines Penetrating the Primary Reactor Containment

Conformance with the design aspects is as stated in the DCD. This guidance is completely within the scope of the DCD.

Regulatory Guide 1.12, Rev. 2, 3/97 – Nuclear Power Plant Instrumentation for Earthquakes

Conformance of the design aspects is as stated in the DCD. Conformance for programmatic and/or operational aspects is documented below.

C.3		Conforms	
C.8		Conforms	

Regulatory Guide 1.13, Rev. 2, 3/07 - Spent Fuel Storage Facility Design Basis

Conformance of the design aspects with Revision 1 of the Regulatory Guide is as stated in the DCD. Conformance with Revision 2 of this Regulatory Guide for programmatic and/or operational aspects is documented below.

C.7		Conforms	

Regulatory Guide 1.20, Rev. 3, 3/07 – Comprehensive Vibration Assessment Program For Reactor Internals During Preoperational and Initial Startup Testing

Conformance with Revision 2 of the Regulatory Guide is as stated in the DCD. This guidance is completely within the scope of the DCD.

Regulatory Guide 1.21, Rev. 1, 6/74 – Measuring Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents From Light-Water-Cooled Nuclear Power Plants

Conformance of the design aspects is as stated in the DCD. Conformance with Revision 1 of this Regulatory Guide for programmatic and/or operational aspects is documented below.

C.1		Conforms	
C.3-C.5		Conforms	
C.6		Conforms	
C.7-C.14		Conforms	

	Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
PTN COL 1.9-1	**Regulatory Guide 1.23, Rev. 1, 3/07 – Meteorological Monitoring Programs for Nuclear Power Plants**			
	General		Exception	Sampling interval for temperature and dew point during siting activities based on guidance in effect at the beginning of the program
	General		Exception	See Table 2.3.3-202.
STD COL 1.9-1	**Regulatory Guide 1.26, Rev. 4, 3/07 – Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants**			
	Conformance with Revision 3 of the Regulatory Guide for DCD scope of work is as stated in the DCD. Conformance with Revision 4 of this Regulatory Guide for remaining scope is documented below.			
	General		Conforms	
	Regulatory Guide 1.28, Rev. 3, 8/85 – Quality Assurance Program Requirements (Design and Construction)			
	Conformance for DCD scope of work is as stated in the DCD. Conformance for remaining scope is documented below.			
	General		Exception	Quality assurance requirements utilize the more recently NRC endorsed NQA-1 in lieu of the identified outdated standards.
	Regulatory Guide 1.29, Rev. 4, 3/07 – Seismic Design Classification			
	Conformance with Revision 3 of the Regulatory Guide for DCD scope of work is as stated in the DCD. Conformance with Revision 4 of this Regulatory Guide for remaining scope is documented below.			
	C.4		Conforms	
	Regulatory Guide 1.30, Rev. 0, 8/72 – Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electric Equipment			
	Conformance for DCD scope of work is as stated in the DCD. Conformance for remaining scope is documented below.			
	General		Exception	Quality assurance requirements utilize the more recently NRC endorsed NQA-1 in lieu of the identified outdated standards.
	Regulatory Guide 1.32, Rev. 3, 03/04 – Criteria for Power Systems for Nuclear Power Plants			
	Conformance of the design aspects with Revision 2 of the Regulatory Guide is as stated in the DCD. Conformance with Revision 3 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
	General		Conforms	
	Regulatory Guide 1.33, Rev. 2, 2/78 – Quality Assurance Program Requirements (Operation)			
	C.1		Conforms	
	C.2		Clarification	See separate conformance statement for each identified Regulatory Guide.
	C.3–C.5		Conforms	
	Regulatory Guide 1.37, Rev. 1, 3/07 – Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water Cooled Nuclear Power Plants			
	Conformance of the design aspects with Revision 0 of the Regulatory Guide is as stated in the DCD. Conformance with Revision 1 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
	General		Conforms	

	Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
STD COL 1.9-1	**Regulatory Guide 1.38, Rev. 2, 5/77 – Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage and Handling of Items for Water-Cooled Nuclear Power Plants**			
	Conformance for DCD scope of work is as stated in the DCD. Conformance for remaining scope is documented below.			
	General		Exception	Quality assurance requirements utilize the more recently NRC endorsed NQA-1 in lieu of the identified outdated standards.
	Regulatory Guide 1.39, Rev. 2, 9/77 – Housekeeping Requirements for Water-Cooled Nuclear Power Plants			
	Conformance for DCD scope of work is as stated in the DCD. Conformance for remaining scope is documented below.			
	General		Exception	Quality assurance requirements utilize the more recently NRC endorsed NQA-1 in lieu of the identified outdated standards.
PTN COL 1.9-1	**Regulatory Guide 1.45, Rev. 1, 5/08 – Guidance on Monitoring and Responding to Reactor Coolant System Leakage**			
	Conformance of the design aspects with Revision 0 of the Regulatory Guide is as stated in the DCD. Conformance with Revision 1 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
	C.7		Conforms	
STD COL 1.9-1	**Regulatory Guide 1.52, Rev. 3, 6/01 – Design, Inspection and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants**			
PTN DEP 6.4-1	Conformance with the design and operational aspects is as stated in the DCD, with the exception of Criteria Section C.4.9 and Table 1. Conformance with Section C.4.9 and Table 1 is documented below.			
	C.4.9		Conforms	
	Table 1		Conforms	
	Regulatory Guide 1.53, Rev. 2, 11/03 – Application of the Single-Failure Criterion to Safety Systems			
	Conformance of the design aspects with Revision 0 of the Regulatory Guide is as stated in the DCD. This guidance is completely within the scope of the DCD.			
	Regulatory Guide 1.54, Rev. 1, 7/00 – Service Level I, II, And III Protective Coatings Applied To Nuclear Power Plants			
	Conformance of the design aspects is as stated in the DCD. Conformance with programmatic and/or operational aspects is documented below.			
	General		Conforms	
	Regulatory Guide 1.57, Rev. 1, 3/07 – Design Limits and Loading Combinations for Metal Primary Reactor Containment System Components			
	Conformance with Revision 0 of the Regulatory Guide is as stated in the DCD. This guidance is completely within the scope of the DCD.			

Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
Regulatory Guide 1.59, Rev. 2, 8/77 – Design Basis Floods for Nuclear Power Plants			
STD COL 1.9-1 General		Exception	Regulatory Guide 1.59, Appendix A indicates use of ANSI N170-1976 “Standards for Determining Design Basis Flooding at Power Reactor Sites.” In place of this standard, ANSI/ANS 2.8-1992 “Determining Design Basis Flooding at Power Reactor Sites” was used. ANSI/ANS 2.8-1992 was withdrawn on July 26, 2002. However, a replacement standard has not been issued. NUREG-0800 2.4.3 Revision 4, March 2007 and 2.4.4 Revision 3, March 2007 include ANSI/ANS 2.8-1992 as a reference. ANSI/ANS 2.8-1992 is also specifically identified in the review procedures subsection of NUREG-0800 2.4.4.
Regulatory Guide 1.61, Rev. 1, 3/07 – Damping Values for Seismic Design of Nuclear Power Plants			
Conformance with Revision 0 of the Regulatory Guide is as stated in the DCD. This guidance is completely within the scope of the DCD.			
Regulatory Guide 1.65, Rev. 0, 10/73 – Materials and Inspections for Reactor Vessel Closure Studs			
Conformance of the design aspects is as stated in the DCD. Conformance with programmatic and/ or operational aspects is documented below.			
C.3		Conforms	
C.4		Exception	ASME XI ISI criteria for reactor vessel closure stud examinations are applied in lieu of the ASME III NB 2545 and NB 2546 surface examinations. The volumetric examinations currently required by ASME XI provide improved (since 1973) detection of bolting degradation.
Regulatory Guide 1.68, Rev. 3, 3/07 – Initial Test Program for Water-Cooled Nuclear Power Plants			
Conformance with Revision 2 of the Regulatory Guide is documented in the DCD. Conformance of the design aspects is as stated in the DCD. Conformance with Revision 3 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
C2-C.9 Appendix B Appendix C		Conforms	
Regulatory Guide 1.70, Rev. 3, 11/78, Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)			
General		Exception	The format and content of the FSAR follow Regulatory Guide 1.206 and the AP1000 Design Control Document as required by Appendix D of 10 CFR Part 52.
Regulatory Guide 1.71, Rev. 1, 3/07 – Welder Qualification for Areas of Limited Accessibility			
Conformance of the design aspects with Revision 0 of the Regulatory Guide is as stated in the DCD. Conformance with Revision 1 of the Regulatory Guide during the operational phase (i.e., after the construction phase is completed per the DCD) is documented below.			
General		Conforms	

Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
STD COL 1.9-1 **Regulatory Guide 1.75, Rev. 3, 2/05 – Criteria for Independence of Electrical Safety Systems**			
Conformance with Revision 2 of the Regulatory Guide is as stated in the DCD. This guidance is completely within the scope of the DCD.			
Regulatory Guide 1.76, Rev. 1, 3/07 – Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants			
Conformance with Revision 0 of the Regulatory Guide is as stated in the DCD. This guidance is completely within the scope of the DCD.			
Regulatory Guide 1.78, Rev. 1, 12/01 – Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release			
Conformance with the design aspects is as stated in the DCD. Conformance with programmatic and/or operational aspects is documented below.			
General		Conforms	
Regulatory Guide 1.82, Rev. 3, 11/03 – Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident			
Conformance with the design aspects is as stated in the DCD. Conformance with programmatic and/or operational aspects is documented below.			
C.1.1.2		Conforms	
C.1.1.5		Conforms	
Regulatory Guide 1.83, Rev. 1, 7/75 - Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes			
Conformance of the design aspects is as stated in the DCD. The programmatic and/or operational aspects are not applicable since this guidance was withdrawn by NRC (74 FR 58324, 11/12/2009).			
PTN COL 1.9-1 **Regulatory Guide 1.84, Rev. 34, 10/07 – Design, Fabrication, and Materials Code Case Acceptability, ASME Section III**			
Conformance with Revision 32 of the Regulatory Guide is as stated in the DCD. This guidance is completely within the scope of the DCD.			
STD COL 1.9-1 **Regulatory Guide 1.86, Rev. 0, 6/74 - Termination of Operating Licenses for Nuclear Reactors**			
This Regulatory Guide is outside the scope of the FSAR.			
Regulatory Guide 1.91, Rev. 1, 2/78 – Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants			
Conformance of the design aspects is as stated in the DCD. Conformance with Revision 1 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
General		Conforms	
Regulatory Guide 1.92, Rev. 2, 07/06 – Combining Modal Responses and Spatial Components in Seismic Response Analysis			
Conformance with Revision 1 of the Regulatory Guide is as stated in the DCD. This guidance is completely within the scope of the DCD.			
Regulatory Guide 1.94, Rev. 1, 4/76 – Quality Assurance Requirements for Installation, Inspection and Testing of Structural Concrete and Structural Steel During the Construction Phase of Nuclear Power Plants			
Conformance for DCD scope of work is as stated in the DCD. Conformance for remaining scope is documented below.			
General		Exception	Quality assurance requirements utilize the more recently NRC endorsed NQA-1 in lieu of the identified outdated standards.

Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
STD COL 1.9-1 **Regulatory Guide 1.97, Rev. 4, 6/06 – Criteria For Accident Monitoring Instrumentation For Nuclear Power Plants**			
Conformance with this Regulatory Guide for programmatic and/or operational aspects is documented below.			
General		Exception	Portable equipment outside the DCD scope conforms to Revision 3 of this Regulatory Guide for consistency with DCD scope since Revision 4 indicates that partial implementation is not advised.
Regulatory Guide 1.101, Rev. 5, 6/05 – Emergency Response Planning and Preparedness for Nuclear Power Reactors			
General		Exception	Rev. 5 is not applicable for this site. Rev. 3 and 4 are essentially the same except for endorsement of NEI 99-01 which is not directly applicable to the AP1000 passive design. The EP conforms to Rev. 3 and 4 with the exception that the EALs are written with necessary modifications to address the passive plant design.
Regulatory Guide 1.109, Rev. 1, 10/77 – Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I			
Conformance of the design aspects is as stated in the DCD. Conformance with Revision 1 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
General		Conforms	
Regulatory Guide 1.110, Rev. 0, 3/76 – Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors			
Conformance of the design aspects is as stated in the DCD. Conformance with Revision 0 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
General		Conforms	
Regulatory Guide 1.111, Rev. 1, 7/77 – Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors			
General		Conforms	
Regulatory Guide 1.112, Rev. 1, 3/07 – Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Nuclear Power Reactors			
Conformance of the design aspects with Revision 0-R of the Regulatory Guide is as stated in the DCD. Conformance with Revision 1 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
General	ANSI 18.1-1999	Conforms	
Regulatory Guide 1.113, Rev. 1, 4/77 – Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I			
General		Conforms	
PTN COL 1.9-1 **Regulatory Guide 1.114, Rev. 3, 10/08 – Guidance to Operators at the Controls and to Senior Operators in the Control Room of a Nuclear Power Unit**			
General		Conforms	
STD COL 1.9-1 **Regulatory Guide 1.115, Rev. 1, 7/77 – Protection Against Low-Trajectory Turbine Missiles**			
Conformance of the design aspects is as stated in the DCD. Conformance with Revision 1 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
General		Conforms	

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Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
Regulatory Guide 1.116, Rev. 0-R, 5/77 – Quality Assurance Requirements for Installation, Inspection, and Testing of Mechanical Equipment and Systems			
Conformance for DCD scope of work is as stated in the DCD. Conformance for remaining scope is documented below.			
General		Exception	Quality assurance requirements utilize the more recently NRC endorsed NQA-1 in lieu of the identified outdated standards.
Regulatory Guide 1.124, Rev. 2, 02/07 – Service Limits and Loading Combinations for Class 1 Linear-Type Supports			
Conformance with Revision 1 of the Regulatory Guide is as stated in the DCD. This guidance is completely within the scope of the DCD.			
Regulatory Guide 1.128, Rev. 2, 2/07 – Installation Design and Installation of Vented Lead-Acid Storage Batteries for Nuclear Power Plants			
Conformance with Revision 1 of the Regulatory Guide is as stated in the DCD. This guidance is completely within the scope of the DCD.			
Regulatory Guide 1.129, Rev. 2, 2/07 – Maintenance, Testing, and Replacement of Vented Lead-Acid Storage Batteries for Nuclear Power Plants			
General	IEEE Std. 450-2002	Exception	Approved Generic Technical Specifications are based on IEEE Std 450-1995.
Regulatory Guide 1.130, Rev. 2, 3/07 - Service Limits and Loading Combinations for Class 1 Plate-And-Shell-Type Supports			
Conformance with Revision 1 of the Regulatory Guide is as stated in the DCD. This guidance is completely within the scope of the DCD.			
Regulatory Guide 1.132, Rev. 2, 10/03 – Site Investigations for Foundations of Nuclear Power Plants			
General		Conforms	
Regulatory Guide 1.133, Rev. 1, 5/81 – Loose-Part Detection Program for the Primary System of Light-Water-Cooled Reactors			
Conformance of the design aspects is as stated in the DCD. Conformance with Revision 1 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
C.2b		Conforms	Procedures are addressed in Section 13.5
C.3a		Conforms	Procedures are addressed in Section 13.5
C.4g		Conforms	Procedures are addressed in Section 13.5
C.4h		Conforms	Procedures are addressed in Section 13.5
C.4i		Conforms	ALARA is addressed in Chapter 12 and Section 13.5
C.4j		Conforms	Training is addressed in Section 13.2
C.6		Exception	Regulatory Guide 1.16 has been withdrawn. Event reporting is performed in accordance with 10 CFR 50.72 and 50.73 utilizing the guidance of NUREG-1022
Regulatory Guide 1.134, Rev. 3, 3/98 – Medical Evaluation of Licensed Personnel at Nuclear Power Plants			
General		Conforms	
Regulatory Guide 1.135, Rev. 0, 9/77 – Normal Water Level and Discharge at Nuclear Power Plants			
Conformance of the design aspects is as stated in the DCD. The programmatic and/or operational aspects are not applicable since this guidance was withdrawn by NRC (74 FR 39349, 08/06/2009).			

	Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
STD COL 1.9-1	**Regulatory Guide 1.138, Rev. 2, 12/03 – Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants**			
	General		Conforms	
	Regulatory Guide 1.139, Rev. 0, 5/78 – Guidance for Residual Heat Removal			
	Conformance with the design aspects is as stated in the DCD. The programmatic and/or operational aspects are not applicable since this guidance was withdrawn by NRC (73 FR 32750, 06/10/2008).			
PTN COL 1.9-1	**Regulatory Guide 1.143, Rev. 2, 11/01 – Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants**			
	Conformance for DCD scope of design is as stated in the DCD. Conformance for site-specific scope of design and for programmatic and/or operational aspects is documented below.			
	General		Conforms	
STD COL 1.9-1	**Regulatory Guide 1.145, Rev. 1, 11/82 (Revised 2/83 to correct page 1.145-7) – Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants**			
	General		Conforms	
PTN COL 1.9-1	**Regulatory Guide 1.147, Rev. 15, 10/07 – Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1**			
	Conformance with Revision 12 of the Regulatory Guide is documented in the DCD. Conformance of the design aspects is as stated in the DCD. Conformance with Revision 15 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
	General		Conforms	
STD COL 1.9-1	**Regulatory Guide 1.149, Rev. 3, 10/01 – Nuclear Power Plant Simulation Facilities for Use in Operator Training and License Examinations**			
	C.1		Conforms	During cold licensing, training is conducted using a simulator with limited scope in accordance with Appendix D of ANSI/ANS-3.5-1998. Operator Licensing examinations are conducted on a simulator meeting the applicable requirements of ANSI/ANS-3.5-1998.
	Regulatory Guide 1.150, Rev. 1, 2/83 – Ultrasonic Testing of Reactor Vessel Welds During Preservice and Inservice Examinations			
	Conformance with the design aspects is as stated in the DCD. The programmatic and/or operational aspects are not applicable since this guidance was withdrawn by NRC (73 FR 7766, 02/11/2008).			
	Regulatory Guide 1.152, Rev. 2, 1/06 – Criteria for Use of Computers in Safety Systems of Nuclear Power Plants			
	Conformance of the design aspects with Revision 1 of the Regulatory Guide is as stated in the DCD. Conformance with Revision 2 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
	General		Exception	The Cyber Security Program is based on March 2009 revisions of the 10 CFR 73.54 regulations in lieu of Revision 2 of this Regulatory Guide.
	Regulatory Guide 1.154, Rev. 0, 1/87 – Format and Content of Plant-Specific Pressurized Thermal Shock Safety Analysis Reports for Pressurized Water Reactors			
	General		Conforms	

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Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
Regulatory Guide 1.159, Rev. 1, 10/03 – Assuring the Availability of Funds for Decommissioning Nuclear Reactors			
General		N/A	This Regulatory Guide is outside the scope of the FSAR.
Regulatory Guide 1.160, Rev. 2, 3/97 – Monitoring the Effectiveness of Maintenance at Nuclear Power Plants			
General		Conforms	
Regulatory Guide 1.162, Rev. 0, 2/96 – Format and Content of Report for Thermal Annealing of Reactor Pressure Vessels			
		N/A	This Regulatory Guide is outside the scope of the FSAR.
Regulatory Guide 1.163, Rev. 0, 9/95 – Performance-Based Containment Leak-Test Program			
Conformance of the design aspects is as stated in the DCD. Conformance with Revision 0 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
General		Conforms	
Regulatory Guide 1.165, Rev. 0, 3/97 – Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion			
General		N/A	Seismic analysis performed in accordance with Regulatory Guide 1.208.
Regulatory Guide 1.166, Rev. 0, 3/97 – Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post earthquake Actions			
General		Conforms	
Regulatory Guide 1.167, Rev. 0, 3/97 – Restart of a Nuclear Power Plant Shut Down by a Seismic Event			
General		Conforms	
Regulatory Guide 1.168, Rev. 1, 2/04 – Verification, Validation, Reviews, and Audits for Digital Computer Software Used in Safety Systems of Nuclear Power Plants			
Conformance of the design aspects with Revision 0 of the Regulatory Guide is as stated in the DCD. Conformance with Revision 1 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
General		Conforms	
Regulatory Guide 1.174, Rev. 1, 11/02 – An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis			
This Regulatory Guide is outside the scope of the FSAR.			
Regulatory Guide 1.175, Rev. 0, 8/98 – An Approach for Plant-Specific, Risk-Informed Decisionmaking: Inservice Testing			
Risk-informed inservice testing is not being utilized for this plant.			
Regulatory Guide 1.177, Rev. 0, 8/98 – An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications			
General		Conforms	
Regulatory Guide 1.178, Rev. 1, 9/03 – An Approach for Plant-Specific Risk-Informed Decisionmaking for Inservice Inspection of Piping			
Risk-informed inservice inspection is not being utilized for this plant.			
Regulatory Guide 1.179, Rev. 0, 1/99 – Standard Format and Content of License Termination Plans for Nuclear Power Reactors			
		N/A	This Regulatory Guide is outside the scope of the FSAR.

Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
Regulatory Guide 1.180, Rev. 1, 10/03 – Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems			
Conformance of the design aspects is as stated in the DCD. Conformance with Revision 1 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
General		Conforms	Exclusion zones are established through administrative controls to prohibit the activation of portable EMI/RFI emitters (e.g., welders and transceivers) in areas where safety-related I&C systems are installed.
Regulatory Guide 1.181, Rev. 0, 9/99 – Content of the Updated Final Safety Analysis Report in Accordance with 10 CFR 50.71(e)			
General		Conforms	
Regulatory Guide 1.182, Rev. 0, 5/00 – Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants			
General		Conforms	
Regulatory Guide 1.184, Rev. 0, 7/00 – Decommissioning of Nuclear Power Reactors			
		N/A	This Regulatory Guide is outside the scope of the FSAR.
Regulatory Guide 1.185, Rev. 0, 7/00 – Standard Format and Content for Post-shutdown Decommissioning Activities Report			
		N/A	This Regulatory Guide is outside the scope of the FSAR.
Regulatory Guide 1.186, Rev. 0, 12/00 – Guidance and Examples for Identifying 10 CFR 50.2 Design Bases			
		N/A	This Regulatory Guide is outside the scope of the FSAR.
Regulatory Guide 1.187, Rev. 0, 11/00 – Guidance for Implementation of 10 CFR 50.59, Changes, Tests, and Experiments			
General		Conforms	
Regulatory Guide 1.188, Rev. 1, 9/05 – Standard Format and Content for Applications To Renew Nuclear Power Plant Operating Licenses			
		N/A	This Regulatory Guide is outside the scope of the FSAR.
Regulatory Guide 1.189, Rev. 1, 3/07 – Fire Protection for Nuclear Power Plants			
Conformance with Revision 0 of the Regulatory Guide is documented in the DCD. Conformance of the design aspects is as stated in the DCD. Conformance with Revision 1 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
General		Conforms	
Regulatory Guide 1.191, Rev. 0, 5/01 – Fire Protection Program for Nuclear Power Plants During Decommissioning and Permanent Shutdown			
		N/A	This Regulatory Guide is outside the scope of the FSAR.
Regulatory Guide 1.192, Rev. 0, 6/03 – Operation and Maintenance Code Case Acceptability, ASME OM Code			
General		Conforms	
Regulatory Guide 1.193, Rev. 1, 8/05 – ASME Code Cases Not Approved for Use			
General		Conforms	

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Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
Regulatory Guide 1.194, Rev. 0, 6/03 – Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants			
General		Conforms	
Regulatory Guide 1.195, Rev. 0, 5/03 – Methods and Assumptions for Evaluating Radiological Consequences of Design Basis Accidents at Light-Water Nuclear Power Reactors			
This Regulatory Guide is not applicable to the AP1000 certified design.			
Regulatory Guide 1.196, Rev. 1, 1/07 – Control Room Habitability at Light-Water Nuclear Power Reactors			
Conformance with Revision 1 of this Regulatory Guide for programmatic and/or operational aspects is documented below. This Regulatory Guide is not applicable to the AP1000 certified design.			
General		Conforms	
Regulatory Guide 1.197, Rev. 0, 5/03 – Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors			
Conformance with the design aspects is as stated in the DCD. Conformance with programmatic and/or operational aspects is documented below.			
General		Conforms	
Regulatory Guide 1.198, Rev. 0, 11/03 – Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites			
General		Conforms	
Regulatory Guide 1.199, Rev. 0, 11/03 – Anchoring Components and Structural Supports in Concrete			
Conformance with Revision 0 of the Regulatory Guide is as stated in the DCD. This guidance is completely within the scope of the DCD.			
Regulatory Guide 1.200, Rev. 1, 1/07 – An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities			
General		Conforms	
Regulatory Guide 1.201, Rev. 1, 5/06 – Guidelines for Categorizing Structures, Systems, and Components in Nuclear Power Plants According to Their Safety Significance			
This Regulatory Guide is not applicable to the AP1000 certified design.			
Regulatory Guide 1.202, Rev. 0, 2/05 – Standard Format and Content of Decommissioning Cost Estimates for Nuclear Power Reactors			
This Regulatory Guide is outside the scope of the FSAR.			
Regulatory Guide 1.203, Rev. 0, 12/05 – Transient and Accident Analysis Methods			
This Regulatory Guide is not applicable to the AP1000 certified design.			
Regulatory Guide 1.204, Rev. 0, 11/05 – Guidelines for Lightning Protection of Nuclear Power Plants			
General		Conforms	
Regulatory Guide 1.205, Rev. 0, 5/06 – Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants			
This Regulatory Guide is not applicable to the AP1000 certified design.			
Regulatory Guide 1.206, Rev. 0, 6/07 – Combined License Applications for Nuclear Power Plants (LWR Edition)			
General	Format	Conforms	
General	Content	Exception	Exceptions to content are identified in Table 1.9-202.

	Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
STD COL 1.9-1	**Regulatory Guide 1.207, Rev. 0, 3/07 – Guidelines for Evaluating Fatigue Analyses Incorporating the Life Reduction of Metal Components Due to the Effects of the Light-Water Reactor Environment for New Reactors**			
	This Regulatory Guide is not applicable to the AP1000 certified design.			
	Regulatory Guide 1.208, Rev. 0, 3/07 – A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion			
	General		Conforms	
	Regulatory Guide 1.209, Rev. 0, 3/07 – Guidelines for Environmental Qualification of Safety-Related Computer-Based Instrumentation and Control Systems in Nuclear Power Plants			
	This Regulatory Guide is not applicable to the AP1000 certified design.			
PTN COL 1.9-1	**Regulatory Guide 1.210, Rev. 0, 06/08 – Qualification of Safety-Related Battery Chargers and Inverters for Nuclear Power Plants**			
	This Regulatory Guide is not applicable to the AP1000 certified design.			
	Regulatory Guide 1.212, Rev. 0, 11/08 – Sizing of Large Lead-Acid Storage Batteries			
	General	IEEE Std 485-1997	Conforms	TS Bases 3.8.1 states that criteria defined in IEEE-485 are used.
	Regulatory Guide 1.221, Rev. 0, 10/11 – Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants			
	This Regulatory Guide is not applicable to the AP1000 certified design.			
	DIVISION 4 – Environmental and Siting			
STD COL 1.9-1	**Regulatory Guide 4.7 Rev. 2, 4/98 – General Site Suitability Criteria for Nuclear Power Stations**			
	General		Conforms	
PTN COL 1.9-1	**Regulatory Guide 4.15, Rev. 2, 7/07 – Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) – Effluent Streams and the Environment**			
	General		Conforms	
	Regulatory Guide 4.21, Rev. 0, 6/08 – Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning			
	General		Conforms	
STD COL 1.9-1	**DIVISION 5 – Materials and Plant Protection**			
	The plant-specific physical security plans include no substantive deviations from the NRC-endorsed template in NEI 03-12, Rev. 6. Therefore, the degree of conformance with Division 5 regulatory guides for the Physical Security Plan, Training and Qualification Plan, and Safeguards Contingency Plan is consistent with the degree of conformance of NEI 03-12, Rev. 6.			
	Regulatory Guide 5.9, Rev. 2, 12/83 – Guidelines for Germanium Spectroscopy Systems for Measurement of Special Nuclear Material			
			N/A	This Regulatory Guide is outside the scope of the FSAR.
	Regulatory Guide 5.12, Rev. 0, 11/73 – General Use of Locks in the Protection and Control of Facilities and Special Nuclear Materials			
	Conformance of the design aspects is as stated in the DCD.			
			N/A	This Regulatory Guide is outside the scope of the FSAR.

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Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
Regulatory Guide 5.65, Rev. 0, 9/86 – Vital Area Access Controls, Protection of Physical Security Equipment, and Key and Lock Controls			
Conformance of the design aspects is as stated in the DCD.			
		N/A	This Regulatory Guide is outside the scope of the FSAR.
Regulatory Guide 5.71, Rev. 0, 1/10 – Cyber Security Programs for Nuclear Facilities			
Conformance with regulatory positions C.1 through C.5 of Regulatory Guide 5.71, Rev. 0, is as stated in the Cyber Security Plan (CSP), with exceptions to the guidance as noted in Attachment A of the CSP.			
DIVISION 8 – Occupational Health			
Regulatory Guide 8.2, Rev. 0, 2/73 – Guide for Administrative Practices in Radiation Monitoring			
General	10 CFR Part 20; ANSI 13.2-1969	Exception	The reference to 10 CFR 20.401 is no longer valid in the current version of 10 CFR Part 20. ANSI N13.2-1969 was reaffirmed in 1988.
Regulatory Guide 8.4, Rev. 0, 2/73 - Direct-Reading and Indirect-Reading Pocket Dosimeters			
General	10 CFR Part 20 ANSI N13.5-1972	Exception	The reference to 10 CFR 20.202 (a) and 20.401 is no longer valid in the current version of 10 CFR Part 20. ANSI N13.5-1972 was reaffirmed in 1989. The two performance criteria specified in Regulatory Guide 8.4 (accuracy and leakage) for these devices are met using acceptance standards in ANSI N322-1997 "American National Standard Inspection, Test, Construction, and Performance Requirements for Direct Reading Electrostatic/Electroscope Type Dosimeters".
Regulatory Guide 8.5, Rev. 1, 3/81 - Criticality and Other Interior Evacuation Signals			
General		Conforms	
Regulatory Guide 8.6, Rev. 0, 5/73 - Standard Test Procedure for Geiger-Muller Counters			
General		Exception	Instrument calibration program is based upon criteria in ANSI N323A-1997 (with 2004 Correction Sheet) “Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments.” The ANSI 42.3-1969 Standard is no longer recognized as sufficient for calibration of modern instruments.

	Criteria Selection	Referenced Criteria	FSAR Position	Clarification/ Summary Description of Exceptions
STD COL 1.9-1	**Regulatory Guide 8.7, Rev. 2, 11/05 - Instructions for Recording and Reporting Occupational Radiation Dose Data**			
	General		Conforms	
	Regulatory Guide 8.8, Rev. 3, 6/78 – Information Relevant to Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable			
	Conformance of the design aspects is as stated in the DCD. Conformance with Revision 3 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
	C.1		Conforms	
	C.3.a		Conforms	
	C.3.b		Exception	Regulatory Guide 1.16 C.1.b.(3) data is no longer reported. Reporting per C.1.b(2) is also no longer required.
	C.3.c		Conforms	
	C.4.b-C.4.d	ANSI Z-88.2, Regulatory Guide 8.15, NUREG-0041	Conforms	Conformance is with the latest revision of NUREG-0041.
	Regulatory Guide 8.9, Rev. 1, 7/93 – Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program			
	General		Conforms	
	Regulatory Guide 8.10, Rev. 1-R, 5/77 – Operating Philosophy For Maintaining Occupational Radiation Exposures as Low as is Reasonably Achievable			
	General		Conforms	
	Regulatory Guide 8.13, Rev. 3, 6/99 – Instruction Concerning Prenatal Radiation Exposure			
	General		Conforms	
	Regulatory Guide 8.15, Rev. 1, 10/99 – Acceptable Programs for Respiratory Protection			
	General		Conforms	
	Regulatory Guide 8.27, Rev. 0, 3/81 – Radiation Protection Training for Personnel at Light-Water-Cooled Nuclear Power Plants			
	General		Conforms	
	Regulatory Guide 8.28, Rev. 0, 8/81 – Audible-Alarm Dosimeters			
	General	ANSI N13.27-1981	Conforms	
	Regulatory Guide 8.29, Rev. 1, 2/96 – Instruction Concerning Risks from Occupational Radiation Exposure			
	General		Conforms	
	Regulatory Guide 8.34, Rev. 0, 7/92 – Monitoring Criteria and Methods To Calculate Occupational Radiation Doses			
	General		Conforms	
	Regulatory Guide 8.35, Rev. 0, 6/92 – Planned Special Exposures			
	General		Conforms	
	Regulatory Guide 8.36, Rev. 0, 7/92 – Radiation Dose to the Embryo/Fetus			
	General		Conforms	
	Regulatory Guide 8.38, Rev. 1, 5/06 – Control of Access to High and Very High Radiation Areas in Nuclear Power Plants			
	Conformance of the design aspects is as stated in the DCD. Conformance with Revision 1 of this Regulatory Guide for programmatic and/or operational aspects is documented below.			
	General		Conforms	

Notes:
(1) - Above stated general alternatives regarding the use of previous revisions of the Regulatory Guide for design aspects as stated in the DCD is provided to preserve the finality of the certified design. Further, each stated conformance with the programmatic and/or operational aspects is only to the extent that a design change or departure from the approved DCD is not required to implement those programmatic and/or operational aspects. As the operational and programmatic aspects become more fully defined (for example, during the preparation, approval, or initial implementation of plant procedures), there exists a potential that a conflict could be identified between the design as certified in the DCD and the programmatic and/or operational aspects of the guidance. In such cases, the design certification (rule) becomes the controlling factor, and the design conformance to the Regulatory Guide is per the revision stated in the DCD.

(2) - A “Criteria Section” entry of “General” indicates a scope for the conformance statement of “all regulatory guide positions related to programmatic and/or operational aspects.” Thus, an associated conformance statement of “Conforms” indicates that the applicant “complies with all regulatory guide positions related to programmatic and/or operational aspects.”

SECTION 2.0: SITE CHARACTERISTICS
TABLE OF CONTENTS

SECTION 2.0 LIST OF TABLES

CHAPTER 2 SITE CHARACTERISTICS

The introductory information at the beginning of Chapter 2 of the referenced DCD is incorporated by reference with the following departures and/or supplements.

Insert the following subsection at the end of the introductory text of DCD Chapter 2, before DCD Section 2.1.

PTN SUP 2.0-1

2.0 SITE CHARACTERISTICS

Chapter 2 describes the characteristics and site-related design parameters of Turkey Point Units 6 & 7. The site location, characteristics, and parameters, as described in the following sections, are provided in sufficient detail to support a safety assessment of the proposed site:

Section 2.1 — Geography and Demography

Section 2.2 — Nearby Industrial, Transportation, and Military Facilities

Section 2.3 — Meteorology

Section 2.4 — Hydrologic Engineering

Section 2.5 — Geology, Seismology, and Geotechnical Engineering

In this chapter, the following terms are used to describe the Turkey Point plant site and surrounding area:

Turkey Point Plant Site — The Units 6 & 7 plant area is part of the larger Turkey Point plant property in unincorporated Miami-Dade County, Florida. The approximately 9400-acre Turkey Point plant property comprises two oil/gas-fired (Units 1 & 2), one gas-fired combined-cycle (Unit 5), and (with the addition of Units 6 & 7) four nuclear powered (Units 3, 4, 6 & 7) steam electric generating units. Figure 2.1-201 shows the Turkey Point site and the surrounding area within 50 miles. Figure 2.1-202 shows the general location of the Turkey Point property and localities surrounding the site within 10 miles.

Vicinity — The area from the center point of the power block footprint to a 5-mile radius. The vicinity includes a much larger tract of land than the Turkey Point plant property. The vicinity is located in Miami-Dade County. For descriptions within

Section 2.5 only, vicinity is defined in accordance with RG 1.208 as a 40-kilometer (25-mile) radius.

Region — The area from the center point of the power block footprint to a 50-mile radius. The Turkey Point plant property is located in a rural, sparsely populated area. For descriptions within Section 2.5 only, region is defined in accordance with RG 1.208 as a 320-kilometer (200-mile) radius.

Table 2.0-201 provides a comparison of site-related design parameters for which the AP1000 plant is designed and site characteristics specific to Units 6 & 7 in support of this safety assessment. The first two columns of Table 2.0-201 are a compilation of the site parameters from DCD Table 2-1 and DCD Tier 1 Table 5.0-1. The third column of Table 2.0-201 is the corresponding site characteristic. The fourth column denotes the section or table in the Units 6 & 7 FSAR where this data is presented. The last column indicates whether or not the site characteristic is bounded by the corresponding DCD site parameter. “Yes” indicates the site characteristic falls within the parameter, while “No” indicates it does not. Where a “No” is indicated, a justification is provided in the FSAR reference. Control room atmospheric dispersion values, expressed as X/Q for all applicable accident analyses, are presented in Table 2.0-202. All of the control room values fall within the DCD acceptance criteria.

PTN SUP 2.0-1

Table 2.0-201 (Sheet 1 of 8)
Comparison of DCD Site Parameters and Turkey Point Units 6 & 7 Site Characteristics

		AP 1000 DCD Site Parameters[a]	Units 6 & 7 Site Characteristics	Units 6 & 7 Site Characteristic Reference	Bounding Yes/No
	Air Temperature				
	Maximum Safety[b]	115°F dry bulb/86.1°F coincident wet bu b[c]	103°F dry bulb/75.2°F coincident wet bulb (100-year return period)	Subsection 2.3.1.5	Yes
PTN DEP 2.0-3		86.1°F wet bu b (noncoincident)	87.4°F wet bulb (non-coincident) (100-year return estimate of 2-hour duration)	Subsection 2.3.1.5	No[d]
	Minimum Safety[b]	–40°F	17.9°F (100-year return period)	Subsection 2.3.1.5	Yes
	Maximum Normal[e]	101°F dry bulb /80.1°F coincident wet bulb	91.3°F dry bu b/79.3°F coincident wet bulb (0.4 percent annual exceedance)	Subsection 2.3.1.5	Yes
PTN DEP 2.0-2		80.1°F wet bu b (noncoincident)[f]	81.5°F wet bulb (non-coincident) (0.4 percent annual exceedance)	Subsection 2.3.1.5	No[d]
	Minimum Normal[e]	–10°F	46.9°F (99.6 percent annual exceedance)	Subsection 2.3.1.5	Yes
	Wind Speed				
PTN DEP 2.0-1	Operating Basis	145 mph (3-second gust); importance factor 1.15 (safety), 1.0 (nonsafety); exposure C; topographic factor 1.0	150 mph (3-second gust, 50-year return) 161 mph (3-second gust, 100-year return); importance factor 1.15 (safety), 1.0 (nonsafety); exposure C; topographic factor 1.0	Subsection 2.3.1.3.1	No[d]
	Tornado	300 mph	200 mph[m]	Subsection 2.3.1.3.2	Yes
		Maximum pressure differential of 2.0 b/in^2	0.9 lb/in^2	Subsection 2.3.1.3.2	Yes

PTN SUP 2.0-1

Table 2.0-201 (Sheet 2 of 8)
Comparison of DCD Site Parameters and Turkey Point Units 6 & 7 Site Characteristics

	AP 1000 DCD Site Parameters[a]	Units 6 & 7 Site Characteristics	Units 6 & 7 Site Characteristic Reference	Bounding Yes/No
Seismic				
CSDRS	CSDRS free field peak ground acceleration of 0.30 g with modified Regulatory Guide 1.60 response spectra[g][h] (See Figures 5.0-1 and 5.0-2). The SSE is now referred to as CSDRS. Seismic input is defined at finished grade except for sites where the nuclear island is founded on hard rock. If the site-specific spectra exceed the response spectra in Figures 5.0-1 and 5.0-2 at any frequency, or if soil conditions are outside the range evaluated for AP1000 design certification, a site-specific evaluation can be performed. This evaluation will consist of a site-specific dynamic analysis and generation of in-structure response spectra at key locations to be compared with the floor response spectra of the certified design at 5-percent damping. The site is acceptable if the floor response spectra from the site-specific evaluation do not exceed the AP1000 spectra for each of the locations or the exceedances are justified.	Peak ground acceleration:(g) 0.06g horizontal 0.06g vertical GMRS peak ground acceleration defined at 100 Hz. Ground Motion Response Spectra: The horizontal and vertical GMRS are bounded by the certified seismic design response spectra (CSDRS)	Subsection 2.5.2.6 Figure 2.5.2-253 Figure 2.5.2-254 Figure 3.7-202	Yes

PTN SUP 2.0-1

Table 2.0-201 (Sheet 3 of 8) Comparison of DCD Site Parameters and Turkey Point Units 6 & 7 Site Characteristics

	AP 1000 DCD Site Parameters[(a)]	Units 6 & 7 Site Characteristics	Units 6 & 7 Site Characteristic Reference	Bounding Yes/No
CSDRS (cont.)	The hard rock high frequency (HRHF) envelope response spectra are shown in Figure 5.0-3 and Figure 5.0-4 defined at the foundation level for 5% damping. The HRHF envelope response spectra provide an alternative set of spectra for evaluation of site specific GMRS. A site is acceptable if its site specific GMRS fall within the AP1000 HRHF envelope response spectra. Evaluation of a site for application of the HRHF envelope response spectra includes consideration of the limitation on shear wave velocity identified for use of the HRHF envelope response spectra. This limitation is defined by a shear wave velocity at the bottom of the basemat equal to or higher than 7,500 fps, while maintaining a shear wave velocity equal to or above 8,000 fps at the lower depths.			
Fault Displacement Potential	No potential fault displacement considered beneath the seismic Category I and seismic Category II structures and immediate surrounding area. The immediate surrounding area includes the effective soil supporting media associated with the seismic Category I and seismic Category II structures.	No fault displacement potential within the investigative area.	Subsection 2.5.3.8	Yes

PTN SUP 2.0-1

Table 2.0-201 (Sheet 4 of 8)
Comparison of DCD Site Parameters and Turkey Point Units 6 & 7 Site Characteristics

	AP 1000 DCD Site Parameters[(a)]	Units 6 & 7 Site Characteristics	Units 6 & 7 Site Characteristic Reference	Bounding Yes/No
Soil				
Average Allowable Static Bearing Capacity	The allowable bearing capacity, including a factor of safety appropriate for the design load combination, shall be greater than or equal to the average bearing demand of 8,900 lb/ft^2 over the footprint of the nuclear island at its excavation depth.	Static bearing capacity: 39,000 b/ft^2.	Subsection 2.5.4.10	Yes
Dynamic Bearing Capacity for Normal Plus Safe Shutdown Earthquake (SSE)	The allowable bearing capacity, including a factor of safety appropriate for the design load combination, shall be greater than or equal to the maximum bearing demand of 35,000 lb/ft^2 at the edge of the nuclear island at its excavation depth, or site-specific analyses demonstrate factor of safety appropriate for normal plus safe shutdown earthquake loads.	Dynamic bearing capacity: 41,000 lb/ft^2.	Subsection 2.5.4.10	Yes
Shear Wave Velocity	Greater than or equal to 1,000 ft/sec based on minimum low-strain soil properties over the footprint of the nuclear island at its excavation depth.	Materials below nuclear island subgrades have V_S greater than 1000 ft/sec.	Subsection 2.5.4.2 Table 2.5.4-215	Yes
Lateral Variability	Soils supporting the nuclear island should not have extreme variations in subgrade stiffness. This may be demonstrated by one of the following:	The natural soil conditions along with the placement of lean concrete fill over the Key Largo Limestone provide uniform soil conditions under all Category 1 structures as defined by RG 1.132.	Subsection 2.5.4.10	Yes

PTN SUP 2.0-1

Table 2.0-201 (Sheet 5 of 8)
Comparison of DCD Site Parameters and Turkey Point Units 6 & 7 Site Characteristics

	AP 1000 DCD Site Parameters[a]	Units 6 & 7 Site Characteristics	Units 6 & 7 Site Characteristic Reference	Bounding Yes/No
Soil (cont.)				
Lateral Variability (cont.)	1. Soils supporting the nuclear island are uniform in accordance with Regulatory Guide 1.132 if the geologic and stratigraphic features at depths less than 120 feet below grade can be correlated from one boring or sounding location to the next with relatively smooth variations in thicknesses or properties of the geologic units, or 2. Site-specific assessment of subsurface conditions demonstrates that the bearing pressures below the footprint of the nuclear island do not exceed 120% of those from the generic analyses of the nuclear island at a uniform site, or 3. Site-specific analysis of the nuclear island basemat demonstrates that the site specific demand is within the capacity of the basemat. As an example of sites that are considered uniform, the variation of shear wave velocity in the material below the foundation to a depth of 120 feet below finished grade within the nuclear island footprint and 40 feet beyond the boundaries of the nuclear island footprint meets the criteria in the case outlined below: Case 1: For a layer with a low strain shear wave velocity greater than or equal to 2500 feet per second, the layer should have approximately uniform thickness, should have a dip not greater than 20 degrees, and should have less than 20 percent variation in the shear wave velocity from the average velocity in any layer.			

PTN SUP 2.0-1

Table 2.0-201 (Sheet 6 of 8)
Comparison of DCD Site Parameters and Turkey Point Units 6 & 7 Site Characteristics

	AP 1000 DCD Site Parameters[a]		Units 6 & 7 Site Characteristics	Units 6 & 7 Site Characteristic Reference	Bounding Yes/No
Soil (cont.)					
Limits of Acceptable Settlement Without Additional Evaluation[k]	Differential Across Nuclear Island Foundation Mat	1/2 inch in 50 ft	0.2 inch in 50 ft (projected)	Subsection 2.5.4.10	Yes (projected)
	Total for Nuclear Island Foundation Mat	6 inches	2.5 inches (projected)		
	Differential Between Nuclear Island and Turbine Building[l]	3 inches	0.6–0.8 inches (projected)		
	Differential Between Nuclear Island and Other Buildings[l]	3 inches	1.6–2.0 inches (projected)		
Liquefaction Potential	No liquefaction considered beneath the seismic Category I and seismic Category II structures and immediate surrounding area. The immediate surrounding area includes the effective soil supporting media associated with the seismic Category I and seismic Category II structures.		None at the site-specific SSE.	Subsection 2.5.4.10	Yes
Minimum Soil Angle of Internal Friction	Minimum soil angle of internal friction is greater than or equal to 35 degrees below the footprint of nuclear island at its excavation depth. If the minimum soil angle of internal friction is below 35 degrees, a site specific analysis shall be performed using the site specific soil properties to demonstrate stability.		Nuclear island excavations are backfilled with lean concrete up to the foundation level of the structures.	Subsection 2.5.4.10 Table 2.5.4-215	Not Applicable
Missiles[n]					
Tornado	4000- b automobile at 105 mph horizontal, 74 mph vertical		4000-lb automobile at 105 mph horizontal, 74 mph vertical	APP-GW-GLR-020, “Wind and Tornado Site Interface Criteria,” Westinghouse Electric Company, LLC.[i] Subsection 3.5.1.5	Yes
	275-lb, 8-in. shell at 105 mph horizontal, 74 mph vertical		275- b, 8-in. shell at 105 mph horizontal, 74 mph vertical		Yes
	1-in.-diameter steel ball at 105 mph in the most damaging direction		1-in.-diameter steel ball at 105 mph in the most damaging direction		Yes

PTN SUP 2.0-1

Table 2.0-201 (Sheet 7 of 8)
Comparison of DCD Site Parameters and Turkey Point Units 6 & 7 Site Characteristics

	AP 1000 DCD Site Parameters[(a)]	Units 6 & 7 Site Characteristics	Units 6 & 7 Site Characteristic Reference	Bounding Yes/No
Flood Level	Less than plant elevation 100’	DCD plant elevation of 100 ft. = 26 ft. North American Vertical Datum 1988 (NAVD 88) (design grade floor elevation) The maximum total (surge and wave action) water elevation from a probable maximum hurricane is 24.8 ft. NAVD 88.	Subsection 2.4.1.1 Subsection 2.4.5.3.3	Yes
Groundwater Level	Less than plant elevation 98’	DCD groundwater elevation of 98 ft. = 24 ft. NAVD 88. Post-construction groundwater conditions indicate an average elevation of approximately –0.4 feet NAVD 88 in the power block area.	Subsection 2.4.12.5	Yes
Plant Grade Elevation	Less than plant elevation 100’ except for portion at a higher elevation adjacent to the annex building	The design grade floor elevation is 26 feet NAVD 88, which corresponds to AP1000 elevation of 100 feet. The actual plant grade is lower and varies to accommodate site grading, drainage, and local site flooding. The finished grade elevation is 25.5 feet NAVD 88.	Subsection 2.4.1.1	Yes
Precipitation				
Rain	20.7 in./hr [1-hr 1-mi^2 PMP]	19.4 in./hr	Subsection 2.4.2.3.1 Table 2.4.2-207	Yes
Snow/Ice	75 pounds per square foot on ground with exposure factor of 1.0 and important factor of 1.2 (safety) and 1.0 (non-safety)	Based on historical data, the recurrent ground snow load for all monitoring stations is 0.026 b/ft^2; therefore, estimations of the weight of snowpack are not necessary for the Turkey Point plant site.	Subsection 2.3.1.3.4	Yes
Atmospheric Dispersion Values X/Q[(j)]				
Site Boundary (0-2 hours)	≤5.1x10^{-4} sec/m^3	4.19E-04 sec/m^3 (EAB)	Subsection 2.3.4.2	Yes

PTN SUP 2.0-1

Table 2.0-201 (Sheet 8 of 8)
Comparison of DCD Site Parameters and Turkey Point Units 6 & 7 Site Characteristics

	AP 1000 DCD Site Parameters[(a)]	Units 6 & 7 Site Characteristics	Units 6 & 7 Site Characteristic Reference	Bounding Yes/No
Site Boundary (annual average)	≤2.0×10^{-5} sec/m^3	1.7E-05 sec/m^3 (EAB)	Subsection 2.3.5.2	Yes
Low Population Zone Boundary				
0–8 hours	≤2.2×10^{-4} sec/m^3	1.87E-05 sec/m^3	Subsection 2.3.4.2	Yes
8–24 hours	≤1.6×10^{-4} sec/m^3	1.25E-05 sec/m^3	Subsection 2.3.4.2	Yes
24–96 hours	≤1.0×10^{-4} sec/m^3	5.25E-06 sec/m^3	Subsection 2.3.4.2	Yes
96–720 hours	≤8.0×10^{-5} sec/m^3	1.51E-06 sec/m^3	Subsection 2.3.4.2	Yes
Population Distribution				
PTN DEP 2.0-4 Exclusion area (site)[(j)]	0.5 mi	The minimum distance from the source boundary to the exclusion area boundary is 1427 ft. (0.27 mi)	Subsection 2.1.2	No[(d)]

(a) DCD Site Parameters are a compilation of DCD Tier 1 Table 5.0-1 and DCD Tier 2 Table 2-1.
(b) Maximum and minimum safety values are based on historical data and exclude peaks of less than 2 hours duration.
(c) The containment pressure response analysis is based on a conservative set of dry-bulb and wet-bu b temperatures. These results envelop any conditions where the dry-bulb temperature is 115°F or less and wet-bulb temperature of less than or equal to 86.1°F.
(d) These Site Characteristics and comparison evaluation are discussed in COLA Part 7, Departures and Exemption Requests.
(e) The maximum normal value is the 1 percent seasonal exceedance temperature. The minimum normal value is the 99 percent seasonal exceedance temperature. The minimum temperature is for the months of December, January, and February in the northern hemisphere. The maximum temperature is for the months of June through September in the northern hemisphere. The 1 percent seasonal exceedance is approximately equivalent to the annual 0.4 percent exceedance. The 99 percent seasonal exceedance is approximately equivalent to the annual 99.6 percent exceedance.
(f) The noncoincident wet-bulb temperature is applicable to the cooling tower only.
(g) With ground response spectra as given in DCD Figures 3.7.1-1 and 3.7.1-2. Seismic input is defined at finished grade except for sites where the nuclear island is founded on hard rock.
(h) Sites that fall within the hard rock high frequency GMRS given in DCD Figures 3I.1-1 and 3I.1- 2 are acceptable.
(i) Per APP-GW-GLR-020, the kinetic energies of the missiles discussed in DCD Section 3.5 are greater than the kinetic energies of the missiles discussed in Regulatory Guide 1.76 and result in a more conservative design.
(j) For AP1000, the term “site boundary” and “exclusion area boundary” are used interchangeably. Thus, the X/Q specified for the site boundary applies whenever a discussion refers to the exclusion area boundary. At Turkey Point the “site boundary” and “exclusion area boundary” are not interchangeable. See Figures 2.1-202 and 2.1-204.
(k) Additional evaluation may include evaluation of the impact of the elevated estimated settlement values on the critical components of the AP1000, determining a construction sequence to control the predicted settlement behavior, or developing an active settlement monitoring system throughout the entire construction sequence as well as a long-term (plant operation) plan.
(l) Differential settlement is measured at center of Nuclear Island and center of adjacent structures.
(m) A 204 mph maximum hurricane wind was calculated for Hurricane Andrew based on a post-event reanalysis (Subsection 2.3.1.3.1).
(n) The effects of hurricane missiles are discussed in Subsection 3.5.2.

PTN SUP 2.0-1

Table 2.0-202
Comparison of Predicted Units 6 & 7 Control Room X/Q Values with DCD Acceptance Criteria

X/Q (sec/m^3) at HVAC Intake for the Identified Release Points[a]														
	Plant Vent or PCS Air Diffuser[b]	Plant Vent	PCS Air Diffuser	Ground Level Contain-ment Release Points[c]	Ground Level Contain-ment Release Points	PORV and Safety Valve Releases[d]	PORV and Safety Valve Releases	Condenser Air Removal Stack[e]	Condenser Air Removal Stack	Steam Line Break Releases	Steam Vent	Fuel Handling Area[f]	Fuel Handling Area Blowout Panel	Fuel Handling Area Truck Bay Door
Release Time	DCD	Units 6 & 7	Units 6 & 7	DCD	Units 6 & 7	DCD	Units 6 & 7	DCD	Units 6 & 7	DCD	Units 6 & 7	DCD	Units 6 & 7	Units 6 & 7
0–2 hours	3.0E-03	1.7E-03	1.3E-03	6.0E-03	1.6E-03	2.0E-02	1.2E-02	6.0E-03	1.6E-03	2.4E-02	1.3E-02	6.0E-03	1.4E-03	1.2E-03
2–8 hours	2.5E-03	1.1E-05	7.5E-03	3.6E-03	9.6E-04	1.8E-02	7.3E-03	4.0E-03	1.2E-03	2.0E-02	7.4E-03	4.0E-03	9.7E-04	8.9E-04
8–24 hours	1.0E-03	5.1E-04	3.4E-04	1.4E-03	4.8E-04	7.0E-03	3.1E-03	2.0E-03	5.2E-04	7.5E-03	3.3E-03	2.0E-03	4.3E-04	3.9E-04
1–4 days	8.0E-04	3.2E-04	2.1E-04	1.8E-03	3.3E-04	5.0E-03	2.3E-03	1.5E-03	4.0E-04	5.5E-03	2.5E-03	1.5E-03	3.1E-04	2.9E-04
4–30 days	6.0E-04	2.0E-04	1.2E-04	1.5E-03	2.0E-04	4.5E-03	1.4E-03	1.0E-03	3.0E-04	5.0E-03	1.4E-03	1.0E-03	2.0E-04	1.9E-04

X/Q (sec/m^3) at Annex Building Door for the Identified Release Points[g]														
	Plant Vent or PCS Air Diffuser[b]	Plant Vent	PCS Air Diffuser	Ground Level Contain-ment Release Points[c]	Ground Level Contain-ment Release Points	PORV and Safety Valve Releases[d]	PORV and Safety Valve Releases	Condenser Air Removal Stack[e]	Condenser Air Removal Stack	Steam Line Break Releases	Steam Vent	Fuel Handling Area[f]	Fuel Handling Area Blowout Panel	Fuel Handling Area Truck Bay Door
Release Time	DCD	Units 6 & 7	Units 6 & 7	DCD	Units 6 & 7	DCD	Units 6 & 7	DCD	Units 6 & 7	DCD	Units 6 & 7	DCD	Units 6 & 7	Units 6 & 7
0–2 hours	1.0E-03	3.7E-04	3.6E-04	1.0E-03	3.4E-04	4.0E-03	8.3E-04	2.0E-02	3.0E-03	4.0E-03	8.1E-04	6.0E-03	3.5E-04	3.5E-04
2–8 hours	7.5E-04	2.3E-04	2.1E-04	7.5E-04	2.0E-04	3.2E-03	4.7E-04	1.8E-02	1.7E-03	3.2E-03	4.6E-04	4.0E-03	2.2E-04	2.3E-04
8–24 hours	3.5E-04	1.1E-04	9.9E-05	3.5E-04	9.7E-05	1.2E-03	2.2E-04	7.0E-03	8.1E-04	1.2E-03	2.1E-04	2.0E-03	1.0E-04	1.0E-04
1–4 days	2.8E-04	6.9E-05	6.0E-05	2.8E-04	6.1E-05	1.0E-03	1.3E-04	5.0E-03	5.3E-04	1.0E-03	1.2E-04	1.5E-03	6.8E-05	7.1E-05
4–30 days	2.5E-04	4.4E-05	3.9E-05	2.5E-04	3.8E-05	8.0E-04	8.2E-05	4.5E-03	2.7E-04	8.0E-04	7.9E-05	1.0E-03	4.1E-05	4.4E-05

(a) These dispersion factors are to be used 1) for the time period preceding the isolation of the main control room and actuation of the emergency habitability system, 2) for the time after 72 hours when the compressed air supply in the emergency habitability system would be exhausted and outside air would be drawn into the main control room, and 3) for the determination of control room doses when the non-safety ventilation system is assumed to remain operable such that the emergency habitability system is not actuated.

(b) These dispersion factors are used for analysis of the doses due to a postulated small line break outside of containment. The plant vent and PCS air diffuser are potential release paths for other postulated events (loss-of-coolant accident, rod ejection accident, and fuel handling accident inside the containment); however, the values are bounded by the dispersion factors for ground level releases.

(c) The listed values represent modeling the containment shell as a diffuse area source, and are used for evaluating the doses in the main control room for a loss-of-coolant accident, for the containment leakage of activity following a rod ejection accident, and for a fuel handling accident occurring inside the containment.

(d) The listed values bound the dispersion factors for releases from the steam line safety and power-operated relief valves. These dispersion factors would be used for evaluating the doses in the main control room for a steam generator tube rupture, a main steam line break, a locked reactor coolant pump rotor, and for the secondary side release from a rod ejection accident.

(e) This release point is included for information only as a potential activity release point. None of the design basis accident radiological consequences analyses model release from this point.

(f) The listed values bound the dispersion factors for releases from the fuel storage and handling area. The listed values also bound the dispersion factors for releases from the fuel storage area in the event that spent fuel boiling occurs and the fuel building relief panel opens on high temperature. These dispersion factors are used for the fuel handling accident occurring outside containment and for evaluating the impact of releases associated with spent fuel pool boiling.

(g) These dispersion factors are to be used when the emergency habitability system is in operation and the only path for outside air to enter the main control room is that due to ingress/egress.

SECTION 2.1: GEOGRAPHY AND DEMOGRAPHY
TABLE OF CONTENTS

SECTION 2.1 LIST OF FIGURES

SECTION 2.1 LIST OF FIGURES (CONT.)

2.1 GEOGRAPHY AND DEMOGRAPHY

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

STD DEP 1.1-1 Subsection 2.1.1 of the DCD is renumbered as Subsection 2.1.4 and moved to the end of Section 2.1. This is being done to accommodate the incorporation of RG 1.206 numbering conventions for Section 2.1.

2.1.1 SITE LOCATION AND DESCRIPTION

PTN COL 2.1-1

2.1.1.1 Site Location

The Units 6 & 7 plant area is part of the larger Turkey Point plant property located approximately 25 miles south of Miami in unincorporated Miami-Dade County, Florida. The approximate 9400-acre Turkey Point plant property includes two gas/oil-fired steam electric generating units, Units 1 & 2, one natural gas combined cycle plant, Unit 5, and four nuclear powered steam electric generating units, Units 3 & 4 and Units 6 & 7 (Reference 201). Figure 2.1-201 shows the Turkey Point site and the surrounding area within 50 miles. Figure 2.1-202 illustrates the general location of the Turkey Point plant property and localities surrounding the site within 10 miles.

The prominent natural features of the region surrounding the Turkey Point plant property, as shown in Figures 2.1-201 and 2.1-202 include Biscayne Bay and the Everglades National Park. Biscayne Bay is surrounded by the barrier islands, which eventually become part of the Florida Keys, and is connected to the Atlantic Ocean by many natural and man-made channels. Tributaries to Biscayne Bay in the region surrounding the Turkey Point plant property include several man-made canals (Reference 206). The Turkey Point plant property is also located near the eastern edge of the Everglades, a vast area of marshland that ranges from Lake Okeechobee to the southern tip of the Florida peninsula (Reference 207). The Turkey Point plant property lies on the Floridian plateau, a partly submerged peninsula of the continental shelf. The peninsula is underlain by approximately 4000 to 15,000 feet of sedimentary rocks consisting of limestone and associated formations (Reference 201).

Miami-Dade County is bounded on the north by Broward County, on the west by Monroe and Collier counties, on the east by Biscayne Bay and the Atlantic Ocean, and on the south by the Florida Bay and the Florida Keys (Monroe County) (Reference 202). The county is located along the southeast tip of the Florida peninsula and covers approximately 2000 square miles of land area with approximately one-third of the area consisting primarily of the Everglades National Park (References 203, 204, and 205). The predominant existing land uses around the Turkey Point plant property are undeveloped and protected areas with Turkey Point Units 1 through 5 and transmission infrastructure occupying the land adjacent to Turkey Point Units 6 & 7 (Reference 201).

Miami-Dade County had a 2006 estimated population of 2,402,208 and includes 35 incorporated areas (municipalities) while the remainder of the county is unincorporated (References 203, 208, and 209). Of the incorporated areas located in Miami-Dade County, the municipalities of Homestead, Islandia, and Florida City are within 10 miles of the Turkey Point plant property. As illustrated in Figures 2.1-201 and 2.1-202, Units 6 & 7 are situated approximately 8 miles east of the municipality of Florida City and 4.5 miles east of the southeastern municipal limits of Homestead and approximately 5.6 miles west of Islandia (References 202 and 222). In the year 2000, the U.S. Census Bureau reported a population of 31,909 for Homestead, 6 for Islandia, and 7843 for Florida City (Reference 209). Communities in the unincorporated area of Miami-Dade County that are within 10 miles of the Turkey Point site include: Naranja, approximately 7.6 miles to the northwest of Units 6 & 7; Princeton, approximately 6.2 miles to the north-northwest of Units 6 & 7; and Goulds, approximately 9.7 miles to the north of Units 6 & 7 (Reference 202).

There are several recreational and park areas located in Miami-Dade County. A few of these recreational areas are located near the Turkey Point plant property, as shown in Figure 2.1-202 and described below:

- The Biscayne National Park consists of 173,000 acres of water, coastal lands, and 42 keys, located to the northeast, east, and southeast of the Turkey Point plant property. The Biscayne National Park headquarters is approximately 2.8 miles north of the site.

- The Biscayne Bay aquatic preserve is a shallow, subtropical lagoon consisting of approximately 69,000 acres of submerged land (Reference 201). The aquatic preserve is in two different areas of Biscayne Bay that are separated by Biscayne National Park (Reference 206). One area of the Biscayne Bay

aquatic preserve runs along the coastal boundary of the Turkey Point plant property (References 201 and 210).

- The Model Lands Basin consists primarily of fresh and saltwater wetlands that form a contiguous habitat corridor with Everglades National Park, Biscayne National Park, and other designated lands in Miami-Dade County. The Model Lands Basin is fragmented with state, local, and private ownership. With the exception of the South Florida Water Management District Canal L-31E, which is adjacent to the Turkey Point plant, the closest Model Lands Basin properties are approximately 2 miles from Units 6 & 7 (References 201 and 211).

- The Crocodile Lake National Wildlife Refuge is a 6600-acre area located south of Units 6 & 7 that is home to several federally endangered and threatened species. The refuge headquarters is located 16 miles south of the plant property but the area is currently closed to the public with access granted by special permit only (Reference 212).

- Homestead Bayfront Park, located approximately 1.7 miles north of Units 6 & 7, is a recreational park owned and operated by Miami-Dade County. The park is adjacent to Biscayne National Park and maintains facilities such as a marina, a picnic pavilion, and a fishing area. The park also offers access to the Biscayne Trail, which traverses Miami-Dade County and is used for pedestrian and biking activities.

- The FPL Everglades Mitigation Bank located west and south of the Turkey Point plant is a wetlands mitigation project returning more than 13,000 acres of wetlands to their historical conditions (Reference 201).

Units 6 & 7 are near a military installation, a racecourse, and a public marina, as shown on Figure 2.1-202. Homestead Air Reserve Base is approximately 4.76 miles northwest of Units 6 & 7. The 482nd Fighter Wing maintains and operates the base. Five tenant organizations use the services and infrastructure at the base. Homestead Miami Speedway is a 600-acre racecourse located approximately 4.7 miles northwest of Units 6 & 7. The Homestead Bayfront Marina, approximately 2.8 miles north of Units 6 & 7, is a public marina in Homestead Bayfront Park (References 201 and 202).

Several highways traverse Miami-Dade County. Interstate 95, U.S. Highway 1, and the Florida Turnpike (State Road 821) are the major transportation routes for north-south traffic flow in the county. The major routes for east-west movement are U.S. Route 41, a two-lane roadway that crosses the peninsula through the

middle of the county into Naples in Collier County, and I-75, which crosses the peninsula to Naples via Miami-Dade, Broward, and into Collier Counties. Main access to the Turkey Point site is Palm Drive (SW 344th Street), which runs in an east-west direction. Palm Drive provides a direct connection with U.S. Highway 1 in Florida City and thereby a direct connection via U.S. Highway 1 to the Florida Turnpike (References 201 and 202).

2.1.1.2 Site Description

Besides the electric power generating facilities, no other commercial, industrial, institutional, or residential structures are located in the Turkey Point plant property. Units 6 & 7 is to the south of Units 1 through 5 as delineated on the site area maps (Figures 2.1-203 and 2.1-204). The center point of the Unit 6 containment building is approximately 215 feet west and 3625 feet south of the center point of the Unit 4 containment building. The Unit 7 footprint is separate from, but adjacent to, the Unit 6 footprint. The center point of Unit 7 is approximately 850 feet west of the center point of Unit 6. The combined power block footprints of Units 6 & 7, which include the transformer area and the containment, turbine, annex, auxiliary and diesel generator buildings, encompass an area of approximately 30 acres. The switchyard comprises an additional 15 acres, the cooling tower reservoir area is approximately 37 acres, and the area contained within the plant area is approximately 218 acres (Figures 2.1-203 and 2.1-205).

The Turkey Point plant primarily resides in the Arsenicker Keys, Florida, and the Card Sound, Florida 7.5-minute United States Geological Survey (USGS) topographic quadrangles (Reference 213). The coordinates of the center of the reactor containment building for Units 6 & 7 are given below in the geodetic latitude/longitude and the Universal Transverse Mercator (UTM) coordinate systems:

Unit	Latitude/Longitude (NAD 27) (Degrees)	Latitude/Longitude (NAD 83) (Degrees)	UTM, Zone 17N (84W to 78W) (NAD 27) (Meters)	UTM, Zone 17N (84W to 78W) (NAD 83) (Meters)
6	N 25° 25' 25.7"	N 25° 25' 27.1"	North/South 2,811,883.63	North/South 2,812,086.79
	W 80° 19' 55.9"	W 80° 19' 55.1"	East/West 567,158.19	East/West 567,179.31
7	N 25° 25' 25.7"	N 25° 25' 27.1"	North/South 2,811,883.62	North/South 2,812,086.79
	W 80° 20' 05.1"	W 80° 20' 04.3"	East/West 566,899.19	East/West 566,920.31

2.1.1.3 Boundary for Establishing Effluent Release Limits

Turkey Point Units 6 & 7 are located within the Turkey Point plant property, as depicted in Figure 2.1-203. A detailed discussion of the gaseous effluent release points is provided in DCD Subsection 11.3.3.3. Figure 2.1-204 depicts these release points. The Units 6 & 7 point of compliance for 10 CFR Part 20 liquid effluent concentration limits is at the point of dilution in the discharge line located at the blowdown sump. After dilution, the effluent is injected into the Boulder Zone via deep injection wells. The blowdown sump, located at the northeast corner of the makeup water reservoir, and the deep injection wells, located at the southern and eastern perimeter of the plant site, are shown in Figure 1.1-201.

All gaseous and liquid effluent release points are within the Turkey Point plant property. All areas outside the Turkey Point plant property are unrestricted in the context of 10 CFR Part 20 and 10 CFR Part 50, Appendix I.

2.1.2 EXCLUSION AREA AUTHORITY AND CONTROL

As required by 10 CFR 100.21(a), an exclusion area boundary (EAB) and a low population zone (LPZ) have been identified to meet the requirements established in 10 CFR 100.3. The EAB for Units 6 & 7 primarily lies within the EAB for Units 3 & 4 with the exception of the eastern and southern portions. The combined EAB provides a minimum distance of 1427 feet from the source boundary for Units 6 & 7 (Figure 2.1-204). The source boundary encompasses all potential release points for both Units 6 & 7. The LPZ for Units 3 & 4 and Units 6 & 7 is a circle with a radius of 5 miles with its center located at the midpoint of Units 3 & 4. The EAB and LPZ are shown in Figures 2.1-203 and 2.1-202, respectively.

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2.1.2.1 Authority

FPL owns most of the property within the Turkey Point plant property boundary, including the entire exclusion area, subject to certain encumbrances on portions of the property within the exclusion area, specifically, certain canal, drainage, reclamation, oil, gas and mineral rights reservations held by the Trustees of the Internal Improvement Fund of the State of Florida and a canal reservation held by Miami-Dade County. Also, a small parcel of submerged land in the southeast and south-southeast portions of the exclusion area is located in the Biscayne Bay waterway. With the exception of the described submerged land, the site boundary entirely encompasses the designated exclusion area for Units 6 & 7. Because of the location of the submerged land, this portion of the exclusion area cannot be reasonably accessed except through FPL property.

Thus, except for the matters noted, FPL has the authority to determine activities within the exclusion area, including the exclusion and removal of personnel and property, and FPL has authority over the exclusion area in the event of an emergency to afford protection of public health and safety. Through the appropriate state and local processes, FPL expects to receive full authority and control over the exclusion area, consistent with the requirements in 10 CFR Part 100. Upon completion of the land transactions with the state and the county, FPL will be able to determine all activities in the entirety of the exclusion area, including the exclusion of personnel and property. In no event shall FPL initiate construction, as defined under 10 CFR 50.10, until it has sufficient authority to determine all activities within the exclusion area.

2.1.2.2 Control of Activities Unrelated to Plant Operation

As described in Subsection 2.1.2.1, upon completion of the land transactions with the state and the county, FPL will be able to determine all activities in the entirety of the exclusion area, including the exclusion of personnel and property. There will be no areas within the exclusion area in which activities unrelated to plant operation would be permitted.

2.1.2.3 Arrangements for Traffic Control

No federal, state, or county roads or railways traverse the Units 6 & 7 exclusion area. As stated in Subsection 2.1.2.1, a small portion of the exclusion area is located in the Biscayne Bay waterway. In accordance with 10 CFR 100.3, FPL has made appropriate and effective arrangements with the United States Coast Guard to control traffic on this waterway in the event of an emergency to protect the public health and safety.

2.1.2.4 Abandonment or Relocation of Roads

No public roads are relocated or abandoned.

2.1.3 POPULATION DISTRIBUTION

The population surrounding the Turkey Point site, to a 50-mile radius, was estimated based on 2000 United States Census Bureau (USCB) decennial census data. The population was estimated on a sector basis in a series of 10 concentric rings. The concentric rings were divided into 16 directional sectors, each sector consisting of 22.5 degrees. The rings were spaced at 0 to 1 mile, 1 to 2 miles, 2 to 3 miles, 3 to 4 miles, 4 to 5 miles, 5 to 10 miles, 10 to 20 miles, 20 to 30 miles, 30 to 40 miles, and 40 to 50 miles with its center located at the midpoint

of Units 6 & 7. The populations for years 2020 through 2090 have been projected by calculating a growth rate using state population projections (by county) as the base. The projected population for the expected first year of plant operation (2027 for Unit 6 and 2028 for Unit 7) is conservatively selected as that for the year 2030.

2.1.3.1 Resident Population Within 10 Miles

Figure 2.1-206 shows the general location of the municipalities and other features within 10 miles of the Turkey Point site. According to the 2010 census, Homestead, which had a population of 60,512 in 2010, is the largest community within 10 miles of the site. Cutler Bay (2010 population of 40,286), Florida City (11,245), Islandia (18), Leisure City (22,655), Naranja (8,303), and Princeton (22,038), all in Miami-Dade County, also lie within 10 miles of the site. The community of Goulds (10,103) is 10 miles north-northwest of the site (Reference 214).

The resident population distribution within 10 miles of the site was computed by overlaying the 2010 census block (the smallest unit of census data) on the grid shown on Figure 2.1-206, and adding the populations of the census block points in each sector/radius. Population projections to year 2030 were obtained from the Office of Economic and Demographic Research and were used to calculate an exponential growth rate for each county within 50 miles of the Turkey Point site (Reference 215). The growth rate for each county was then used to project future populations (in each sector and radius, taking into account the percent of each sector in a particular county).

The population distributions (including transient population) and related information were tabulated for radial distances in each of the 16 sectors. Figure 2.1-207 through Figure 2.1-215 show the total (resident and transient) population for the year 2010 and the projected populations, by decade, through the year 2090. The current population within 10 miles is assumed to be that shown for the year 2010. For the 0–1 mile radius, the north sector is the only direction containing a population (the Turkey Point employees). For clarity, zero populations for the other 15 sectors within the 0-1 mile radius are not shown on the figures. The 10-mile radius populations for the years 2010 through 2090 (by decade) are as follows:

Year	10-Mile Radius Population
2010	192,594
2020	208,501
2030	225,825
2040	244,692
2050	265,234
2060	287,599
2070	311,946
2080	338,444
2090	367,285

2.1.3.2 Resident Population Between 10 and 50 Miles

The 50-mile radius centered on Units 6 & 7 includes all or parts of four counties in Florida (Figure 2.1-216). Estimates of the year 2010 resident population between 10 and 50 miles from Turkey Point were computed using the same methodology used to develop the 10-mile population distribution.

The population grid from 10 to 50 miles is shown on Figure 2.1-216. The 10- to 50-mile population distributions for the years 2010 through 2090 (by decade) are shown on Figure 2.1-217 through Figure 2.1-225. The 50-mile radius populations (including the 0- to 10-mile populations) for each year are:

Year	50-Mile Radius Population
2010	3,464,756
2020	3,728,167
2030	4,012,989
2040	4,321,018
2050	4,654,194
2060	5,014,635
2070	5,404,626
2080	5,826,651
2090	6,283,428

2.1.3.3 Transient Population

2.1.3.3.1 Transient Population Within 10 Miles

Variations in population because of recreational and industrial land uses have been accounted for by keying recreational facility capacities and employment numbers to the sector/radius areas shown on Figure 2.1-206. For conservatism, peak seasonal and daily populations have been accounted for in the base (year 2010) population and projected, by decade, through the year 2090 along with

resident population. The transient population segment includes people in the workforce, hotels/motels, recreational areas, and migrant populations.

Employees within 10 miles fall into two categories: (1) those that live and work within 10 miles of Units 6 & 7, and (2) those that live outside of the 10-mile radius and commute to jobs in the emergency planning zone (EPZ). Those in the first category are already counted as permanent residents. To minimize double counting, only those employees that commute into the EPZ were included as transients (Reference 216).

Employee transient information is based on *Journey to Work* employment data from the USCB. Employees at Units 3 & 4 were included in the transient population for the 0- to 1-mile radius (1467 employees). It is assumed that there is no employment in the Monroe County portion of the EPZ. Based on employment data in the evacuation time estimate, there are 20,472 employees commuting into the EPZ (Reference 216).

Recreational opportunities were also evaluated to determine seasonal and daily variations in population and population distribution. Recreational opportunities in the area include Biscayne National Park, Black Point Park, Black Point Marina, Camp Owaissa Bauer, Coral Castle Museum, Harris Field, Homestead Sports Complex, Keys Gate Golf Club, Larry and Penny Thompson Memorial Park, South Miami-Dade Cultural Arts Center, Prime Outlets in Florida City, Southland Mall, and Homestead Bayfront Marina/Herbert Hoover Marina and Park (Reference 216). These recreational areas were evaluated as follows:

- Biscayne National Park is adjacent to the Turkey Point site, bordering it to the south, east, and west. On a daily basis, there are approximately 400 people at the facility, assumed to be transients. Campsites at the park are only accessible by boat (Reference 216).

- Black Point Park and Marina is located approximately 7 miles north of the Turkey Point site. The park contains a pavilion that can shelter 50-100 people. Black Point Park can have up to 8000 visitors during special events. An average of 50 percent of these visitors are EPZ residents. Therefore, 4000 transients are at the park during peak times. Black Point Marina has 425 regular parking spaces, 18 handicap parking spaces, and 2 strollers-only parking for the 178 in-water slips and 10 floating docks at the facility. There are 203 parking spots for cars with trailers and 10 handicap parking spots for cars with trailers, therefore 2613 transients are at the park during peak times (Reference 216).

- Camp Owaissa Bauer is a children's camp approximately 10 to 11 miles northwest of the site. Because the camp would be evacuated in the event of an emergency, the transient population was included in this analysis. The camp can accommodate 150 overnight campers in dormitory-style cabins, with separate staff quarters (Reference 216).

- The Coral Castle Museum is approximately 8 miles northwest of the Turkey Point site. Patrons of the museum are evenly split between local residents and tourists. There are 100 visitors per day during the peak season, 50 of whom are transients (Reference 216).

- Harris Field is 8 miles west-northwest of the Turkey Point site. Based on the number of parking spaces at the football stadium, there could be 591 people at the facility (Reference 216).

- Homestead Sports Complex is 3 miles west of the Turkey Point site. The peak times this facility is used are summer weekends. There are an estimated 1000 people at the facility during peak times. It is assumed all of these visitors are transients (Reference 216).

- Keys Gate Golf Club is 7 miles west-northwest of the Turkey Point site. The golf club entertains 200 people during the peak season, 50 percent of whom are transients (Reference 216).

- Larry & Penny Thompson Memorial Park is approximately 11 miles north-northwest of the Turkey Point site, but would also be evacuated in the event of an emergency at the plant because of its proximity to the EPZ. Therefore, the transient population attributed to this recreational facility has been included in the current and projected population distributions. The park is adjacent to the Miami Metro zoo and has 270 acres to offer visitors. The campground has 240 separate campsites for recreational vehicles. The campground is assumed to be fully occupied with non-EPZ residents (i.e., transient). Based on the capacity of 240 campsites (four people per site), 960 campers could be present at the campground. There are also 200 additional parking spaces available for daytrippers. Assuming two people per vehicle, an additional 400 daytrippers visit the facility, for a total of 1360 transients at Larry and Penny Thompson Memorial Park (Reference 216).

- South Miami-Dade Cultural Arts Center is located 43 miles north of the Turkey Point site. The theater can accommodate 200 vehicles and 1100 people. There is one festival per month that attracts 2500 people. Half of the visitors

are local residents. Therefore a maximum of 1250 transients and 313 transient vehicles are at the facility at any given time, assuming 4 people per vehicle (Reference 216).

- The Prime Outlets at Florida City include 40 discount stores and a small food court. It is located approximately 8 miles west of the Turkey Point site. There are 3500 vehicles and two tour buses at the facility during peak hours. The outlets are a more significant attraction to non-EPZ residents because they are located along the main route to the Florida Keys. Thirty-five percent of the parking lot capacity is assumed to be non-EPZ residents. Assuming three people per vehicle plus 20 people per bus, a peak number of 3715 transients could be present at the Prime Outlets of Florida (Reference 216).

- The Southland Mall (formerly Cutler Ridge Mall) includes several large department stores and more than 100 specialty stores. It is approximately 10 miles north-northwest of the Turkey Point site, just off of the Florida Turnpike. Parking lot capacity of the mall is approximately 5100 parking spaces. The mall is not a significant attraction for non-EPZ residents because there are many other large malls located north of the EPZ. Therefore, 25 percent of the mall's visitors are assumed to be non-EPZ residents. During a peak day, the mall can accommodate 1275 transient vehicles resulting in 3825 transients (three people per vehicle) (Reference 216).

- The Homestead Bayfront Park/Herbert Hoover Marina is 2.8 miles from Turkey Point site. The peak visitation on weekends averages approximately 2000 people at the marina based on 500 parked vehicles, assumed to be transients (Reference 216).

Lodging facilities within 10 miles also account for seasonal and daily variations in population and population distribution. People staying in hotels and motels in the area have also been accounted for in this transient study. Capacities and the average number of people staying at the facilities during peak occupancy were determined (Reference 216).

Accounting for major employers, overnight accommodations, major recreation areas, and marinas within 10 miles, a total of 44,388 transients, could be present within 10 miles and 53,547 within the EPZ (Reference 216).

The 10-mile transient population was added to the resident distribution and projected for future years (Figure 2.1-207 through Figure 2.1-215). The baseline transient population distribution for the 10-mile radius is:

Radius	Direction	Number of Transients
0–1	N	1,467
2–3	N	2,400
5–10	N	7,508
5–10	SSE	7,363
5–10	W	8,493
5–10	WSW	50
5–10	WNW	11,943
5–10	NW	1,327
5–10	NNW	3,837
10-EPZ	N	1,503
10–EPZ	NW	150
10–EPZ	NNW	7,506
	Total	53,547

2.1.3.3.2 Transient Population Between 10 and 50 Miles

Variations in population because of recreational and industrial land uses within 10 to 50 miles are generally described in this section. The transient population from 10 to 50 miles from the Turkey Point site was not quantified because of the large error associated with keying these populations to sectors. For emergency planning, the 10-mile radius is the most critical area in which to accurately quantify the population distribution for evacuation purposes and accident analysis; therefore, the 10- to 50-mile radius transient population has been characterized but not quantified or keyed to sectors.

Four south Florida counties (Broward, Collier, Miami-Dade, and Monroe) and two major metropolitan areas (Miami and Ft. Lauderdale) lie within 50 miles of the Turkey Point site, as shown on Figure 2.1-201. South Florida is a popular vacation destination for both U.S. and foreign tourists. Broward County, which includes greater Fort Lauderdale and its beaches, has seen a steady increase in the number of visitors in recent years, from 8.5 million in fiscal year 2003 to 10.1 million in fiscal year 2010 (Reference 217). More than 12.6 million people visited Miami-Dade County in 2010, the highest number ever recorded (Reference 218). Domestic visitors made up 52 percent of those who traveled to the Miami area, while international visitors made up 48 percent. Collier County, which includes the "Paradise Coast" of Naples and Marco Island, saw more than 1.38 million tourists in 2010 (Reference 219). However, as shown on Figure 2.1-216, only a small inland portion of Collier County, which is part of the Big Cypress National Preserve, lies within 50 miles of the site. Monroe County, the southernmost county in the continental United States, is comprised of the Florida Keys and portions of

Everglades National Park and Big Cypress National Preserve. Approximately 70 percent of visitors to the Florida Keys arrive by car. Smaller numbers arrive by air and by cruise ship. In 2010, approximately 2.6 million people came by car to the Keys, 850,300 visitors came by ship, and 277,966 by air (Reference 220).

Seasonal variations in population include agricultural workers that move through the area during planting and harvesting periods. These workers may also make up a portion of the transient population in the 10- to 50-mile radius. The USCB does not keep counts of seasonal agriculture workers. However, the U.S. Department of Agriculture does keep count of the number of farms, by county, that employ migrant labor. Three of the four counties that lie within 50 miles of the Turkey Point site contain farms that employ migrant labor: Broward (24 farms), Collier (38 farms), and Miami-Dade (234 farms). There are no farms in Monroe County that employ migrant labor (Reference 221).

There is much uncertainty associated with quantifying the transient population to 50 miles. Because of this uncertainty, the transient population was not keyed to sectors or projected for future years.

2.1.3.4 Low Population Zone

The LPZ consists of the area falling within 5 miles of the center of Units 3 & 4. No facilities or institutions requiring special consideration for emergency planning purposes such as schools, nursing homes, hospitals, prisons, or major employers (other than Turkey Point) are known to exist in the LPZ. Two recreational facilities are in the LPZ. The Dante Fascell Visitor Center at Biscayne National Park is approximately 3 miles north of Units 6 & 7, and hosts approximately 400 visitors a day. The Homestead Bayfront Park/Herbert Hoover Marina, which can accommodate 2000 visitors, is approximately 2 miles north of the Turkey Point site. Figure 2.1-226 shows topographical features of the LPZ.

The resident and transient population distributions in the LPZ for each decade from 2010 through 2090 are shown on Figure 2.1-207 through Figure 2.1-215. The total populations in the LPZ for years 2010 through 2090 are:

Year	LPZ Population
2010	3881
2020	4221
2030	4591
2040	4993
2050	5431
2060	5905
2070	6424
2080	6984
2090	7598

2.1.3.5 Population Center

The closest population center (population of greater than 25,000) is the city of Homestead. Units 6 & 7 are approximately 4.5 miles east of the southeastern municipal limits of Homestead. Homestead's population in 2010 was 60,512 (Reference 214). The distance to the boundary of the population center is 1.6 times the radius of the 5-mile LPZ. This distance meets the requirement that the population center distance be at least one and one-third times the distance from the reactor to the outer boundary of the LPZ (10 CFR 100.21(b)).

Population groupings within 10 miles are located from approximately 7 to 10 miles from the Turkey Point site, ranging from the west to north sectors (Figure 2.1-206). The overall population density for the 10-mile radius is 1165 people per square mile for the year 2010 and is projected to increase to 2221 by the year 2090. The west-northwest sector from 5 to 10 miles, the location of the city of Homestead, contains the largest number of residents within 10 miles.

The largest population groupings within 50 miles are located north of the site in the Miami metropolitan area.

2.1.3.6 Population Density

Given the reactor startup dates of 2027 for Unit 6 and 2028 for Unit 7, and an operational period of 60 years, operations could extend until 2088. Figure 2.1-227 shows the cumulative population (including transients) in 2030 (within about 5 years after initial site approval). On the same figure, spanning the same radial distances, a population curve shows the required population to achieve a hypothetical density of 500 people per square mile as required by RG 4.7, Position C.4. To determine the cumulative population for the hypothetical density of 500 people per square mile, the density was multiplied by the land area (area

within the circle characterized as land) at various radii as well as the circular area. Due to the number of Turkey Point employees at the 1 mile radius, the 2030 population is greater than the 500-people-per-square-mile density criterion specified in RGs 1.206 and 4.7, using both land area and circular area. Using land area to determine the population from a hypothetical density of 500 people-per-square-mile, the projected 2030 population at the 10 and 20 mile radii exceed this criterion. Using circular area, the projected 2030 population at the 10 and 20 mile radii exceed the population calculated using a hypothetical density of 500 people-per-square-mile.

While the Turkey Point site does not meet the RG 4.7 population density criterion of 500 people-per-square-mile within 20 miles of the site, related safety factors were considered to provide assurance that members of the public living in the proximity of an operating reactor can either be protected or safely evacuated such that they will not be subjected to excessive radiological doses in the unlikely event of a radiological emergency. These considerations included assurance that the Turkey Point site:

- Met the radiation dose requirements to the public established in 10 CFR 52.79(a)(1)(vi) (Subsection 15.6.5.3.7.3)
- Developed the Turkey Point Emergency Plan, along with the associated Turkey Point Evacuation Time Estimate, which takes into account the consequences of radiological emergencies, as required by 10 CFR 50.47 and 10 CFR 50 Appendix E

For particular sites located away from a very densely populated center but not in an area of low density, such as Turkey Point, RG 4.7 requires that the analysis of alternative sites pay particular attention to alternative sites having lower population density. In selecting the Turkey Point site, an analysis of alternative sites for the Turkey Point site for the construction and operation of two nuclear power reactors was performed as required by 10 CFR 51.45(b)(3). This evaluation process was also consistent with the special case noted in NUREG-1555, Section 9.3(III)(8), and considered the advantages already present at existing nuclear facilities within the region of interest. Initially, following a detailed evaluation process, potential sites were identified for consideration. These sites were then evaluated based on a range of performance criteria and weight factors derived using methodology consistent with the modified Delphi process specified in the Electric Power Research Institute, Inc.'s document, *Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application*. During these initial screening phases, specific consideration was given to the avoidance of high

population areas, and a prominent weight factor for the population criterion was used during the screening of potential alternative sites. After three successive stages of qualitative and quantitative evaluation, the top five candidate sites were identified. A comparison of the environmental impacts from construction and operation for the proposed site and each of the top alternative sites indicated that environmental impacts would, in general, be higher than or similar to those at the Turkey Point site. Therefore, based on these analyses, FPL concluded that no alternative site is environmentally preferable to the proposed Turkey Point site.

Further, in accordance with RG 4.7, when identifying Turkey Point as the preferred alternative over other alternative sites with lower nearby population densities, the principal considerations influencing FPL's selection of the Turkey Point site included several unique safety, economic, reliability, and environmental attribute advantages that would not be realized if the plant was developed elsewhere. Specifically, the Turkey Point site is considered to have critical advantages over the other alternative sites with respect to the following five project features:

1. Ability to Balance Generation and Load in Southeast Florida (economic, reliability attributes)

2. Unique Cooling Water Supply Source (safety, reliability, and environmental attributes)

3. Land Availability (economic and environmental attributes)

4. Existing Nuclear Power Plant Infrastructure (safety, economic, and environmental attributes)

5. Emergency Planning Infrastructure (safety and economic attributes)

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2.1.4 COMBINED LICENSE INFORMATION FOR GEOGRAPHY AND DEMOGRAPHY

PTN COL 2.1-1 This COL item is addressed in Section 2.1 and Subsections 1.1.1 and 1.2.2.

2.1.5 REFERENCES

201. Florida Power & Light Company, *Site Certification Application, Turkey Point Uprate Project*, January 2008.

202. Rand McNally, *Miami-Dade County Street Guide*, 2008.

203. Miami-Dade County Information Center, *About Miami-Dade County*. Available at http://www.miamidade.gov/infocenter/about_miami-dade.asp, accessed September 12, 2008.

204. U.S. Census Bureau, *United States Summary 2000 — Population and Housing Unit Counts*, Issued April 2004.

205. U.S. Geological Survey, *South Florida Information Access — Report 99-4094*. Available at http://sofia.usgs.gov/publications/wri/99-4094 /studyarea.html, accessed May 15, 2008.

206. Cantillo, A., K. Hale, E. Collins, L. Pikula, and R. Caballero, *Biscayne Bay: Environmental History and Annotated Bibliography*, NOAA Technical Memorandum NOS NCCOS CCMA 145, U.S. Department of Commerce, July 2000.

207. Galloway, D., D. Jones, and S. Ingebritsen, *Land Subsidence in the United States*, U.S. Geological Survey, Circular 1182, 1999.

208. U.S. Census Bureau, *State & County QuickFacts. Miami-Dade County, Florida*. Available at http://quickfacts.census.gov/qfd/states/12/12 086.html, accessed May 9, 2008.

209. U.S. Census Bureau, *Population Miami-Dade County by Municipality, 1980, 1990 and 2000*. Available at http://www.miamidade.gov/planzone/ Library/Census/population_by_municipality_1980_1990_2000.pdf, accessed May 15, 2008.

210. Office of Coastal and Aquatic Managed Areas, *Biscayne Bay Aquatic Preserve*, April 2005.

211. South Florida Water Management District, *Model Lands Basin Map*. Available at https://my.sfwmd.gov/portal/page?_pageid=2236,4690203, 2236_4690316&_dad=portal&_schema=PORTAL, accessed May 14, 2008.

212. U.S. Fish & Wildlife Service, *Crocodile Lake National Wildlife Refuge*. Available at http://www.fws.gov/southeast/crocodilelake, accessed May 15, 2008.

213. U.S. Geological Survey, *Map Locator*. Available at http://store.usgs.gov/cgi-bin/maplocator.pl?store_url=http://store.usgs.gov/scripts/wgate/zww2040555a9e/~flNlc3Npb249UFJEOklHU0tBSENJR1NTQVAwMjowMDAyLjAwMGYuNmYzNGM4MDQuN2FjMSZ*aHR0cF9jb250ZW50X2NoYXJzZXQ9aXNvLTg4NTktMSZ*U3RhdGU9MjEwMC4wMDEuMDUuMDg=?~okcode=SESH, accessed May 15, 2008.

214. U.S. Census Bureau, *DP-1: Profile of General Population and Housing Characteristics: 2010, 2010 Demographic Profile Data*. Available at http://factfinder2.census.gov/, accessed March 22, 2012.

215. Office of Economic and Demographic Research, *Total County Population: April 1, 1970–2030*. Available at http://edr.state.fl.us/population.htm, accessed March 9, 2012.

216. KLD Engineering, P.C., *Development of Evacuation Time Estimates for Turkey Point Nuclear Power Plant*, Rev. 4, April 2015.

217. Broward County, *Broward County, Florida — Fiscal Year 2012 Adopted Operating Budget*. Available at http://www.broward.org/BUDGET/Pages/archives.aspx, accessed March 22, 2012.

218. Greater Miami Convention and Visitor Bureau, *2010/2011 Annual Report*. Available at http://www.miamiandbeaches.com/about/about.asp, accessed March 22, 2012.

219. Naples Marcos Island Everglades Paradise Coast, *2010 Tourism Impact Facts*. Available at http://paradisecoast.com/media_center/research_files/1305311135, accessed March 22, 2012.

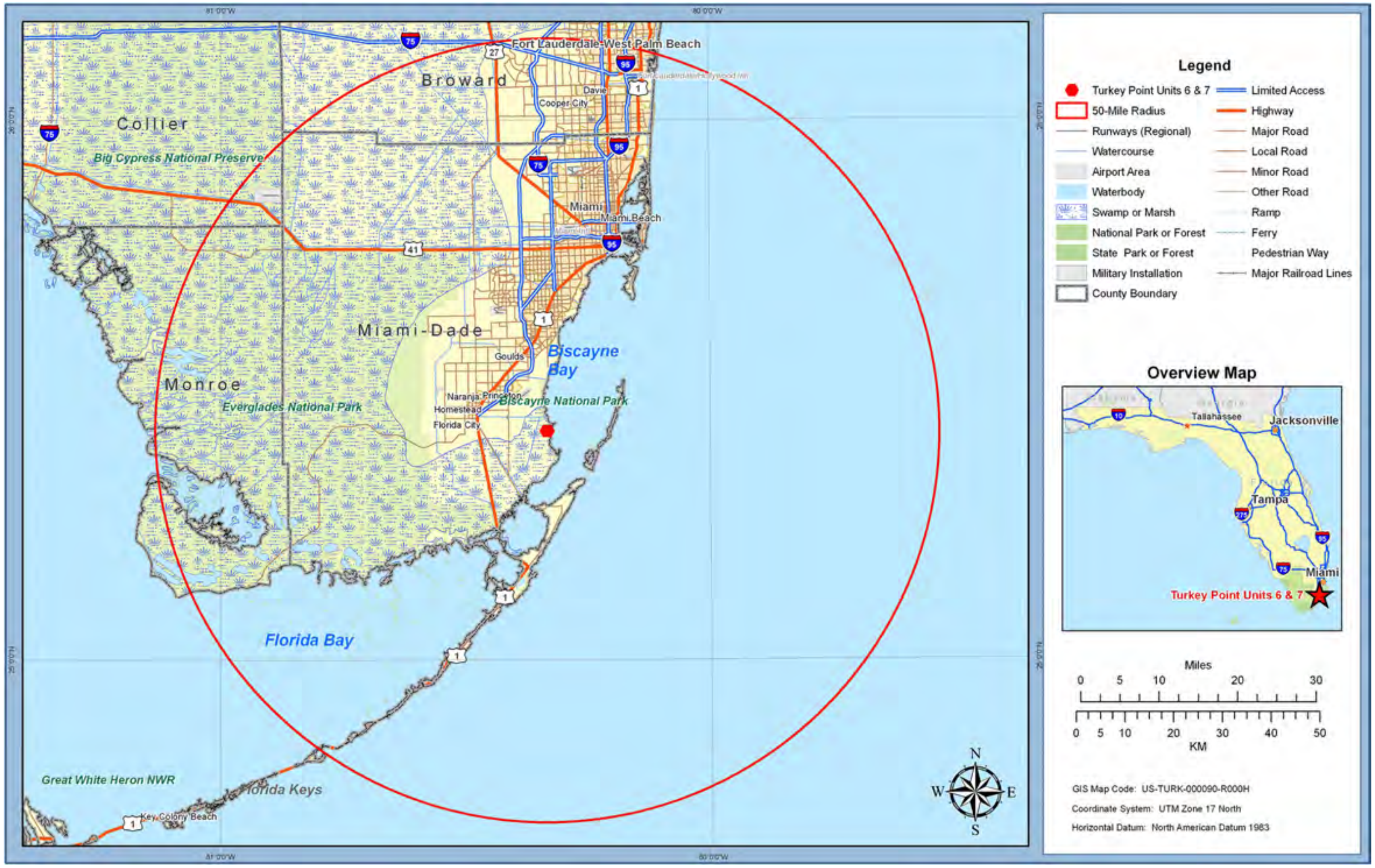
220. Monroe County Tourism, *Tourism*. Available at http://www/monroecounty-fl.gov/search.aspx?M=DC&S=1&SearchString= visitor numbers&ysnCount=0&showall=1, accessed March 22, 2012.

221. U.S. Department of Agriculture, State of Florida, *2007 Census of Agriculture — County Data, National Agricultural Statistics Service*, 2007.

222. Environmental Systems Research Institute, U.S. MapData Places (md_pic_sdc), Map Series, 2006.

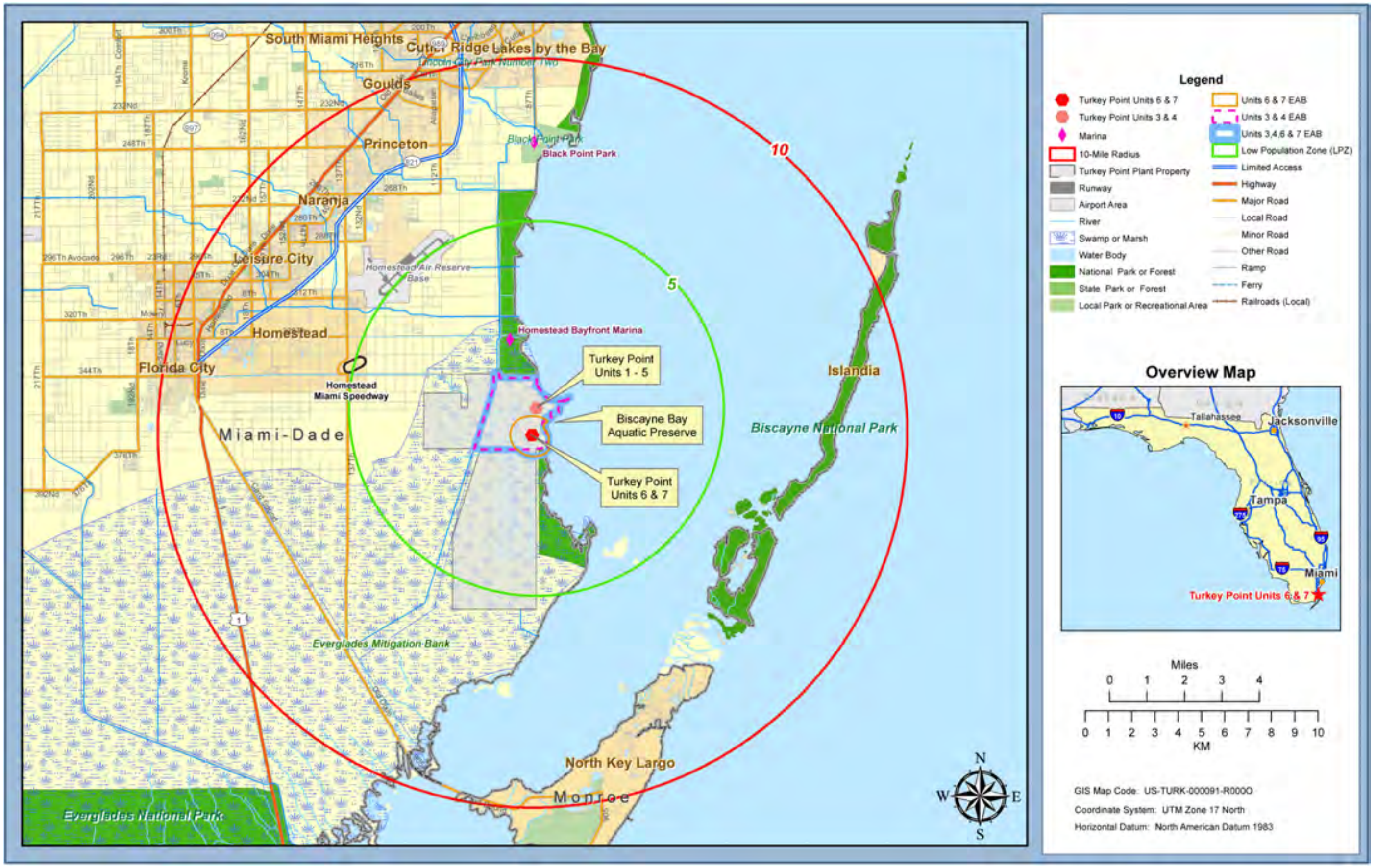
PTN COL 2.1-1

Figure 2.1-201 Turkey Point Surrounding Area (50-Mile Radius)



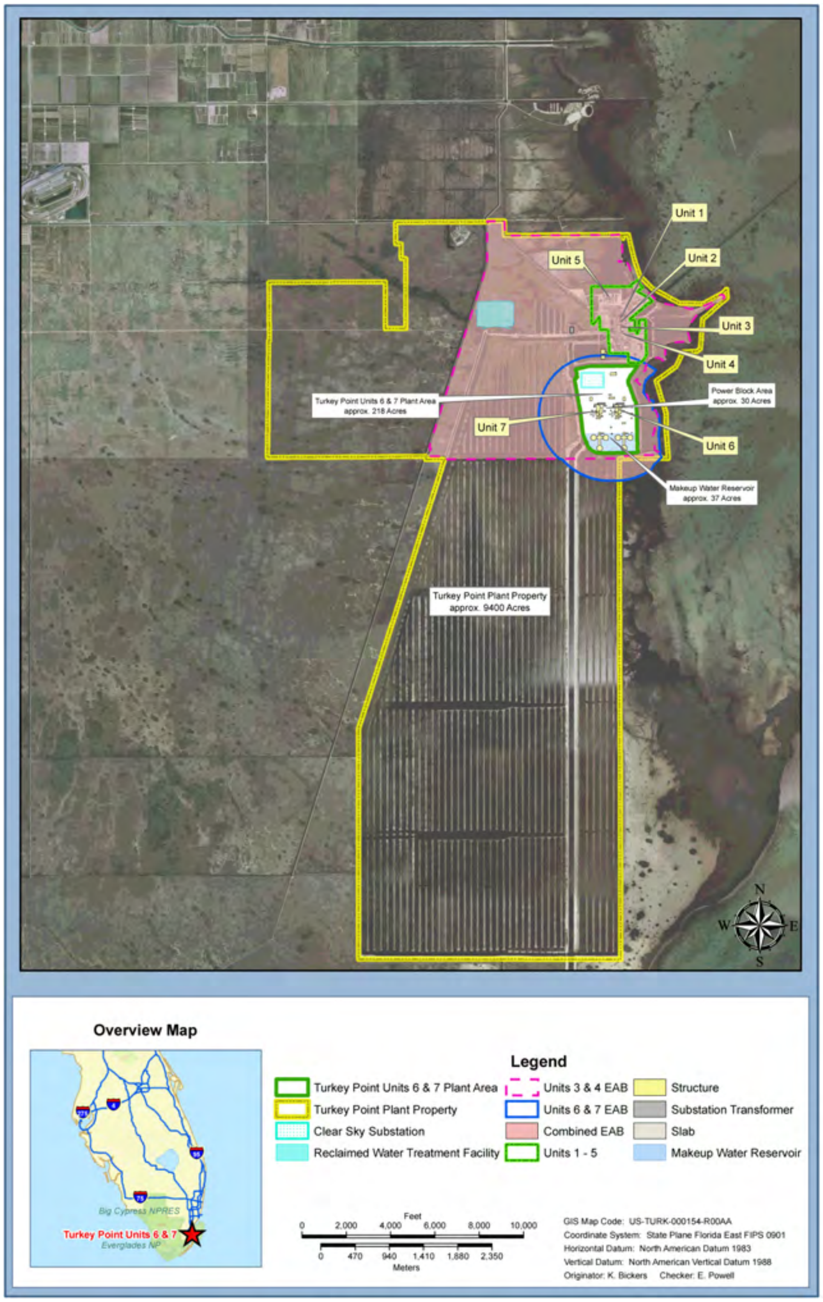
PTN COL 2.1-1

Figure 2.1-202 Turkey Point Surrounding Area (10-Mile Radius)



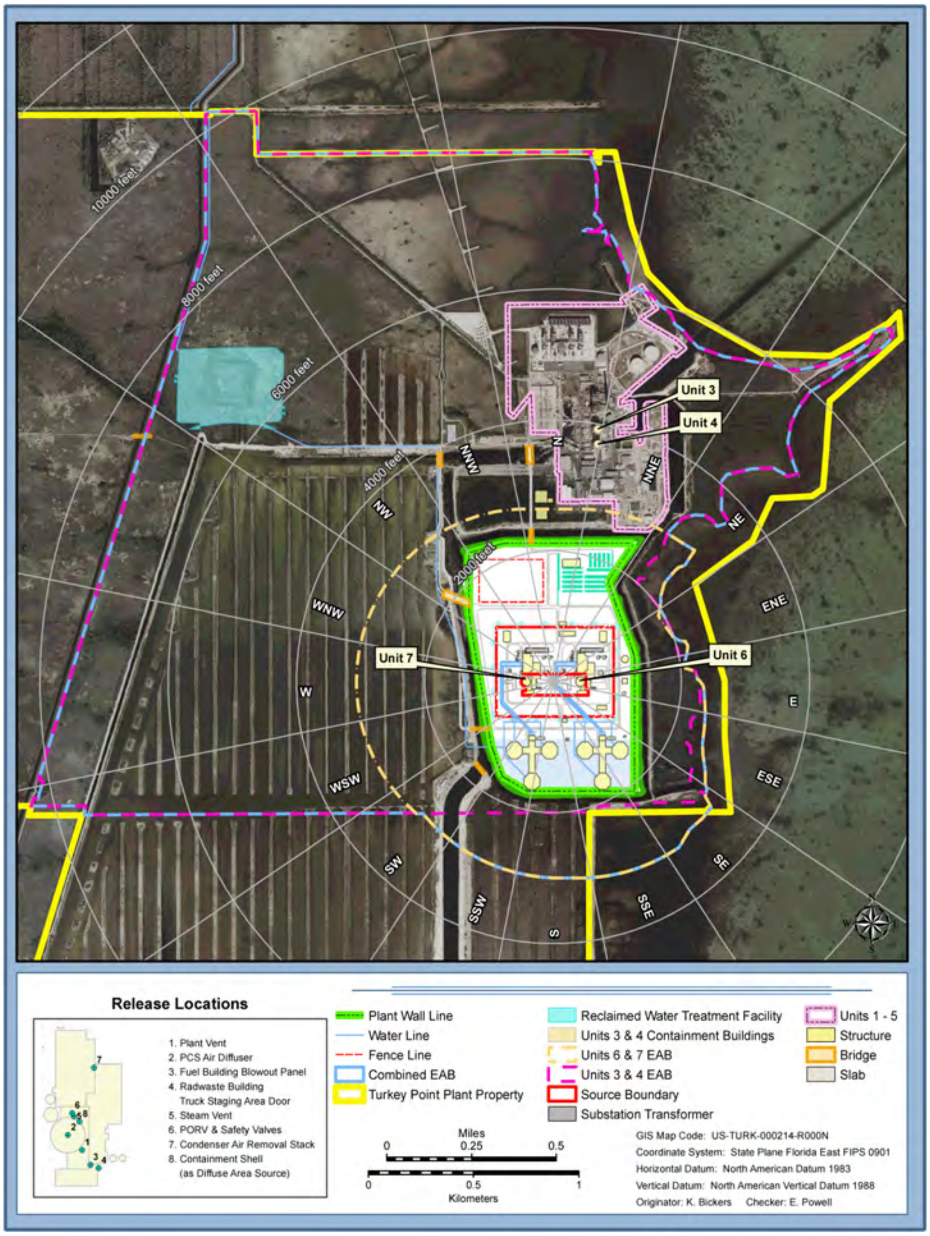
PTN COL 2.1-1

Figure 2.1-203 Turkey Point Site Area Map



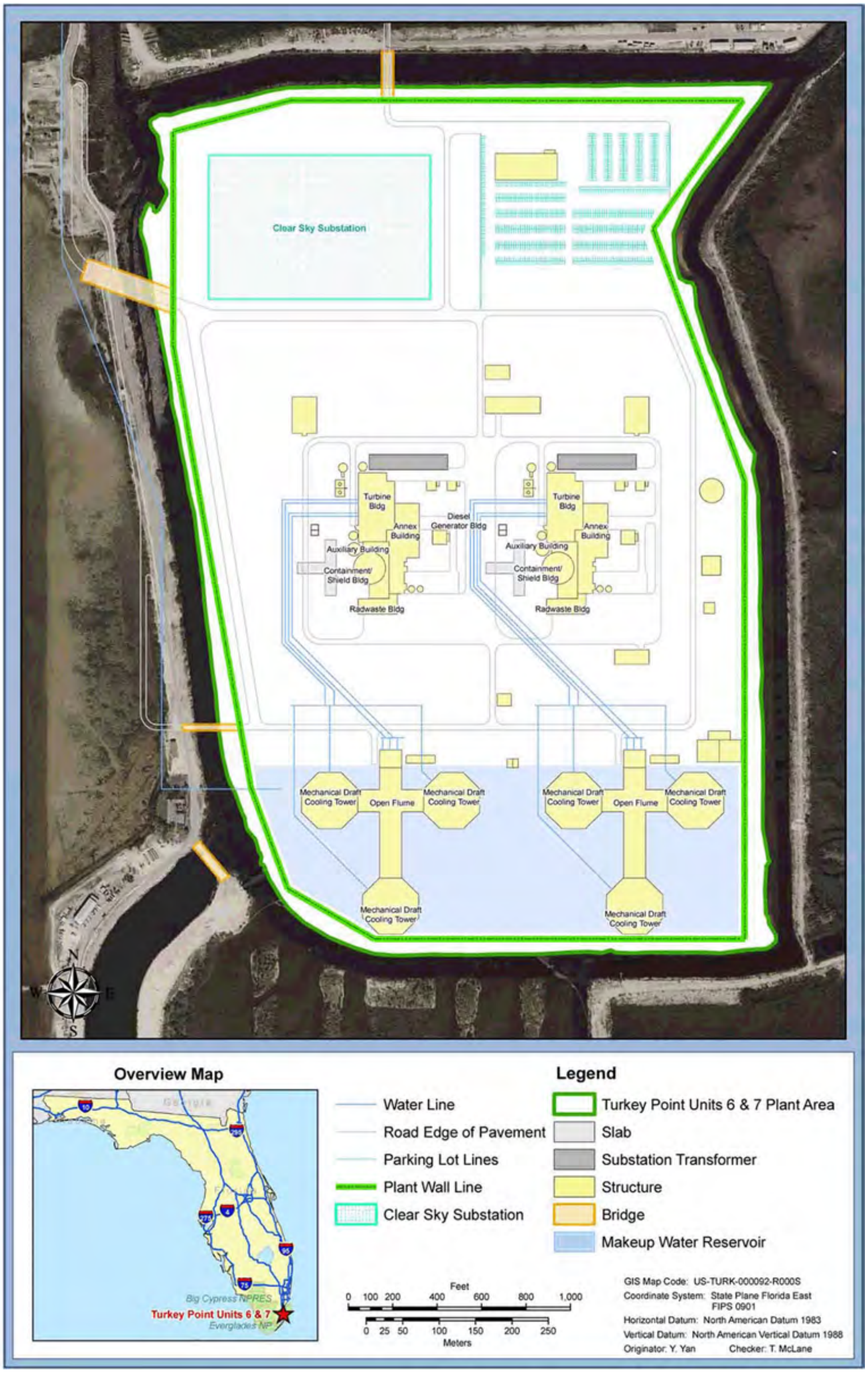
PTN COL 2.1-1

Figure 2.1-204 Turkey Point Enlarged Site Area Map



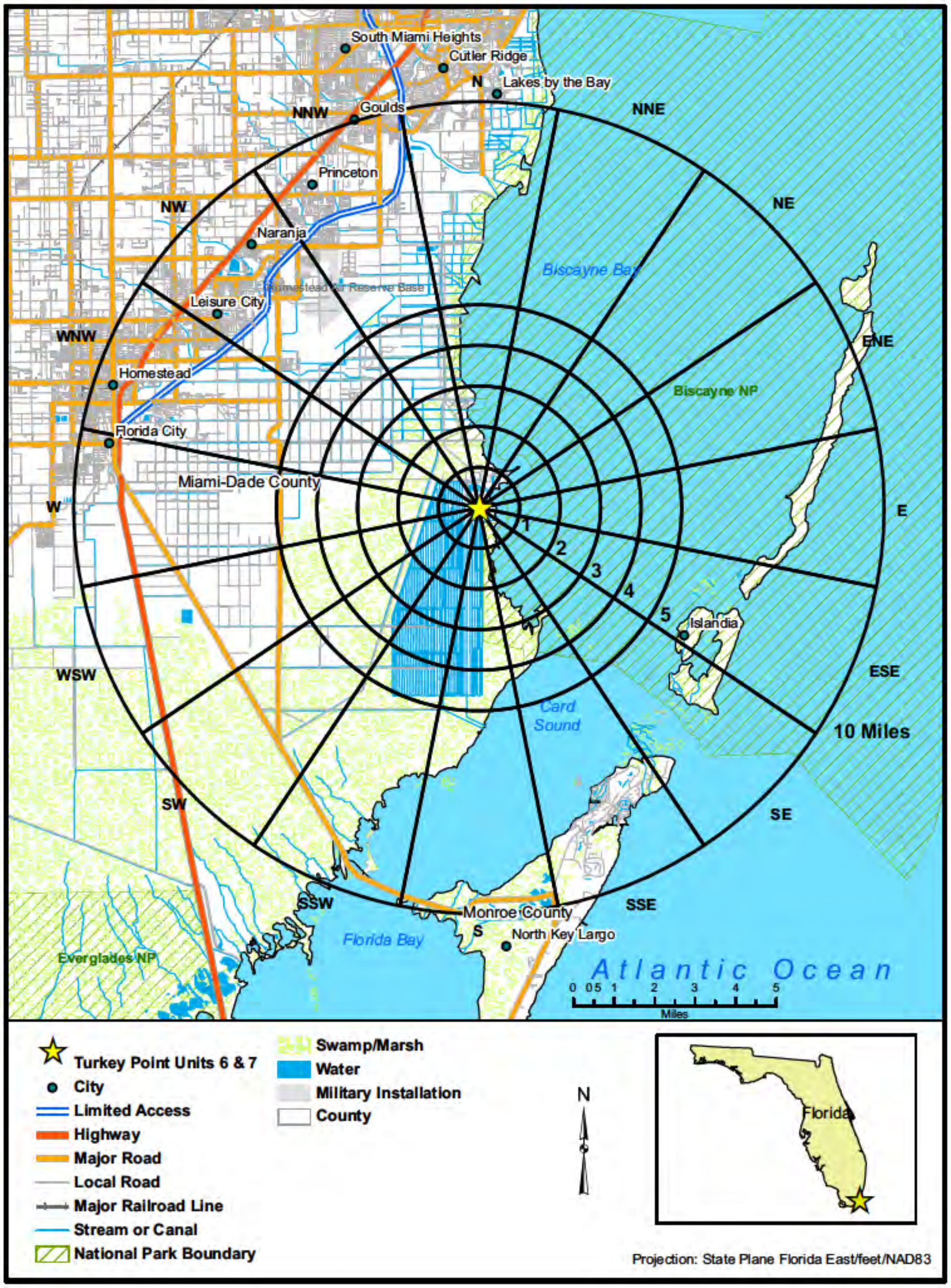
PTN COL 2.1-1

Figure 2.1-205 Principal Plant Structures within the Site Area



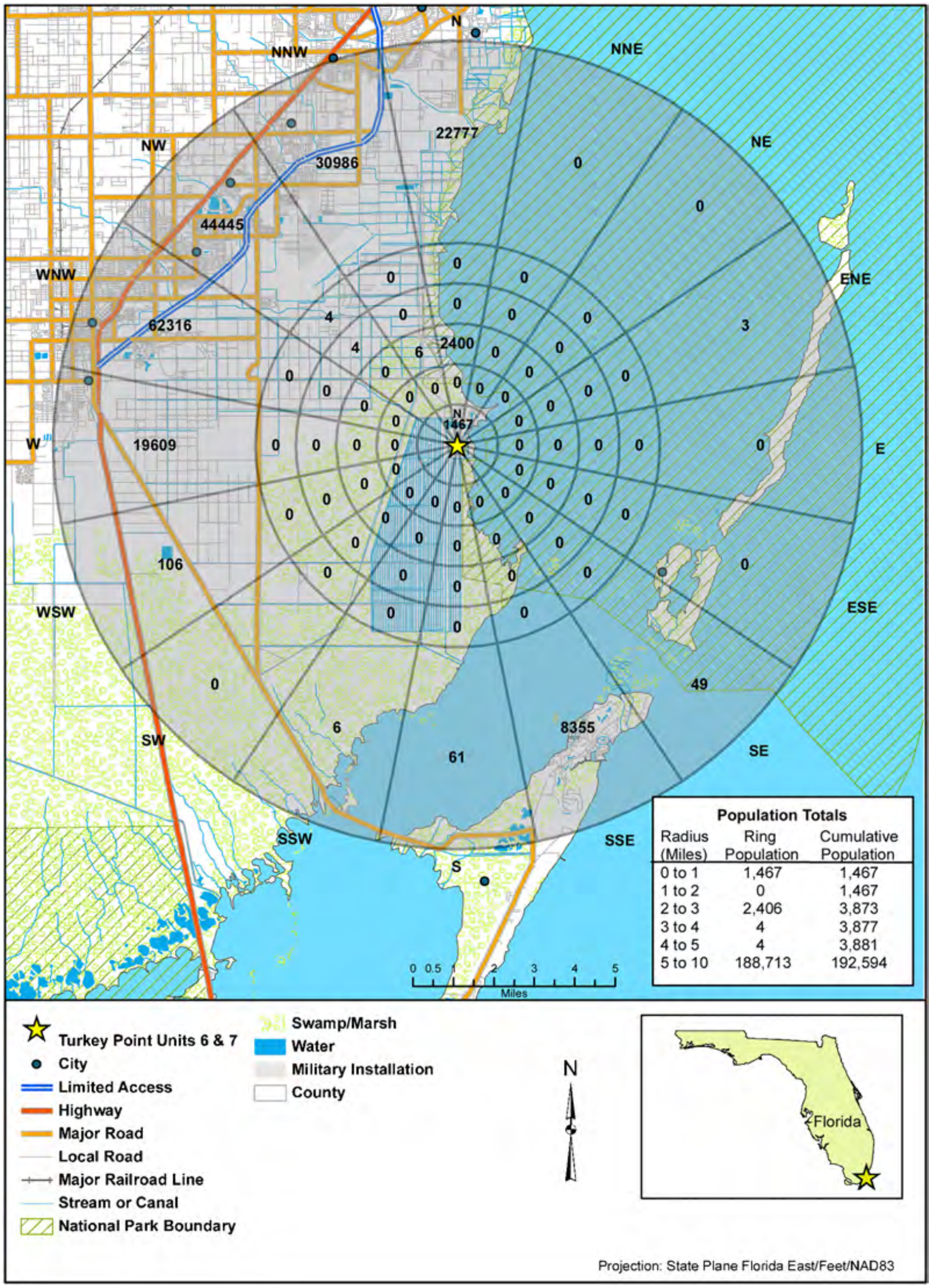
PTN COL 2.1-1

Figure 2.1-206 10-Mile Vicinity with Direction Sectors



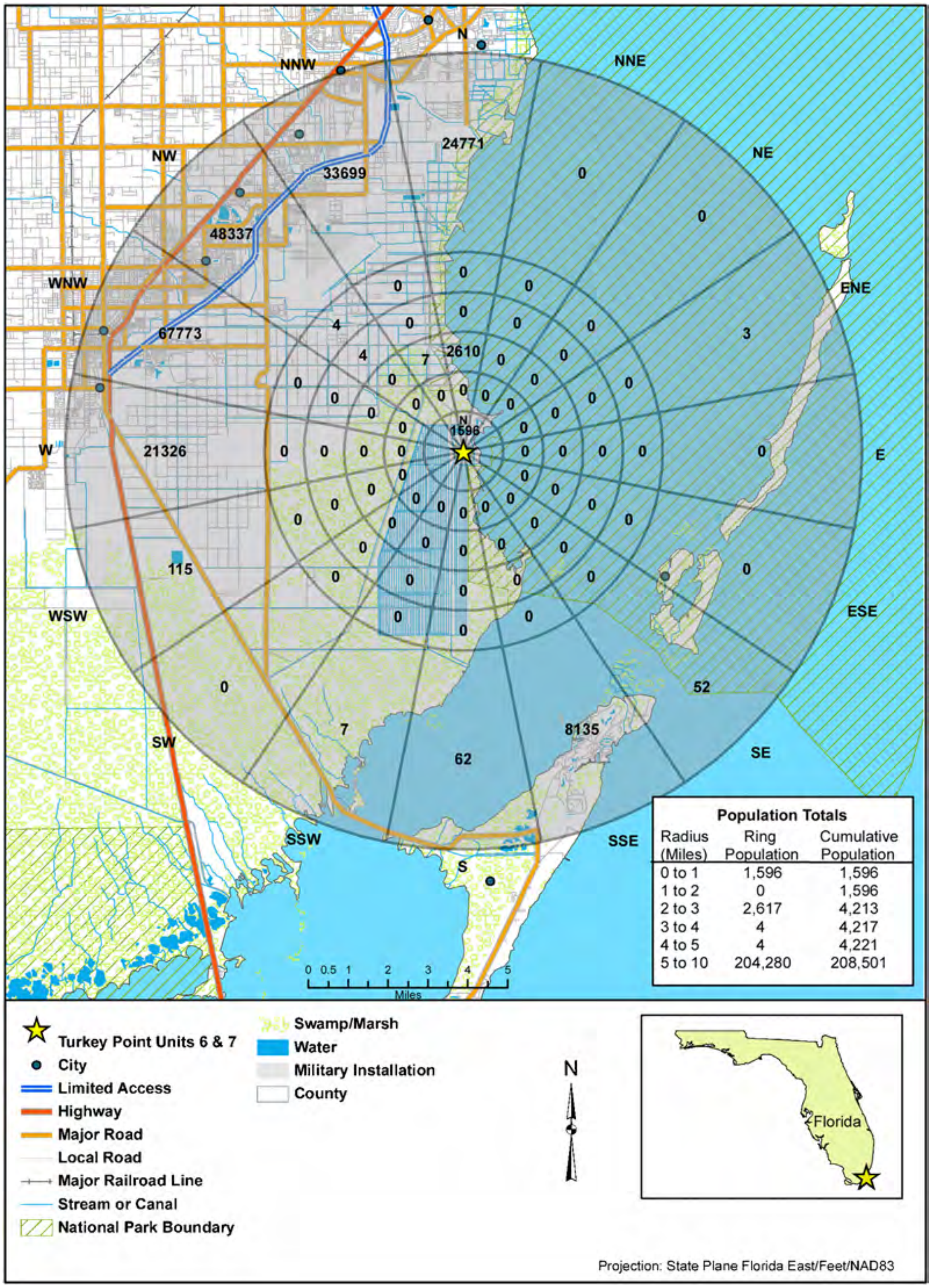
PTN COL 2.1-1

Figure 2.1-207 10-Mile 2010 Resident and Transient Population Distribution



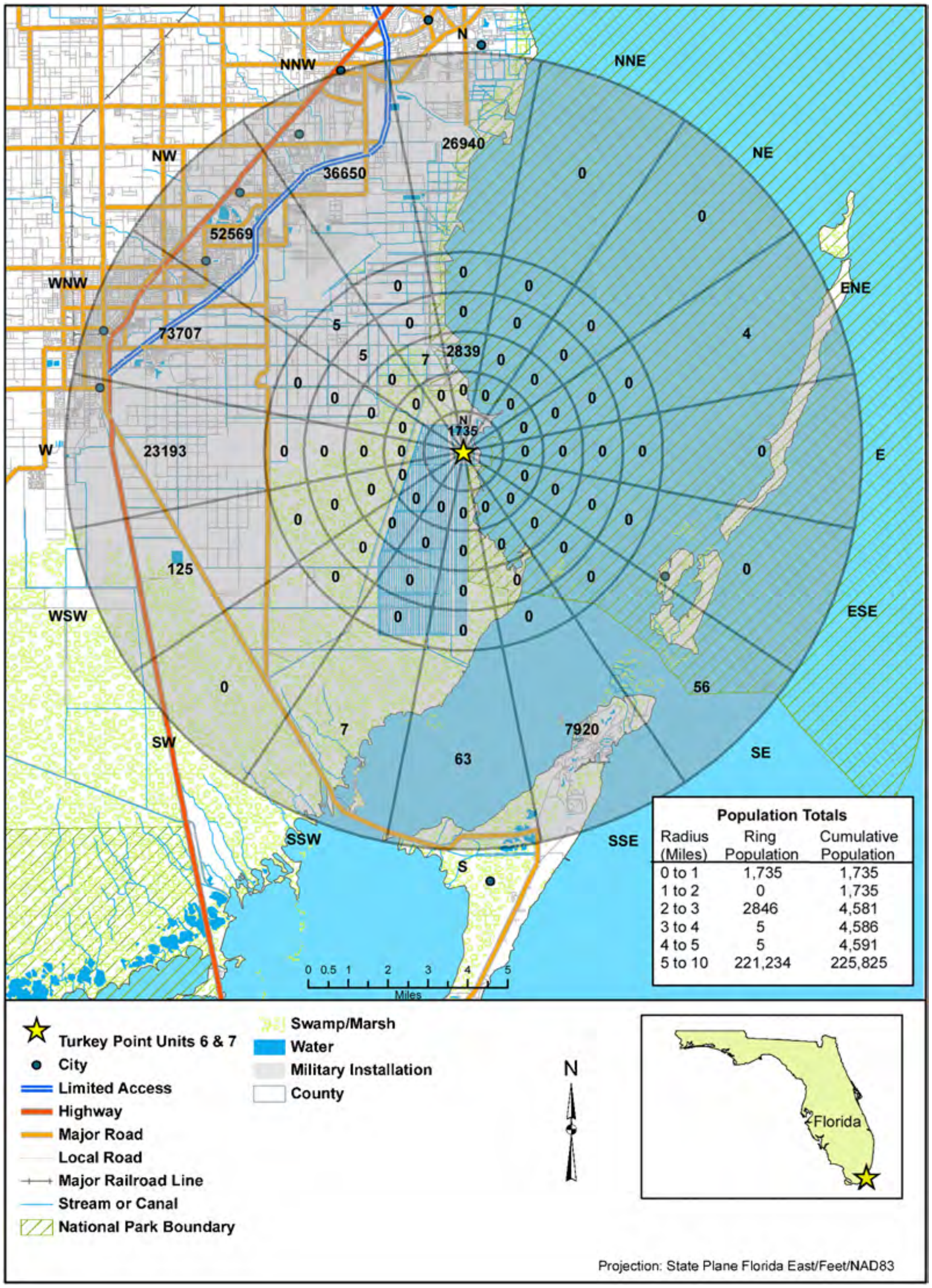
PTN COL 2.1-1

Figure 2.1-208 10-Mile 2020 Resident and Transient Population Distribution



PTN COL 2.1-1

Figure 2.1-209 10-Mile 2030 Resident and Transient Population Distribution

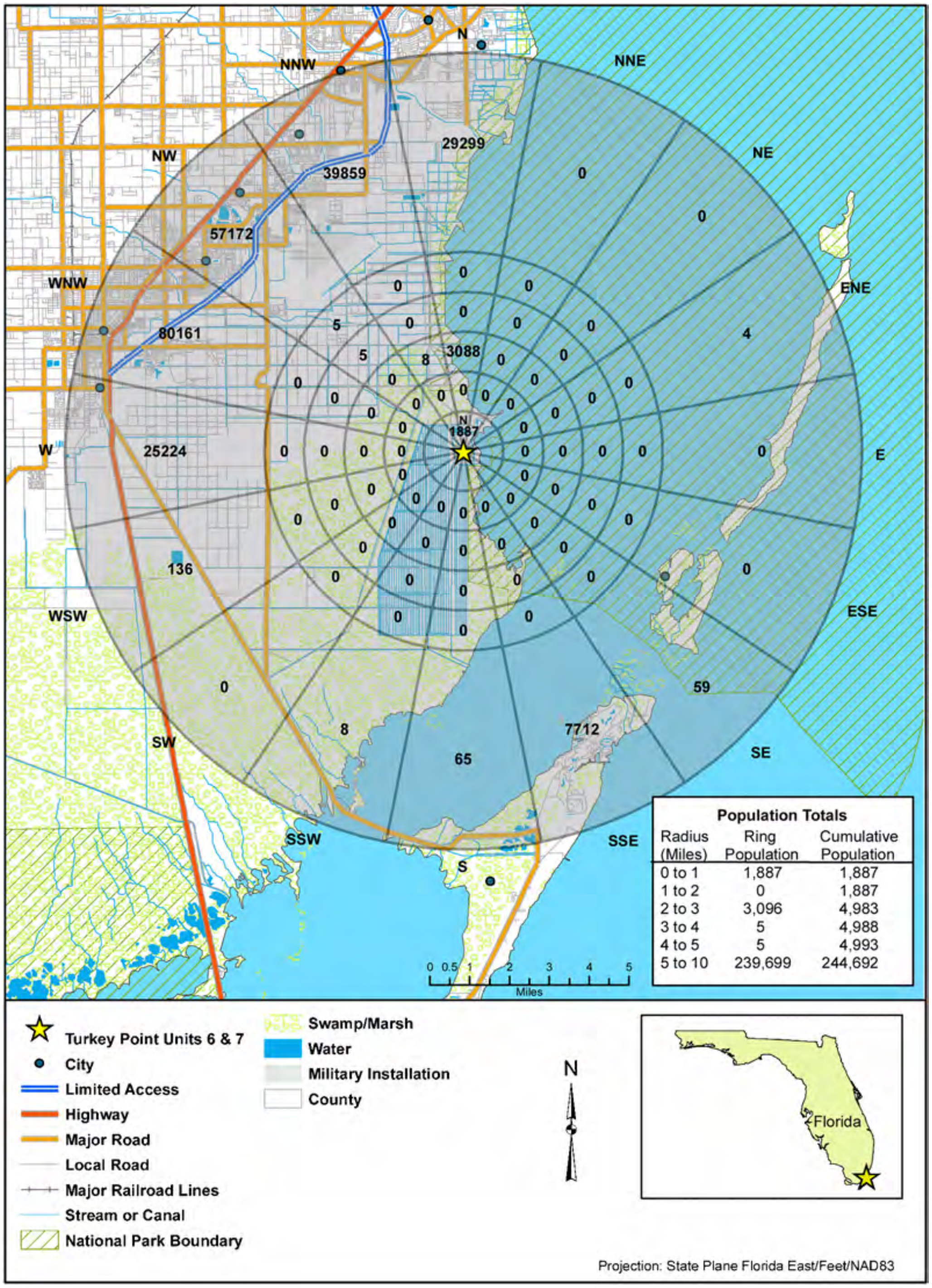


Population Totals

Radius (Miles)	Ring Population	Cumulative Population
0 to 1	1,735	1,735
1 to 2	0	1,735
2 to 3	2846	4,581
3 to 4	5	4,586
4 to 5	5	4,591
5 to 10	221,234	225,825

PTN COL 2.1-1

Figure 2.1-210 10-Mile 2040 Resident and Transient Population Distribution

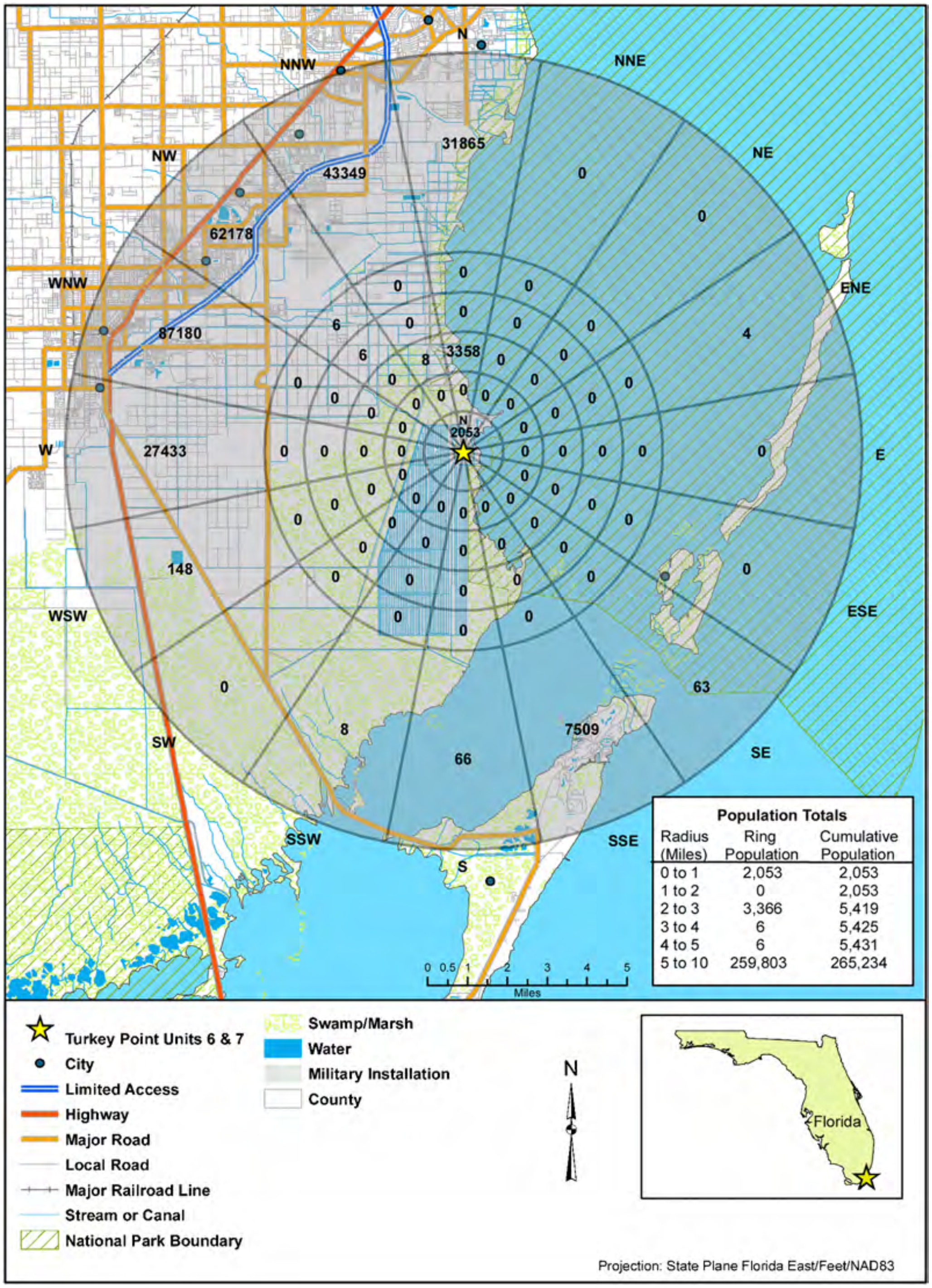


Population Totals

Radius (Miles)	Ring Population	Cumulative Population
0 to 1	1,887	1,887
1 to 2	0	1,887
2 to 3	3,096	4,983
3 to 4	5	4,988
4 to 5	5	4,993
5 to 10	239,699	244,692

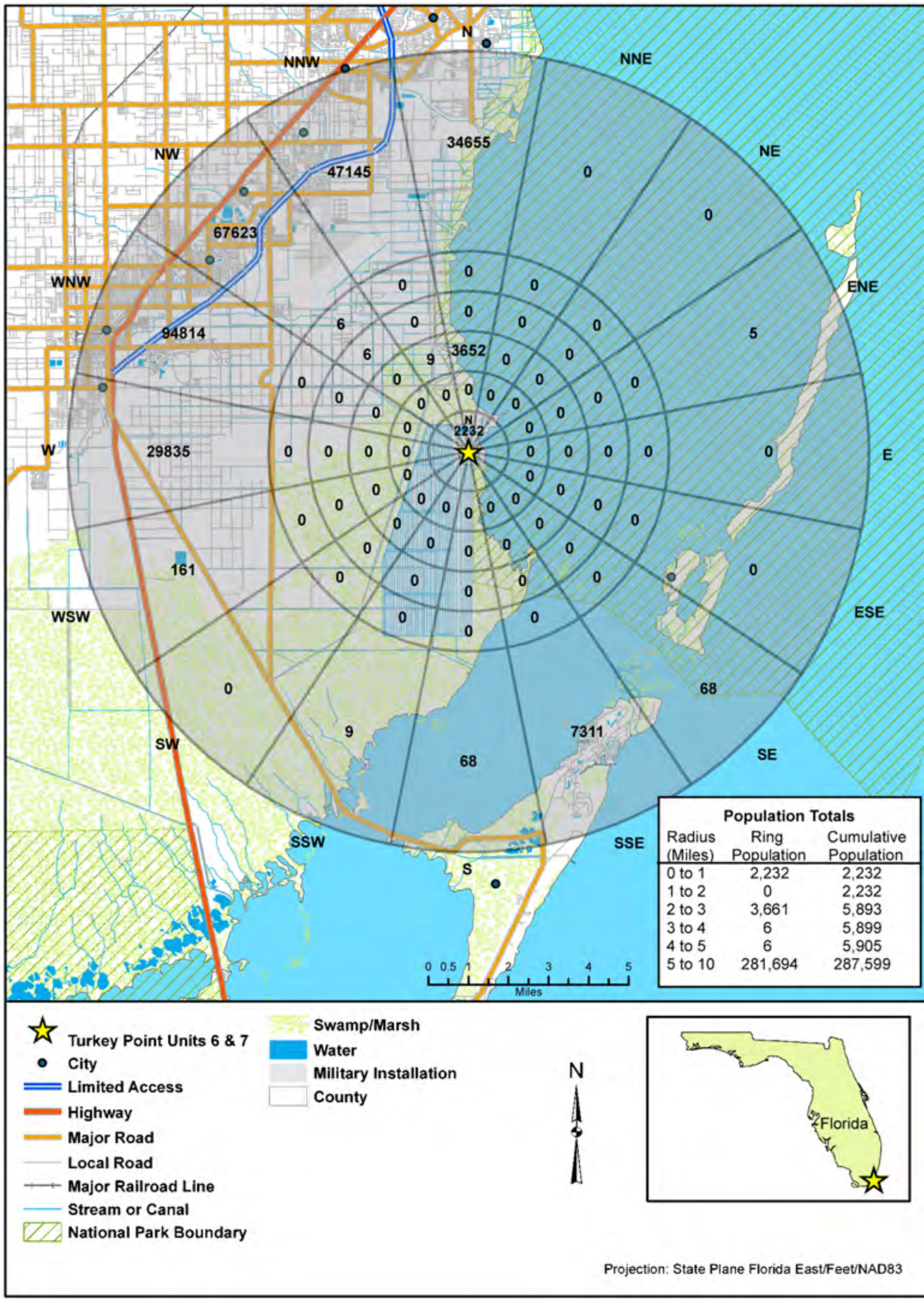
PTN COL 2.1-1

Figure 2.1-211 10-Mile 2050 Resident and Transient Population Distribution



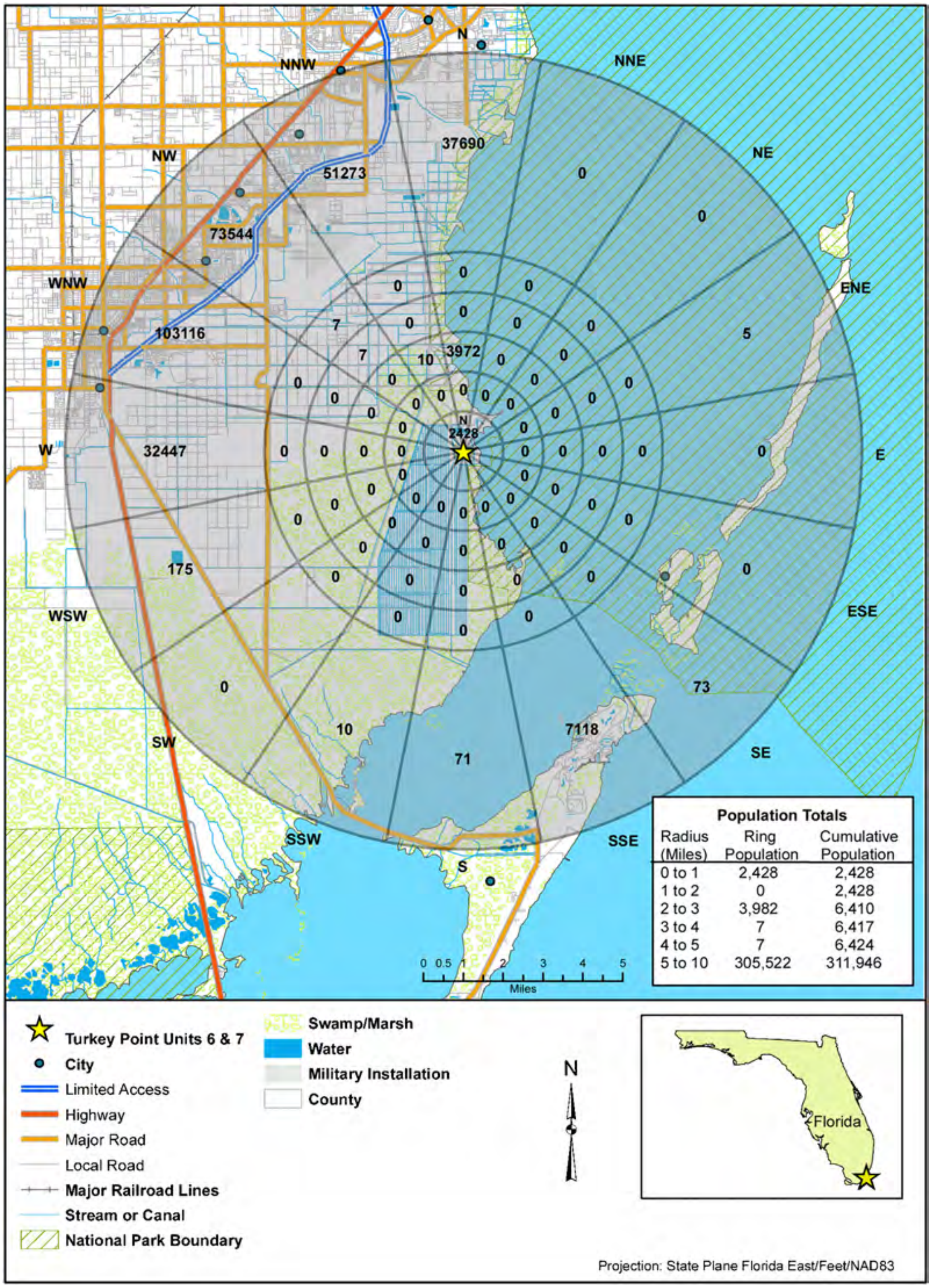
PTN COL 2.1-1

Figure 2.1-212 10-Mile 2060 Resident and Transient Population Distribution



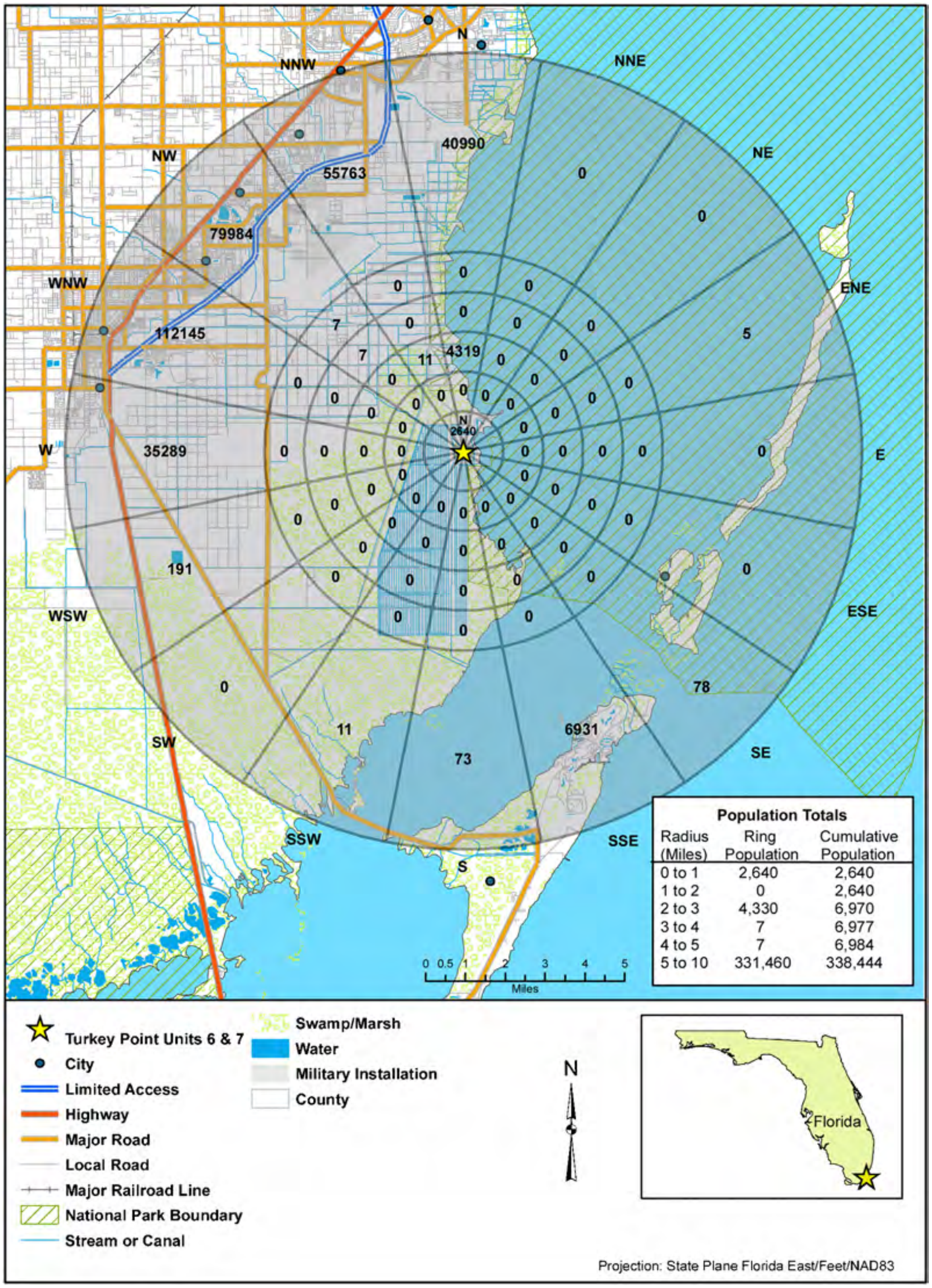
PTN COL 2.1-1

Figure 2.1-213 10-Mile 2070 Resident and Transient Population Distribution



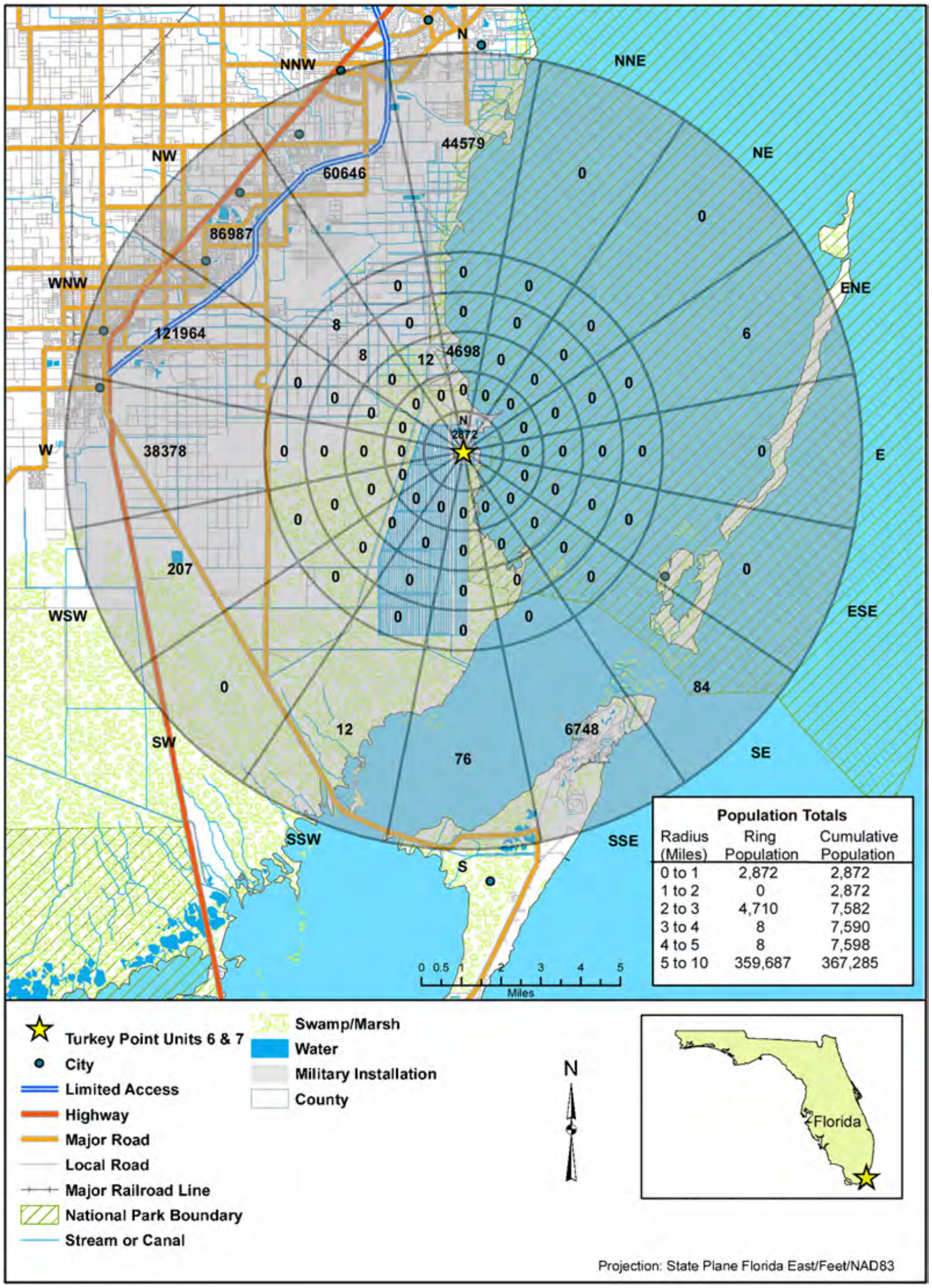
PTN COL 2.1-1

Figure 2.1-214 10-Mile 2080 Resident and Transient Population Distribution



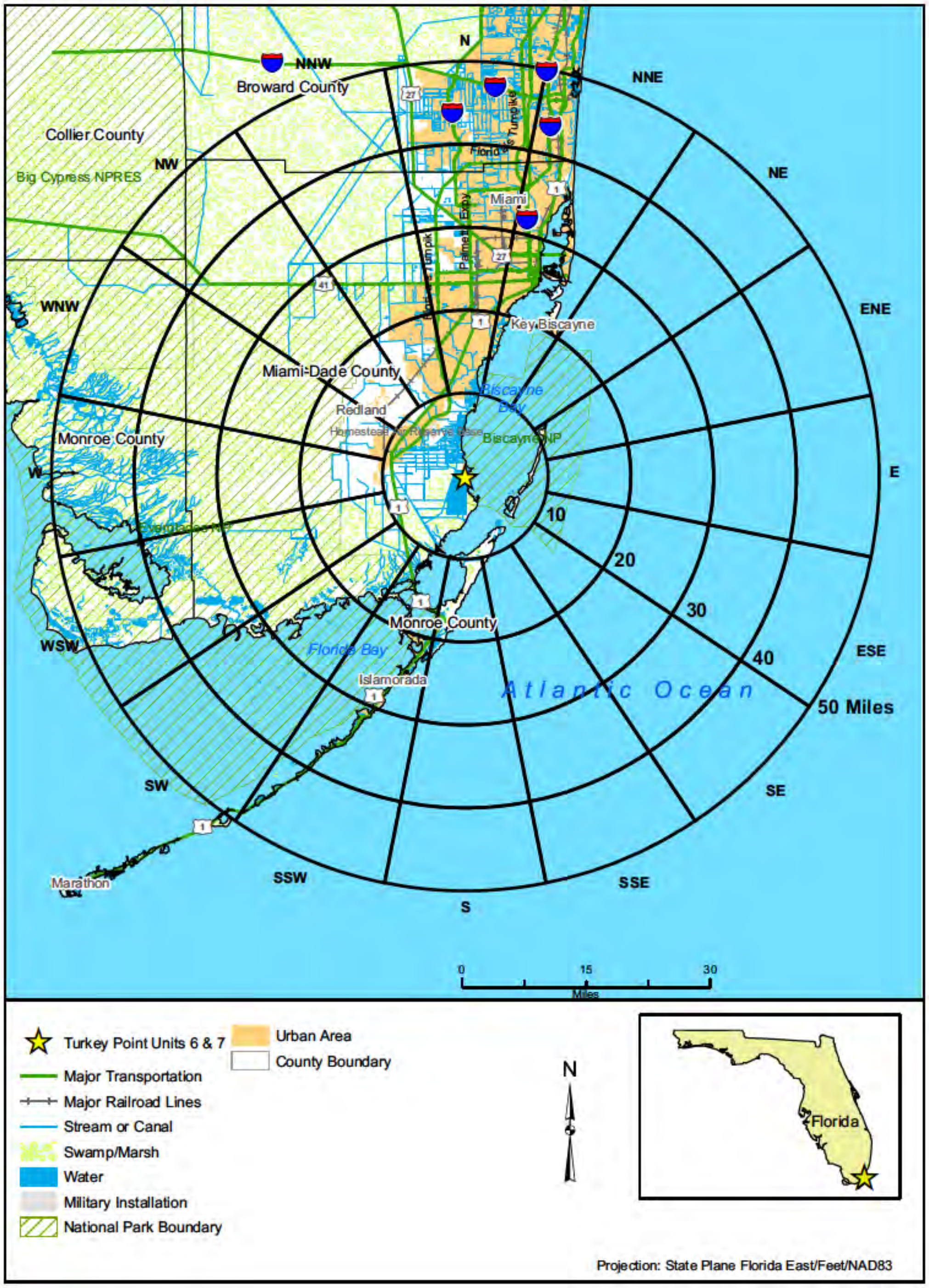
PTN COL 2.1-1

Figure 2.1-215 10-Mile 2090 Resident and Transient Population Distribution



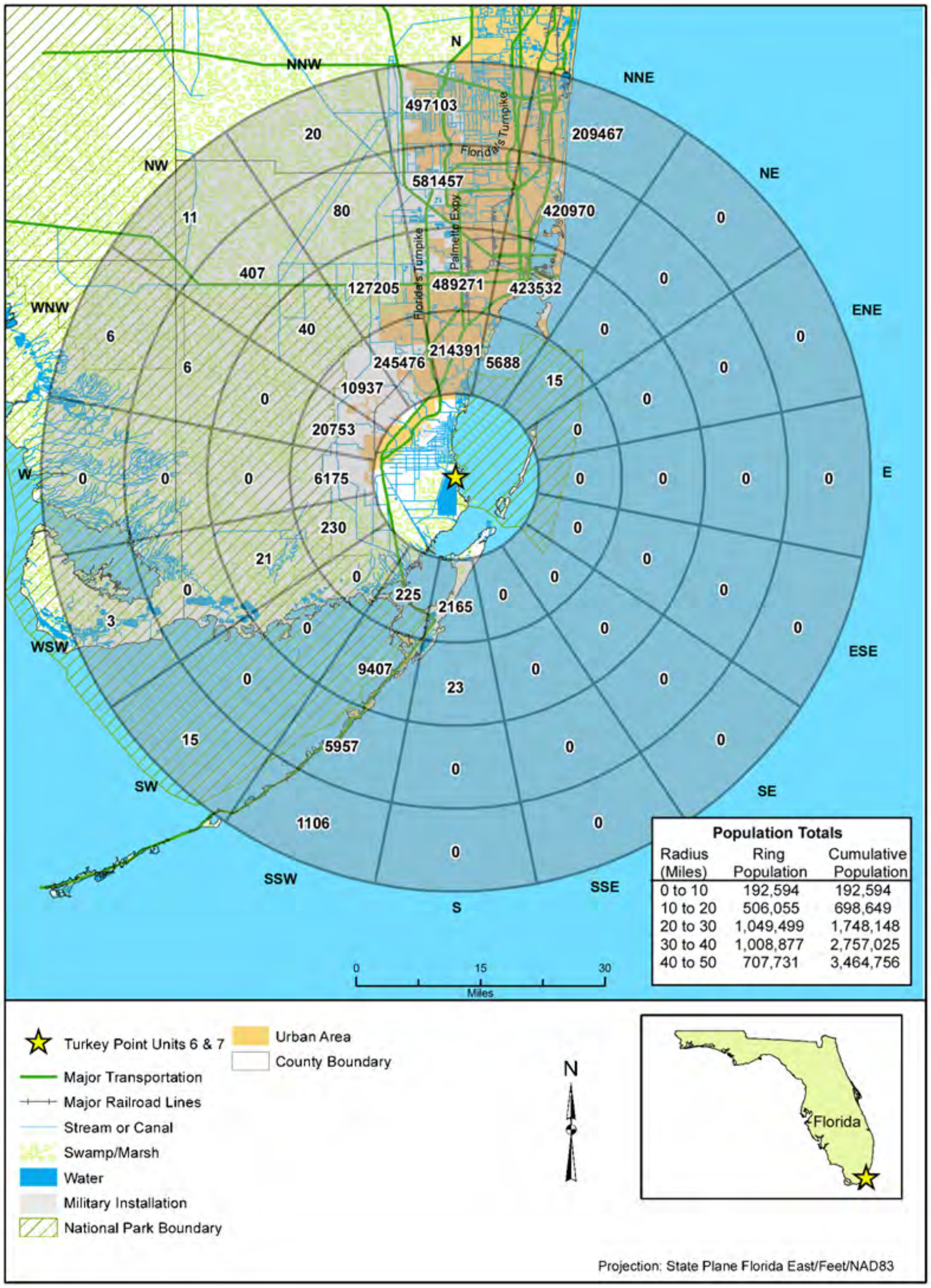
PTN COL 2.1-1

Figure 2.1-216 50-Mile Region with Direction Sectors



PTN COL 2.1-1

Figure 2.1-217 50-Mile 2010 Resident Population Distribution

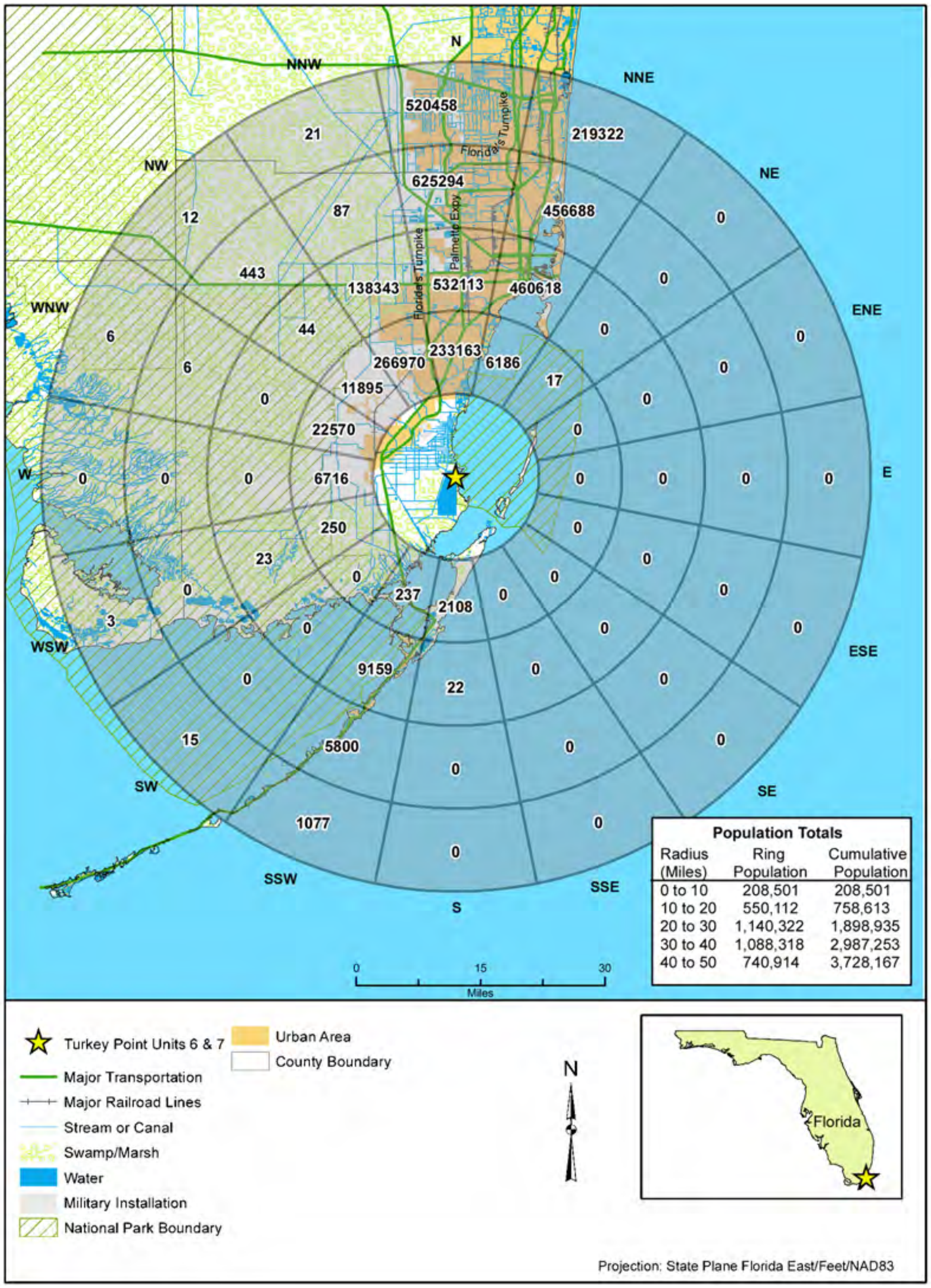


Population Totals

Radius (Miles)	Ring Population	Cumulative Population
0 to 10	192,594	192,594
10 to 20	506,055	698,649
20 to 30	1,049,499	1,748,148
30 to 40	1,008,877	2,757,025
40 to 50	707,731	3,464,756

PTN COL 2.1-1

Figure 2.1-218 50-Mile 2020 Resident Population Distribution

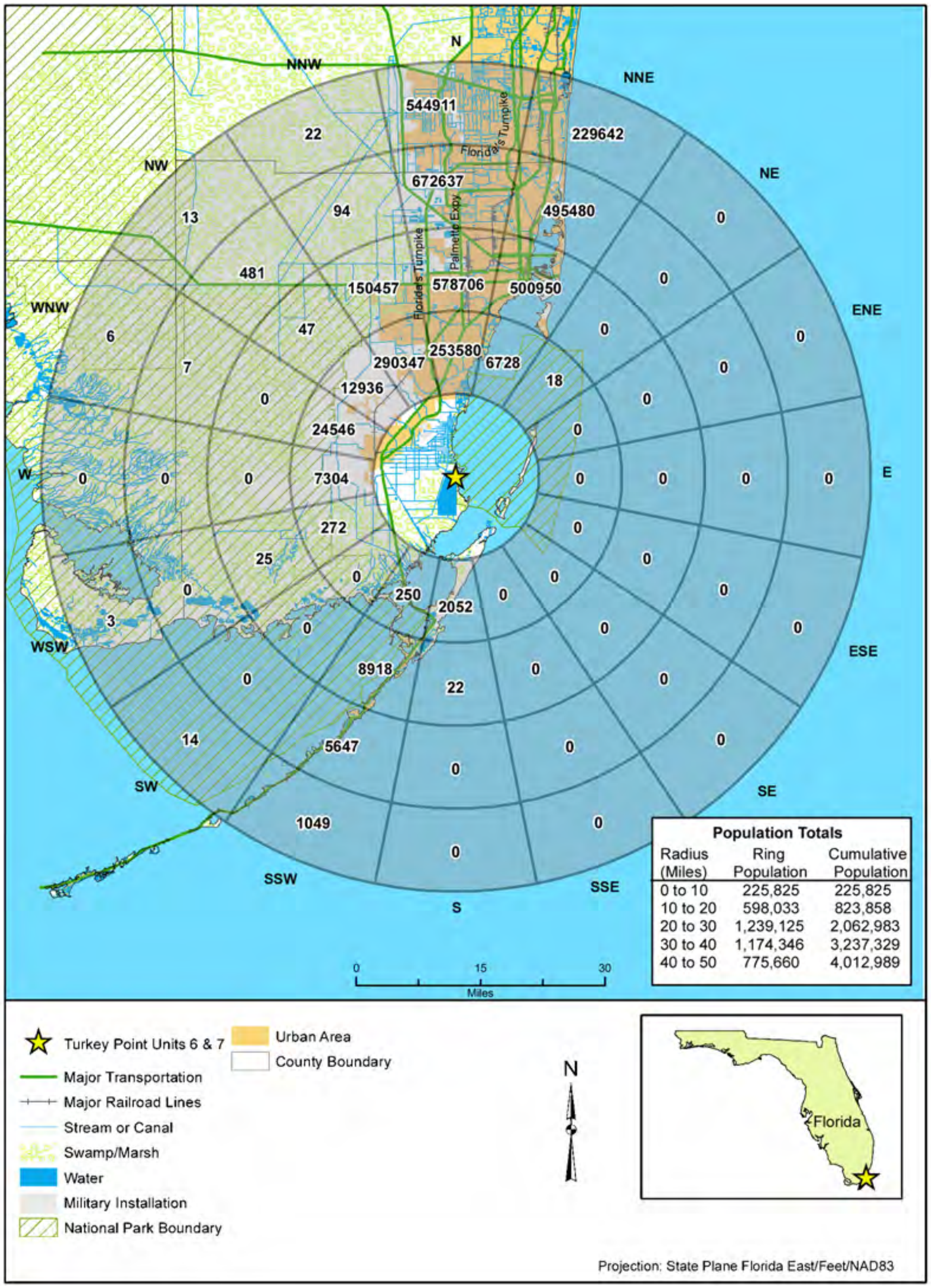


Population Totals

Radius (Miles)	Ring Population	Cumulative Population
0 to 10	208,501	208,501
10 to 20	550,112	758,613
20 to 30	1,140,322	1,898,935
30 to 40	1,088,318	2,987,253
40 to 50	740,914	3,728,167

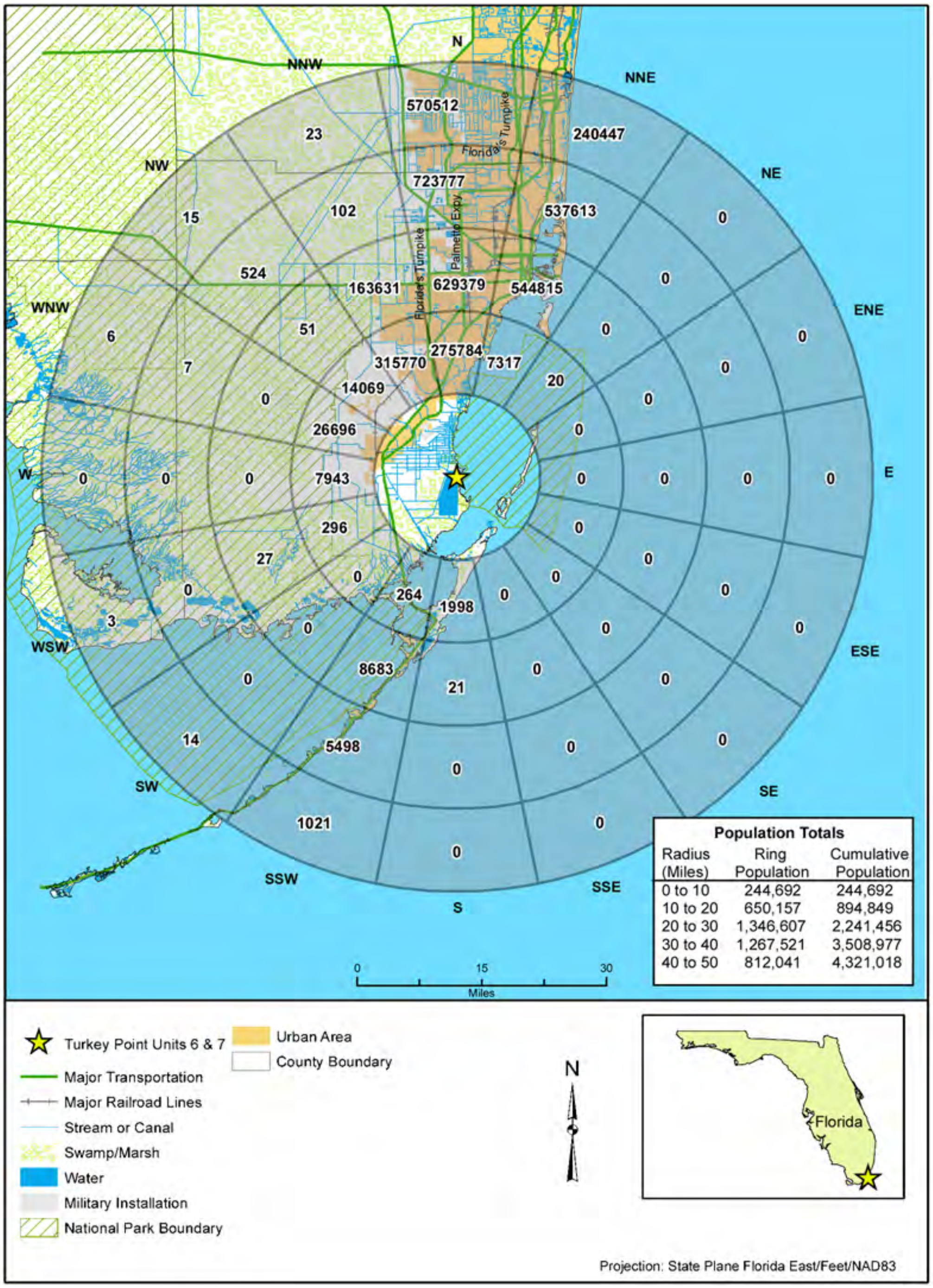
PTN COL 2.1-1

Figure 2.1-219 50-Mile 2030 Resident Population Distribution



PTN COL 2.1-1

Figure 2.1-220 50-Mile 2040 Resident Population Distribution

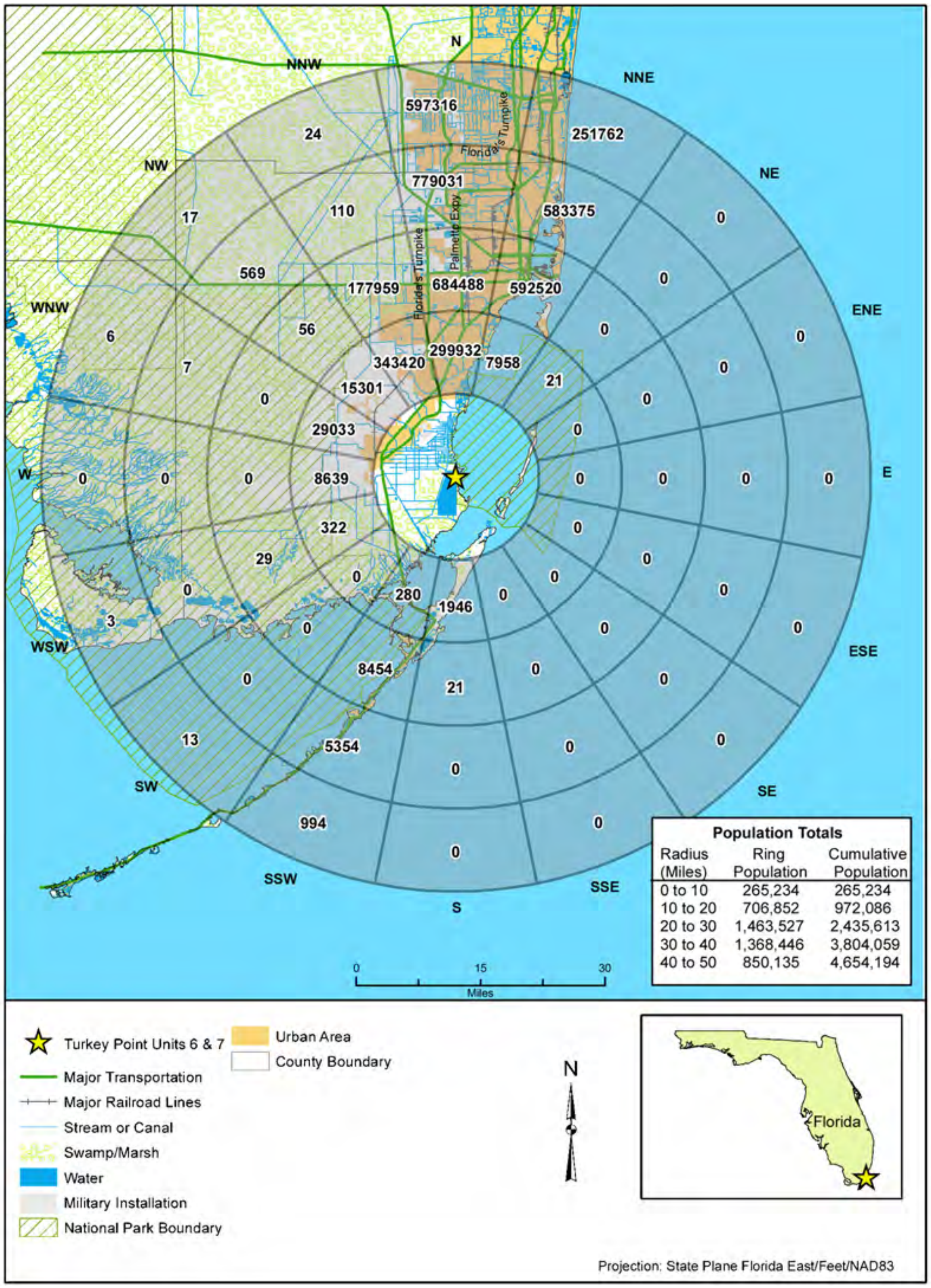


Population Totals

Radius (Miles)	Ring Population	Cumulative Population
0 to 10	244,692	244,692
10 to 20	650,157	894,849
20 to 30	1,346,607	2,241,456
30 to 40	1,267,521	3,508,977
40 to 50	812,041	4,321,018

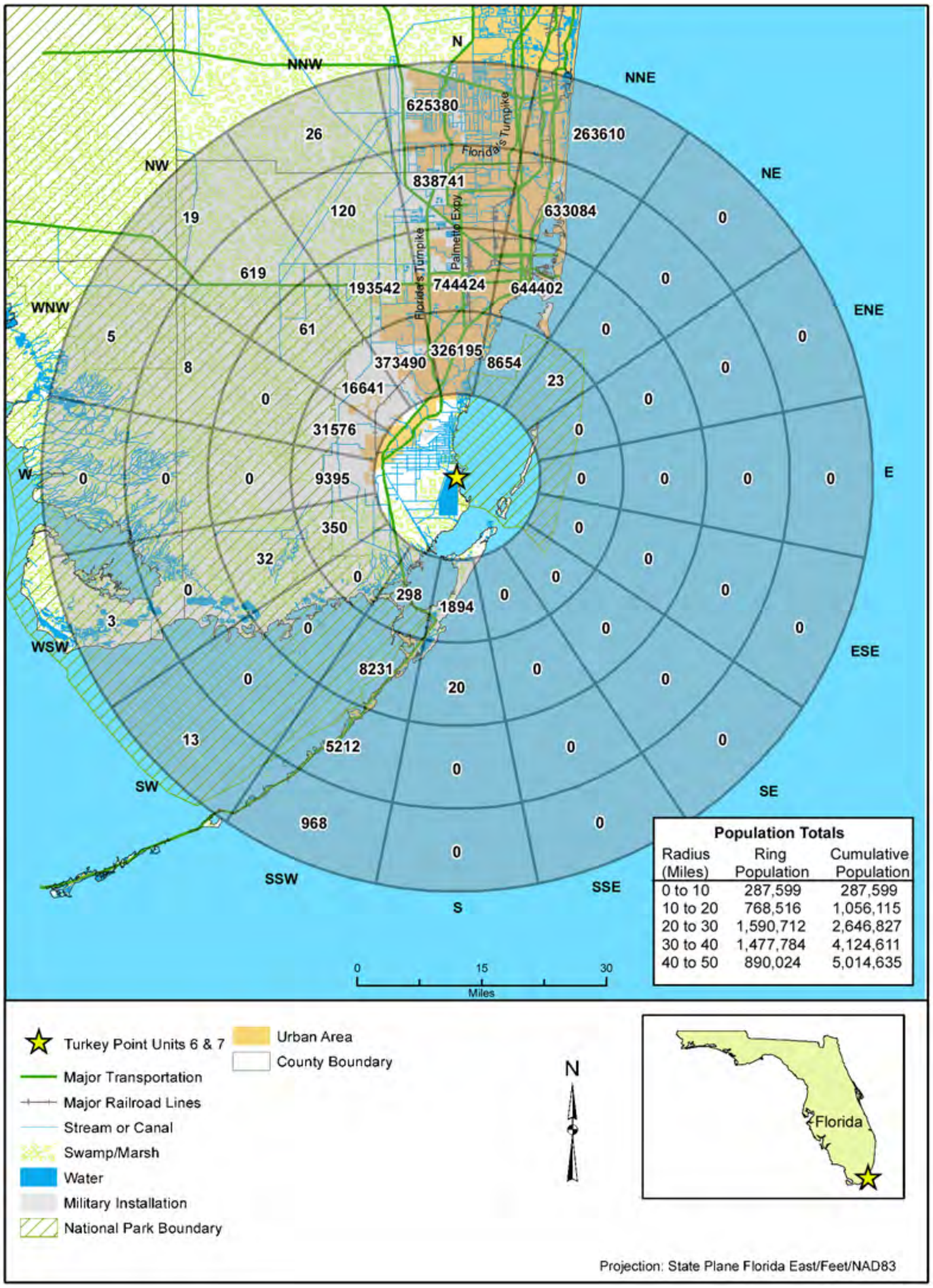
PTN COL 2.1-1

Figure 2.1-221 50-Mile 2050 Resident Population Distribution



PTN COL 2.1-1

Figure 2.1-222 50-Mile 2060 Resident Population Distribution

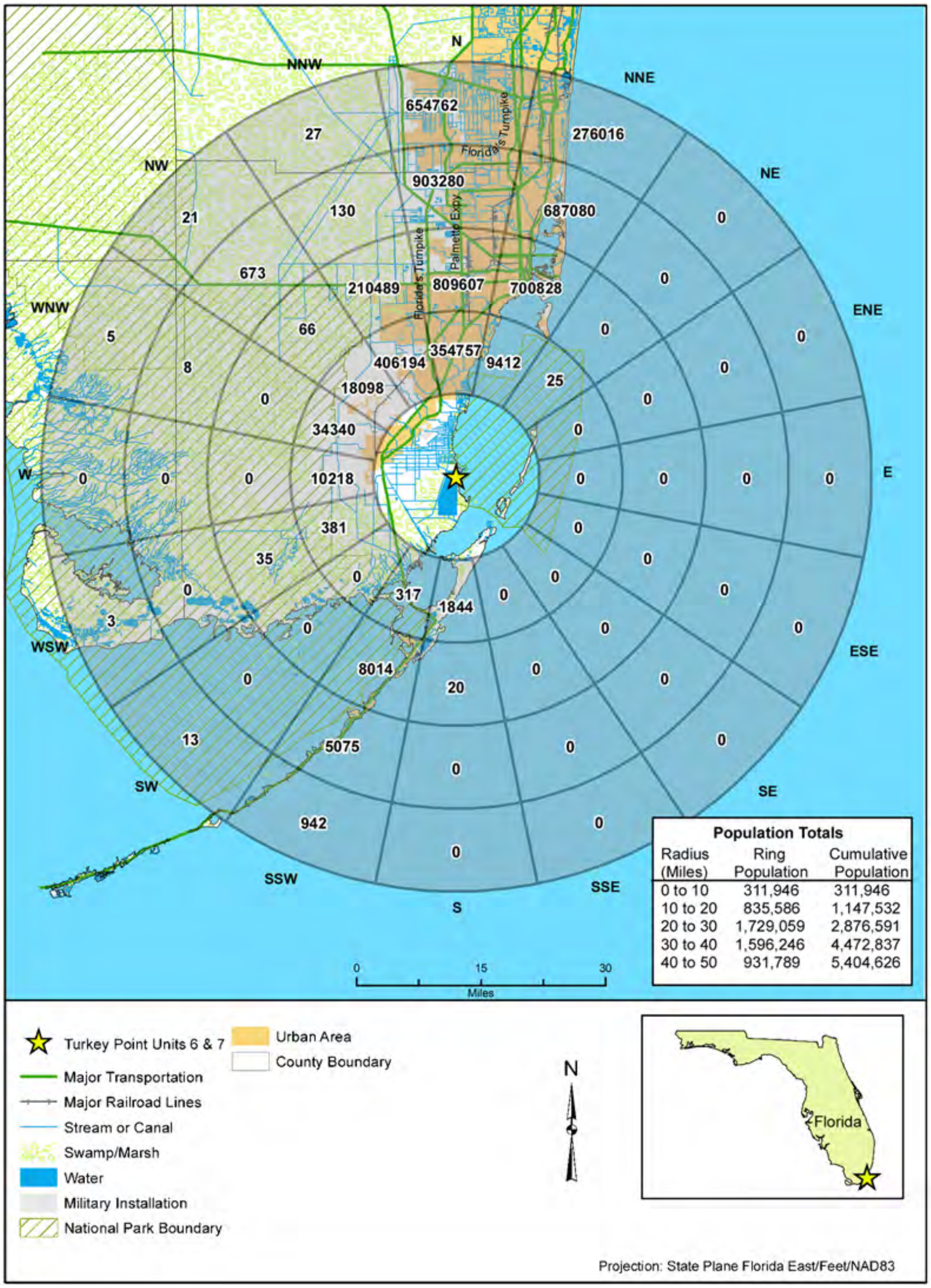


Population Totals

Radius (Miles)	Ring Population	Cumulative Population
0 to 10	287,599	287,599
10 to 20	768,516	1,056,115
20 to 30	1,590,712	2,646,827
30 to 40	1,477,784	4,124,611
40 to 50	890,024	5,014,635

PTN COL 2.1-1

Figure 2.1-223 50-Mile 2070 Resident Population Distribution

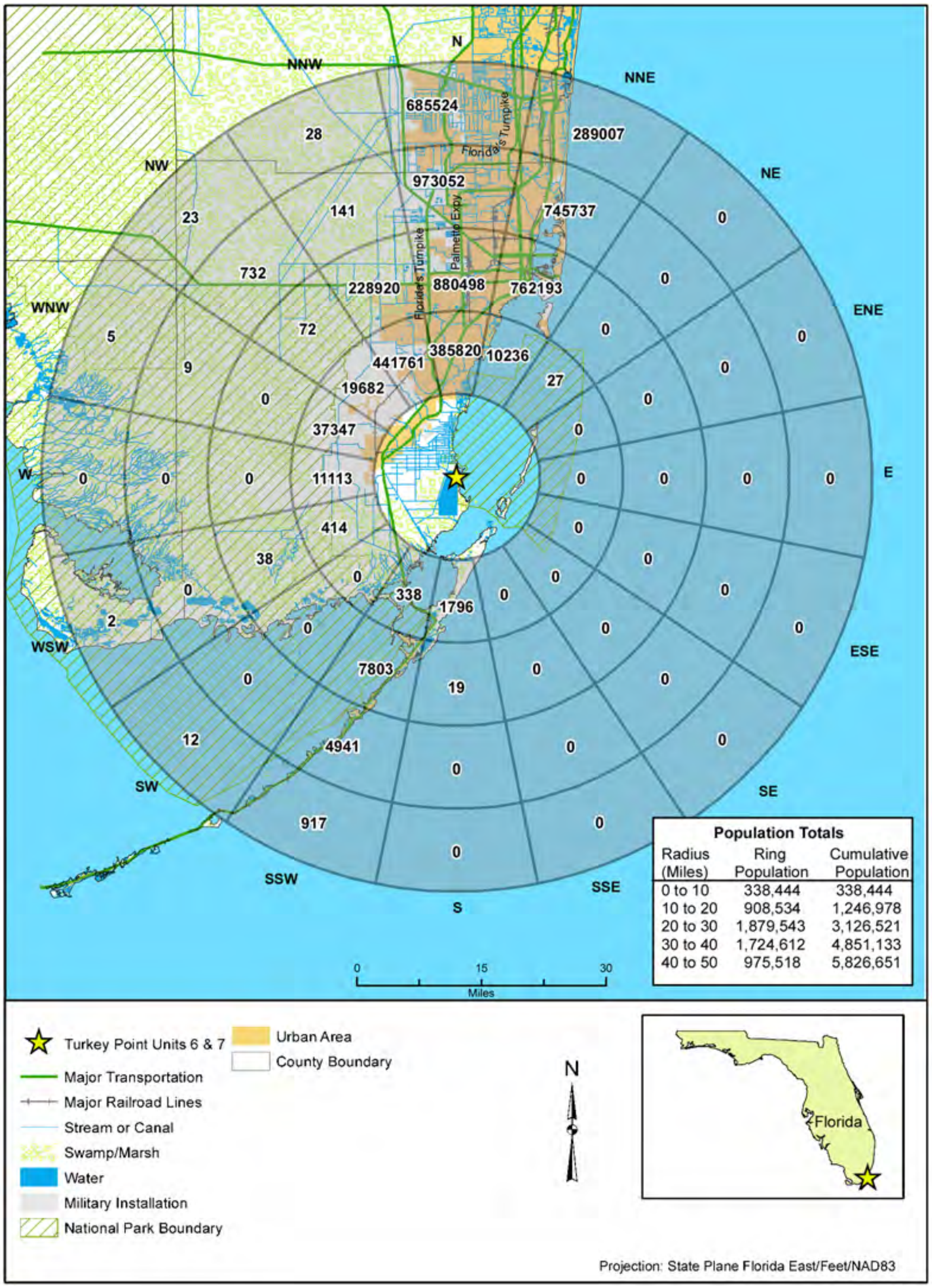


Population Totals

Radius (Miles)	Ring Population	Cumulative Population
0 to 10	311,946	311,946
10 to 20	835,586	1,147,532
20 to 30	1,729,059	2,876,591
30 to 40	1,596,246	4,472,837
40 to 50	931,789	5,404,626

PTN COL 2.1-1

Figure 2.1-224 50-Mile 2080 Resident Population Distribution

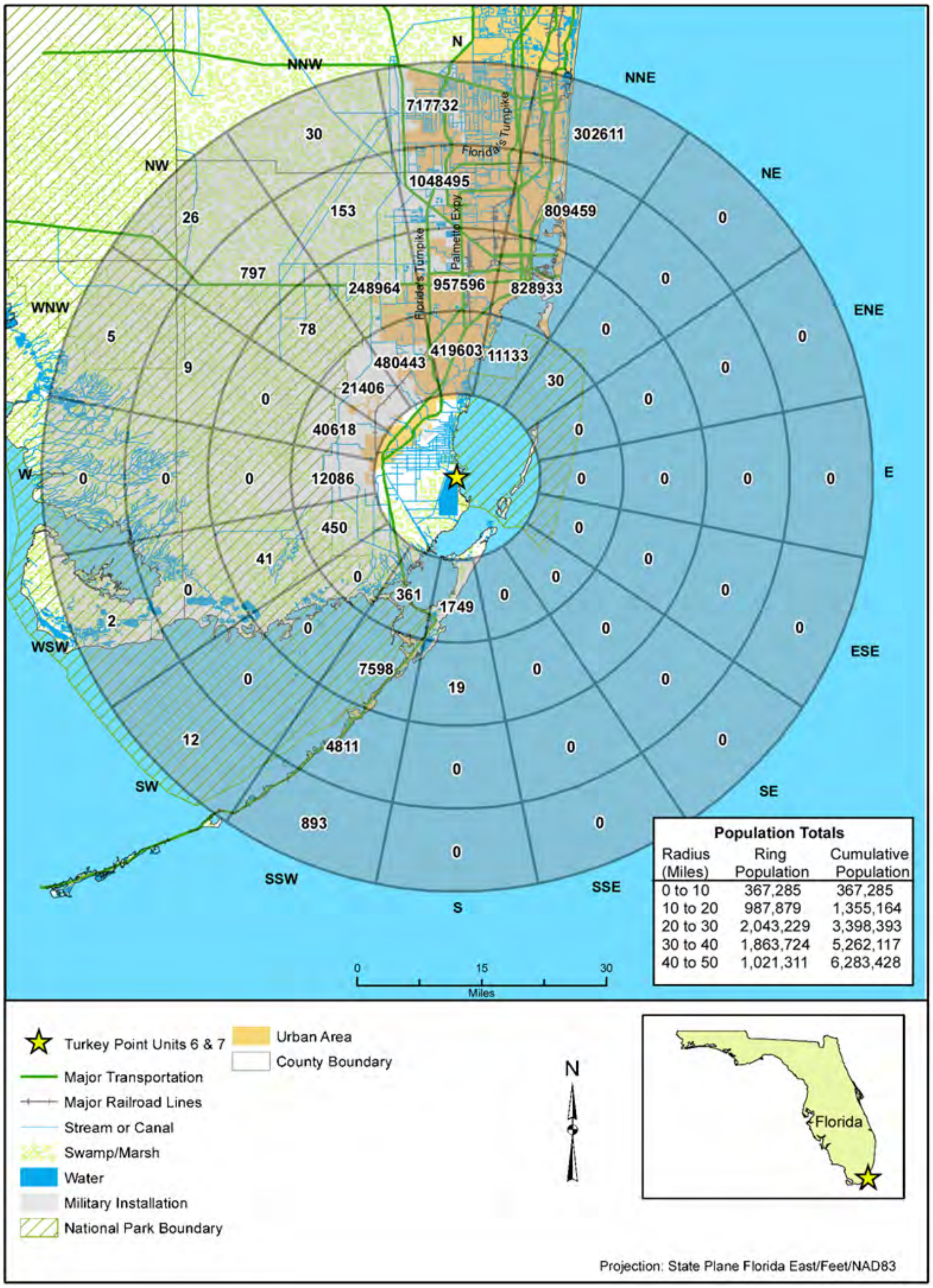


Population Totals

Radius (Miles)	Ring Population	Cumulative Population
0 to 10	338,444	338,444
10 to 20	908,534	1,246,978
20 to 30	1,879,543	3,126,521
30 to 40	1,724,612	4,851,133
40 to 50	975,518	5,826,651

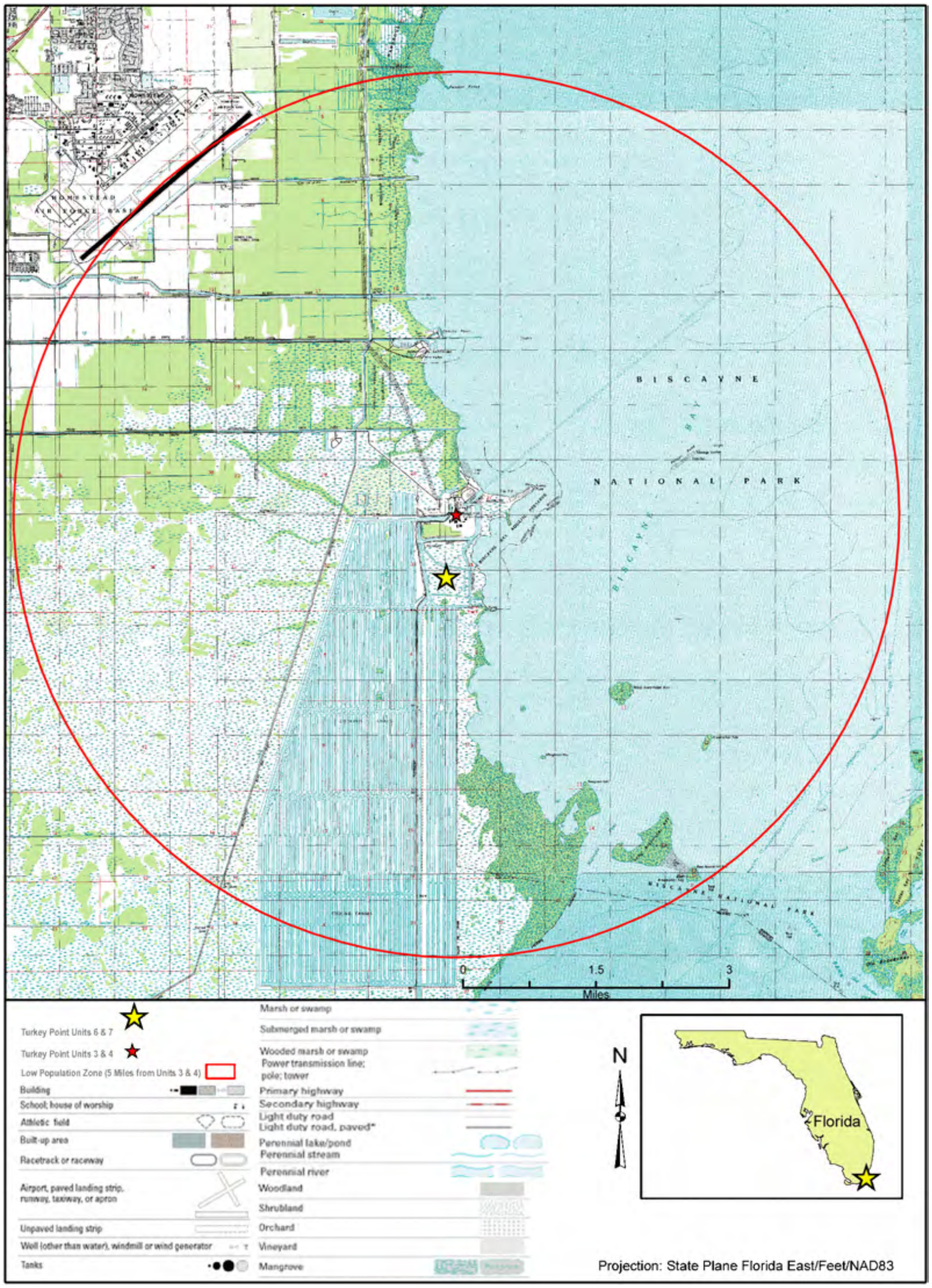
PTN COL 2.1-1

Figure 2.1-225 50-Mile 2090 Resident Population Distribution



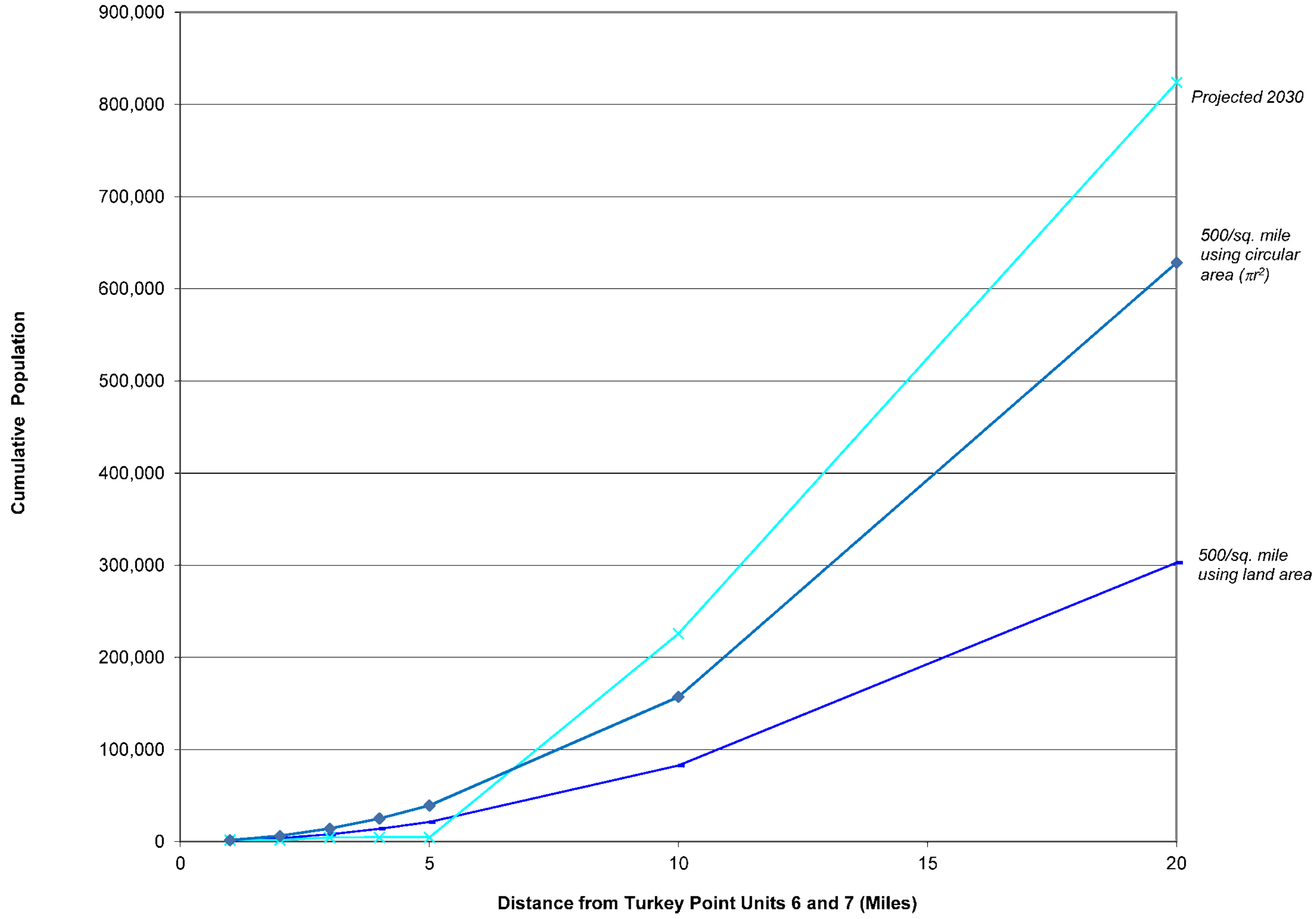
PTN COL 2.1-1

Figure 2.1-226 Low Population Zone



PTN COL 2.1-1

Figure 2.1-227 Comparison to RG 4.7 Siting Criteria



SECTION 2.2:
NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES
TABLE OF CONTENTS

SECTION 2.2 LIST OF TABLES

SECTION 2.2 LIST OF FIGURES

2.2 NEARBY INDUSTRIAL, TRANSPORTATION, AND MILITARY FACILITIES

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

PTN COL 2.2-1

The purpose of this section is to establish whether the effects of potential accidents onsite or in the vicinity of the site from present and projected industrial, transportation, and military installations and operations should be used as design basis events for plant design parameters related to the selected accidents. Facilities and activities within the vicinity, 5 miles, of Turkey Point Units 6 & 7 were considered to meet the guidance in RG 1.206. Facilities and activities at greater distances are included as appropriate to their significance.

STD DEP 1.1-1

Subsection 2.2.1 of the DCD is renumbered as Subsection 2.2.4 and moved to the end of Section 2.2. This is being done to accommodate the incorporation of RG 1.206 numbering conventions for Section 2.2.

2.2.1 LOCATIONS AND ROUTES

PTN COL 2.2-1
PTN COL 3.5-1
PTN COL 3.3-1

Potential hazard facilities and routes within the vicinity (5 miles) of Units 6 & 7, and airports within 10 miles of Units 6 & 7 are identified along with significant facilities at a greater distance in accordance with RG 1.206, RG 1.91, RG 4.7, and relevant sections of 10 CFR Parts 50 and 100.

An investigation of the potential external hazard facilities and operations within 5 miles of Units 6 & 7 concluded there is one significant industrial facility associated with a military installation identified for further analysis. An evaluation of major transportation routes within the vicinity of Units 6 & 7 identified one natural gas transmission pipeline system and one navigable waterway for assessment (References 206, 207, and 208).

Potential hazard analysis of internal events includes chemical storage associated with Units 1 through 5 and site-specific onsite chemical storage facilities associated with Units 6 & 7 along with an onsite transportation route.

A site vicinity map (Figure 2.2-201) details the following identified facilities and road and waterway transportation routes:

Significant Industrial and Military Facilities Within 5 Miles

- Turkey Point Units 1 through 5
- Homestead Air Reserve Base

Transportation Routes Within 5 Miles

- Onsite transportation route
- Miami to Key West, Florida Intracoastal Waterway
- Florida Gas Transmission Company, Turkey Point Lateral Pipeline and Homestead Lateral Pipeline

An evaluation of nearby facilities and transportation routes within 10 miles of Units 6 & 7 revealed that there are no additional facilities significant enough to be identified as potential hazard facilities. (References 207, 224, and 225)

Potential hazard analyses of airports within 10 miles of Units 6 & 7 are identified along with airway and military operation areas. There are two airports within 10 miles of the plant and one airway identified whose centerline is located approximately 5.98 miles from the plant identified for further analysis. (References 209, 210, 223, and 240)

Figure 2.2-202 illustrates the following identified airports and airway routes within 10 miles of Units 6 & 7, including:

Airport and Airway Routes Within 10 Miles

- Turkey Point Heliport
- Homestead Air Reserve Base
- Ocean Reef Club Airport
- Airway V-3

There are no identified hazard facilities, routes, or activities greater than 10 miles that are significant enough to be identified (References 207, 223, 224, 225, and 240).

Items illustrated in Figures 2.2-201 and 2.2-202 are described in Subsection 2.2.2.

2.2.2 DESCRIPTIONS

Descriptions of the industrial, transportation, and military facilities located in the vicinity of Units 6 & 7 and identified in Subsection 2.2.1 are provided in the subsequent subsections in accordance with RG 1.206.

2.2.2.1 Description of Facilities

In accordance with RG 1.206, two facilities, along with the site-specific onsite chemical storage facilities associated with Units 6 & 7, were identified for review:

- Turkey Point Units 1 through 5
- Homestead Air Reserve Base

Table 2.2-201 provides a concise description of each facility, including its primary function and major products, as well as the number of people employed.

2.2.2.2 Description of Products and Materials

A more detailed description of each of these facilities, including a description of the products and materials regularly manufactured, stored, used, or transported, is provided in the following subsections. In accordance with RG 1.206, chemicals stored or situated at distances greater than 5 miles from the plant do not need to be considered unless they have been determined to have a significant impact on the proposed facilities.

The South Florida Regional Planning Council, Emergency Management Division, was contacted to obtain information regarding offsite chemical storage. The EPA's Envirofacts/Enviromapper database was also queried to ascertain if other facilities of significance existed in addition to the facilities identified after evaluating the Superfund Amendments and Reauthorization Act (SARA) Title III, Tier II reports obtained from South Florida Regional Planning Council. Other than the Turkey Point Units 1 through 5 site, there was only one identified external facility, Homestead Air Reserve Base, within 5 miles of the Turkey Point site with

hazardous material storage in quantities identified as meeting SARA Title III Tier II reporting requirements. A review of SARA reports encompassing an area extending out from Units 6 & 7 with a minimum radius of 7.24 miles out to a maximum radius of 28.45 miles inclusive of the following zip codes: 33035, 33033, 33032, 33039, and 33037 revealed that there are no other facilities or storage locations identified that could have a significant impact on Units 6 & 7. The evaluation for those facilities located greater than 5 miles from Units 6 & 7 was based on identifying whether any of these facilities contained highly toxic, highly volatile chemicals not bounded by the onsite storage of these chemicals with risk management program calculated endpoint distances of at least 25 miles (References 224, 225, and 226). Therefore, further analysis beyond these two facilities and the site-specific onsite chemical storage facilities associated with Units 6 & 7 is not required.

2.2.2.2.1 Turkey Point Plant

Units 1 through 5 are located on the approximate 9400-acre Turkey Point plant property. Units 1 and 2 are gas/oil-fired steam electric generating units; Units 3 and 4 are nuclear powered steam electric generating units; and Unit 5 is a natural gas combined cycle plant. The two 400 MW (nominal) gas/oil-fired steam electric generation units have been in service since 1967 (Unit 1) and 1968 (Unit 2). These units currently burn residual fuel oil and/or natural gas with a maximum equivalent sulfur content of 1 percent. The two 700 MW (nominal) nuclear units are pressurized water reactor units that have been in service since 1972 (Unit 3) and 1973 (Unit 4). Unit 5 is a nominal 1150 MW combined-cycle unit that began operation in 2007 (Reference 244). The chemicals associated with Units 1 through 5 identified for possible analysis and their storage locations are presented in Table 2.2-202. The disposition of hazards associated with these chemicals is summarized in Tables 2.2-207 and 2.2-208 and the subsequent analysis of the chemicals identified for further analysis is addressed in Subsection 2.2.3.

Units 6 & 7 are located southwest of Units 1 through 5 as delineated on the site area maps (Figures 2.1-203 and 2.1-205). The center point of the Unit 6 reactor building is approximately 215 feet west and 3625 feet south of the center point of the Unit 4 containment. The Units 6 & 7 onsite chemicals identified for possible analysis and their storage location are presented in Table 2.2-202, including the AP1000 standard chemicals described in DCD Table 6.4-1. The disposition of hazards associated with these chemicals is summarized in Tables 2.2-207 and 2.2-208. The subsequent hazards associated with the AP1000 standard chemicals are addressed in DCD Table 2.2-1 and Table 6.4-201. DCD Table 2.2-1 provides specific information concerning onsite explosion and flammable vapor

cloud safe distances associated with the AP1000 standard chemicals. Table 6.4-201 provides specific information concerning the toxicity analysis associated with the standard AP1000 chemicals for Units 6 & 7. A site-specific analysis is included for those chemicals stored at Units 6 & 7 which were not included in the standard AP1000 chemical analyses (DCD Table 2.2-1 and Table 6.4-201). The subsequent analysis of the site-specific chemicals identified for further analysis is addressed in Subsection 2.2.3.

2.2.2.2.2 Homestead Air Reserve Base

The Homestead Air Reserve Base is located approximately 4.76 miles north-northwest of Units 6 & 7 (Figure 2.2-201). Construction of a fully operating military base (Homestead Army Air Field) began at the current Homestead Air Reserve Base site in September of 1942 to serve as a maintenance and fueling stopover for aircraft headed overseas during World War II.

Today, the 482nd Fighter Wing, the host unit of Homestead Air Reserve Base, continues to support contingency and training operations of U.S. Southern Command and a number of tenant units including Headquarters Special Operations Command South, U.S. Coast Guard Maritime Safety and Security Team, and an air and maritime unit of U.S. Customs and Border Protection. The Homestead Air Reserve Base is a fully combat-ready unit capable of providing F-16C multipurpose fighter aircraft, along with mission ready pilots and support personnel, for short-notice worldwide deployment. In addition, the Homestead Air Reserve Base is home to the most active North American Aerospace Defense Command alert site in the continental United States, operated by a detachment of F-15 fighter interceptors from the 125th Fighter Wing Florida Air National Guard.

The Homestead Air Reserve Base has 2365 total personnel including 267 active-duty personnel, 1245 Air Force Reserve Command and National Guard personnel, 779 civilians, and 74 civilian contractors (References 202 and 203). The chemicals stored at the Homestead Air Reserve Base identified for possible analysis are presented in Table 2.2-203. The disposition of hazards associated with these chemicals is summarized in Table 2.2-209 and the subsequent analysis of these chemicals is addressed in Section 2.2.3.

2.2.2.3 Description of Pipelines

There are two natural gas transmission pipelines operated by Florida Gas Transmission Company within 5 miles of the plant as depicted in Figure 2.2-201. The Florida Gas Transmission Company owns and operates a high-pressure

natural gas pipeline system that serves FPL and other customers in south Florida. Two of the pipelines, the Turkey Point Lateral and the Homestead Lateral, are located within 5 miles of Units 6 & 7. A more detailed description of the pipelines are presented in the following subsection, including the pipe size, age, operating pressure, depth of burial, location and type of isolation valves, and type of gas or liquid presently carried. Information pertaining to the various pipelines is also presented in Table 2.2-204.

2.2.2.3.1 Florida Gas Transmission Company/Turkey Point Lateral Pipeline

The Florida Gas Transmission Company Turkey Point Lateral is a 24-inch diameter pipeline that was installed in 1968. The pipeline operates at a maximum pressure of 722 pound-force per square inch gauge (psig) and provides gas service to Turkey Point's gas-fired power plants. The pipeline is buried to an approximate depth of 42 inches below grade. The nearest isolation valve is located approximately 11.8 miles from the south end of the 24-inch Turkey Point Lateral. The isolation valve is manually operated. At the closest approach to Units 6 & 7, the Turkey Point Lateral pipeline, depicted on Figure 2.2-201, passes within approximately 4535 feet of the Unit 6 auxiliary building. The Turkey Point Lateral transports natural gas and there are not any future plans to transport any other products.

2.2.2.3.2 Florida Gas Transmission Company/Homestead Lateral Pipeline

The Florida Gas Transmission Company Homestead Lateral is a 6.625-inch diameter pipeline that tees off of the 24-inch Turkey Point Lateral approximately 3 miles north of the Turkey Point site and extends in a westward direction to provide gas service to the City of Homestead. The Homestead Lateral was installed in 1985, and also operates at a maximum pressure of 722 psig. This pipeline is buried to an approximate depth of 42 inches below grade. There is a manually operated isolation valve located just downstream of the 24 inch by 6 inch tee at the take-off of the Homestead Lateral. The Homestead Lateral transports natural gas and there are not any future plans to transport any other products. Because of the proximity and diameter of the Turkey Point Lateral pipeline in comparison to the Homestead lateral pipeline, the Turkey Point Lateral pipeline presents a greater hazard, and as such, the Turkey Point Lateral pipeline analysis is bounding and no further analysis of the Homestead Lateral pipeline is warranted.

2.2.2.4 Description of Waterways

Units 6 & 7 are located on the western shore of south Biscayne Bay. Biscayne Bay is a shallow coastal lagoon located on the lower southeast coast of Florida (Reference 258). The bay is approximately 38 miles long, approximately 11 miles wide on average, and has an area of approximately 428 square miles (References 259 and 260). On the southern portion of the Biscayne Bay where Units 6 & 7 are located, the bay is approximately 8 miles wide and 9 miles long and extensive sandbars exist. South Biscayne Bay is separated from Card Sound to the south by a sandbar area encompassing the Arsenicker Keys and Cutter Bank. The nearshore shallow areas of the western side of south Biscayne Bay are generally less than 5 feet deep (Reference 205).

The Biscayne Bay contains the Miami to Key West, Florida Intracoastal Waterway. The only commodity transported on the Miami to Key West, Florida Intracoastal Waterway is residual fuel oil. In 2005, there were 611,000 short tons of residual fuel oil transported, and the entirety of this commodity was delivered to the Turkey Point plant (Table 2.2-205, Reference 206).

The Turkey Point turning basin is approximately 300 feet wide, 1200 feet long and approximately 20 feet deep (Reference 205). The Turkey Point fuel unloading dock is located on the north side of the turning basin. The concrete constructed fuel oil dock at the Turkey Point plant can handle one barge at a time. Residual fuel oil is delivered exclusively by barges that typically are approximately 228 feet long, 54 feet wide, and have a draft of 6.5 feet when loaded. This size barge will transport approximately 18,000 barrels of oil. Residual fuel oil is unloaded from the barges to the two fuel oil storage tanks located north of the unloading dock. In a typical week, five to seven deliveries of oil may be made and each delivery requires about 5 hours to unload. Because the storage of residual fuel oil at the Turkey Point site, two 268,000 barrel tanks, exceeds the quantity transported by a barge, the storage tanks present a greater hazard, and as such, the analysis of residual fuel oil located in the storage tanks is bounding and no further analysis of the residual fuel oil transported by the barge is warranted.

2.2.2.5 Description of Highways

Miami-Dade County is traversed by several highways. Interstate 95, U.S. Highway 1 and the Florida Turnpike (State Road 821) are the major transportation routes for north-south traffic flow in the county. The major route for east-west movement is U.S. Route 41 which crosses the middle of the county (Reference 207). Main access to the Turkey Point site is Palm Drive (SW 344th

Street), which runs in an east-west direction along the northern boundary of the Turkey Point site. Palm Drive provides a connection with U.S. Highway 1 and the Florida Turnpike. There are no major highways within 5 miles of Units 6 & 7 (Figure 2.2-201, References 201 and 207).

To ascertain which hazardous materials may be transported on the roadways within 5 miles of Units 6 & 7, the industries that may store hazardous materials—and, hence, have either the materials transported to the site or transported from the site—were identified through SARA Title III, Tier II reports as described in Subsection 2.2.2.2. The only identified chemicals whose transportation route may approach closer than 5 miles to Units 6 & 7 are those chemicals transported onto the Turkey Point plant property. Of these chemicals, gasoline was the only identified roadway transportation event that is not bounded by an event involving the onsite storage vessel for each identified chemical. Each of the identified onsite chemicals that had the potential to explode, or form a flammable or toxic vapor cloud, is analyzed to determine safe distances.

2.2.2.6 Description of Railroads

There are no railroads in the vicinity (5 miles) of Units 6 & 7 (Figure 2.2-201, Reference 207).

2.2.2.7 Description of Airports

In accordance with RG 1.206 and RG 1.70, Homestead Air Reserve Base is the only identified airport located within the vicinity (5 miles) of Units 6 & 7 other than the Turkey Point Heliport located onsite. Further, RG 4.7 recommends that major airports within 10 miles be identified. The Ocean Reef Club Airport is a small private airport located approximately 7.4 miles from Units 6 & 7 (Figure 2.2-202, References 223 and 240).

A more detailed description of each of these airports is presented in the subsequent sections, including distance and direction from the site, number and type of aircraft based at the airport, largest type of aircraft likely to land at the airport facility, runway orientation and length, runway composition, hours attended, and yearly operations where available. Information pertaining to airports located within 10 miles of the site is presented in tabular form in Table 2.2-206. A screening evaluation of the closest major airport in the region, Miami International Airport, is also included in this table to ascertain whether this airport is or may be of significance in the future.

2.2.2.7.1 Airports

2.2.2.7.1.1 Turkey Point Heliport

The Turkey Point site operates its own corporate heliport. The Turkey Point heliport is located in the southeast corner of the Units 3 & 4 parking lot approximately 3100 feet north of Units 6 & 7. The heliport is an approximate 22-foot by 22-foot concrete pad. The maximum gross weight of the helicopter operated at the site, an Agusta A109E Power Helicopter, is 6600 pounds. There were approximately 79 takeoffs and landing operations in 2007. As described in Subsection 2.2.2.7.2, it is not expected that an aircraft of this weight and size would have an impact on safety-related structures (References 227 and 228). Further, the number of operations at the heliport, especially in comparison with other aviation facilities is infrequent. Due to the weight of the aircraft (thus low penetration hazard) using the heliport and infrequent operations, no further analysis of the heliport is warranted.

2.2.2.7.1.2 Homestead Air Reserve Base

Homestead Air Reserve Base is located approximately 4.76 miles north-northwest from the proposed Units 6 & 7. The U.S. Air Force owns the airport, and the airport is for private use, with permission required before landing. The airport has a concrete/grooved runway, Runway 05/23, which is 11,200 feet long and 300 feet wide. The runway headings are 50 degrees (Runway 05) and 230 degrees (Runway 23). The traffic pattern for Runway 05 is right and the traffic pattern for Runway 23 is left (Reference 209).

The Homestead Air Reserve Base has approximately 36,429 annual operations and this projection is not expected to change over the period of the license duration (Reference 208). Consistent with RG 1.206, the Homestead Air Reserve Base located approximately 4.76 miles from the site, was considered because the plant-to-airport distance is less than 5 miles.

Homestead Air Reserve Base indicated that the military aircraft onsite consisted of F-16Cs with a wingspan of 32 feet 10 inches and F-15As with a wingspan of 42 feet 9 inches. The reported number of military operations was 24,902 per year. The Homestead Air Reserve Base also indicated that there were 7430 operations per year from U.S. Customs Border Patrol aircraft along with 4097 transient aircraft operations per year (Reference 208).

2.2.2.7.1.3 Ocean Reef Club Airport

Ocean Reef Club Airport is a privately owned airport located 7.41 miles south southeast from Units 6 & 7. The airport is an amenity associated with the Ocean Reef Club. All aircraft must be registered and permission is required before landing. There is no scheduled airline service associated with the airport and the airport is unattended (Reference 242).

The airport has an asphalt runway that is 4500 feet long and 70 feet wide. The runway headings are 40 degrees (Runway 04) and 220 degrees (Runway 22). The landing pattern is to the left. There are approximately 25 aircraft based on the site, 15 single-engine planes and 10 multi-engine planes. The plant-to-airport distance criteria in accordance with NUREG-0800 is $500D^2$, where D is the distance in statute miles from the site, for airports located within 5 to 10 statute miles from the site, giving the airport a significance factor of 27,454 operations per year. The airport is an unattended private facility with just 25 aircraft based on the field with no control tower (References 209 and 210). To reach a significance factor of 27,454 operations, each aircraft would need to average approximately 1,098 operations per year. Therefore, it is reasonably assumed that the airport operations at this facility meet the plant-to-airport distance/annual operations criteria and no further evaluation is warranted.

2.2.2.7.2 Aircraft and Airway Hazards

There is one airport, Homestead Air Reserve Base, located approximately 4.76 miles from Units 6 & 7. The Homestead Air Reserve Base has approximately 36,429 annual operations and this projection is not expected to change over the period of the license duration (Reference 208). As required by RG 1.206, an aircraft hazard analysis should be provided for all airports with a plant-to-airport distance less than 5 statute miles from the site.

The Units 6 & 7 site meets acceptance criteria 1.B. of Section 3.5.1.6 of NUREG-0800—there are no military training routes or military operations areas within 5 miles of the site. The centerline of the closest military training route, IR-53, is approximately 11.5 nautical miles, 13.2 statute miles, from Units 6 & 7, while the closest military operations area, Lake Placid military operations area, is approximately 115 nautical miles or 132.3 statute miles from Units 6 & 7 (Reference 223).

The Units 6 & 7 site is located closer than 2 statute miles to the nearest edge of a federal airway. The site is approximately 5.98 statute miles from the centerline of

airway V3/G439 as depicted in Figure 2.2-202. The width of a federal airway is typically 8 nautical miles, 4 nautical miles (4.6 statute miles) on each side of the centerline, placing the airway approximately 1.4 statute miles to the nearest edge (Reference 211). The edge of the closest high altitude airway is located further than 2 statute miles from Units 6 & 7 (Reference 240). Because of the proximity of airway V3/G439 to Units 6 & 7, criteria 1.C. set in Section 3.5.1.6 of NUREG-0800 that the plant is at least 2 statute miles beyond the nearest edge of a federal airway is not met.

Therefore, a calculation to determine the probability of an aircraft accident that could possibly result in radiological consequences to the site was performed following NUREG-0800 and DOE-STD-3014-96 to determine whether the accident probability rate is less than an order of magnitude of 1E–07. The probability of an aircraft crashing into the plant and its impact frequency evaluation are estimated using a four-factor formula that considers: (1) the number of operations; (2) the probability that an aircraft will crash; (3) given a crash, the probability that the aircraft crashes into a 1-square-mile area where the facility is located; and (4) the size of the facility. In order to estimate aircraft crash frequencies, this method applies the four-factor formula to two different flight phases, near-airport activities or airport operations that considers takeoffs and landings, and non-airport activities or in-flight phase operations (Reference 212). This assessment of impact frequency assumes that all impacts will lead to facility damage and a possible release of radioactive material.

Mathematically, the four-factor formula is:

$$F = \Sigma N_{ijk} * P_{ijk} * f_{ijk}(x,y) * A_{ij} \qquad \text{(Equation 1)}$$

Where,

F = estimated annual aircraft crash impact frequency for the facility of interest (no./year)

N_{ijk} = estimated annual number of site-specific aircraft operations for each applicable summation parameter (no./year)

P_{ijk} = aircraft crash rate (per takeoff or landing for near-airport phases and per flight for the in-flight (non-airport) phase of operation for each applicable summation parameter)

$f_{ijk}(x,y)$ = aircraft crash location conditional probability (per square mile) given a crash evaluated at the facility location for each applicable summation parameter

A_{ij}	=	the site-specific effective area for the facility of interest that includes skid and fly-in effective areas (square miles) for each applicable summation parameter, aircraft category or subcategory, and flight phase for military aviation
i	=	(index for flight phases): i=1, 2, and 3 (takeoff, in-flight, and landing)
j	=	(index for aircraft category or subcategory): j=1, 2, …, 11
k	=	(index for flight source): k=1, 2, …, k
Σ	=	Σk Σj Σi
ijk	=	site-specific summation over flight phase, i; aircraft category or subcategory, j; and flight source, k

Effective Area

The effective area was calculated using the method provided in the DOE Standard, DOE–STD-3014-96 (Reference 212). For the AP1000 design, the safety-related structures are contained on the nuclear island which consists of the containment or shield building and the auxiliary building. To calculate a conservative estimate of the effective target area, a bounding building was used in accordance with the DOE standard with the following assumptions:

- The total footprint area of the safety-related structures was obtained to estimate the equivalent width/length (W, L) of a bounding building, and thus the building diagonal length, R.
- For the AP1000 design, when determining the length, L of the bounding building, the actual length of the auxiliary building, 254 feet, was used.
- The total volume of the bounding building is obtained in order to estimate the equivalent height of the rectangular bounding building.
- In this calculation, the 78-foot wingspan was conservatively chosen to represent military aircraft wingspan. Homestead Air Reserve Base indicated that the military aircraft on site consisted of F-16Cs with a wingspan of 32 feet 10 inches and F-15As with a wingspan of 42 feet 9 inches (Reference 208).

Based on those assumptions, the effective areas for general aviation, air carrier, air taxi and commuter, large military (takeoff), large military (landing), small military (takeoff), and small military (landing) type of aircraft are 0.01730, 0.04309, 0.03859, 0.03775, 0.03660, 0.02166, and 0.02824 square miles, respectively.

Airport Operations Impact Frequency

Using the four-factor formula, the total impact frequency from airport operations, which includes near airport activities and considers takeoffs and landings, into the plant was determined to be 2.56E-07 per year. Even though most of the airport operations are attributed to small military aircraft operations, the calculated impact frequency was dominated by general aviation operations. The lower impact frequency attributed to Homestead Air Reserve Base is largely due to the orientation of the runway at Homestead Air Reserve Base. Crash location probability values are primarily distributed about the x-axis, the extended runway centerline—for military aircraft, this distribution is also dependent on the pattern side of the runway. When the x-axis is placed along the center of the runway, the Units 6 & 7 site lies nearly on the y-axis, accounting for the low crash location probabilities for airport operations. In determining the airport operation frequency, the following assumptions were formulated:

- Based on data received from Homestead Air Reserve Base, it was assumed that for each aircraft category, 75 percent of the operations occurred on Runway 05 and 25 percent of the operations occurred on Runway 23, resulting in:
  - 18,678 small military operations for Runway 05
  - 6,226 small military operations for Runway 23
  - 5,574 large military operations for Runway 05
  - 1,858 large military operations for Runway 23
  - 3,074 general aviation operations for Runway 05
  - 1,026 general aviation operations for Runway 23

Non-Airport Operations Impact Frequency

For non-airport operations, or the in-flight phase, methods provided in DOE Standard DOE-STD-3014-96 were used and the total impact frequency from non-airport operations into the plant was determined to be 3.61E-06 per year (Reference 212).

The determined impact frequency using this methodology is heavily weighted towards general aviation aircraft due to the large probability, N * P * f(x,y), of

general aviation crashes throughout the continental United States. The analysis of non-airport operations impact frequency was based on the four-factor formula, as used for airport operations for the class of aircraft *j*:

$$F_j = N_j * P_j * f_j (x,y) * A_j$$

Where, the product NP represents the expected number of in-flight crashes per year; f(x,y) is the probability, given a crash, that the crash occurs in a 1-square-mile area surrounding the facility of interest, and A is the effective area of the facility (Reference 212). For this calculation, the values of N * P * f(x,y) selected are the continental U.S. averages.

Total Impact Frequency

This assessment led to a total impact frequency of 3.86E-06 per year when considering both the airport and non-airport operations, which is greater than an order of magnitude of 1E-07 per year. Therefore, an evaluation against a second criterion (core damage frequency, CDF, less than 1E-08 per year) was performed. This evaluation is presented in Subsection 19.58.2.3.1 and concludes that no further evaluation of aircraft impact is required, given that the core damage frequency associated with aircraft impacts is less than 1E-08 per year.

2.2.2.8 Projections of Industrial Growth

The Units 6 & 7 site is located in unincorporated Miami-Dade County, Florida. Miami-Dade County has adopted a Comprehensive Development Master Plan to meet the requirements of the Local Government Comprehensive Planning and Land Development Regulation Act, Chapter 163, Part II, Florida Statutes, and Chapter 9J-5, Florida Administrative Code. The Comprehensive Development Master Plan was last revised in October 2006.

The Comprehensive Development Master Plan Map illustrates the locations of major institutional uses, communication facilities, and utilities of metropolitan significance. The 2025 expansion area boundary delineated on the Land Use Plan Map does not depict any future industrial area expansion within 5 miles of Units 6 & 7 (Reference 213).

Thus, a review of Miami-Dade County's Comprehensive Development Master Plan does not indicate any future projections of new major industrial, military, or transportation facilities located within the vicinity of the Units 6 & 7 site (Reference 213).

2.2.3 EVALUATION OF POTENTIAL ACCIDENTS

An evaluation of the information provided in Subsections 2.2.1 and 2.2.2, for potential accidents that should be considered as design basis events, and the potential effects of those identified accidents on the nuclear plant in terms of design parameters (e.g., overpressure, missile energies) and physical phenomena (e.g., concentration of flammable or toxic clouds outside building structures), was performed in accordance with the criteria in 10 CFR Parts 20, 52.79, 50.34, 100.20, and 100.21, using the guidance contained in RG 1.78, 1.91, 4.7, and 1.206.

2.2.3.1 Determination of Design-Basis Events

RG 1.206 states that design basis events, internal and external to the nuclear plant, are defined as those accidents that have a probability of occurrence on the order of magnitude of 1E-07 per year or greater with potential consequences serious enough to exceed the guidelines in 10 CFR Part 100 affecting the safety of the plant. The following accident categories are considered in selecting design basis events: explosions, flammable vapor clouds (delayed ignition), toxic chemicals, fires, collisions with the intake structure, and liquid spills. On the basis of the identification of industrial, transportation, and military facilities presented in Subsections 2.2.1 and 2.2.2, the postulated accidents within these categories are analyzed at the following locations:

- Onsite chemical storage (Units 1 through 5)
- Site-specific onsite chemical storage (Units 6 & 7)
- Nearby chemical and fuel storage facilities (Homestead Air Reserve Base)
- Nearby transportation routes (Florida Gas Transmission Company (Turkey Point Lateral-natural gas transmission pipeline), and an onsite transportation route)

2.2.3.1.1 Explosions

Accidents involving detonations of explosives, munitions, chemicals, liquid fuels, and gaseous fuels are considered for facilities and activities either onsite or within the vicinity of the plant, where such materials are processed, stored, used, or transported in quantity. NUREG-1805 defines explosion as a sudden and violent release of high-pressure gases into the environment. The strength of the wave is measured in terms of overpressures (maximum pressure in the wave in excess of

normal atmospheric pressure). Explosions come in the form of detonations or deflagrations. A detonation is the propagation of a combustion zone at a velocity that is greater than the speed of sound in the un-reacted medium. A deflagration is the propagation of a combustion zone at a velocity that is less than the speed of sound in the un-reacted medium (Reference 214).

The effects of explosions are a concern in analyzing structural response to blast pressures. The effects of blast pressure from explosions from nearby railways, highways, navigable waterways, or facilities to safety-related plant structures are evaluated to determine if the explosion would have an adverse effect on plant operation or would prevent safe shutdown of the plant.

2.2.3.1.1.1 Explosions /Trinitrotoluene Mass Equivalency

The onsite chemicals (Units 1 through 5 [Table 2.2-207] and site-specific chemicals associated with Units 6 & 7 [Table 2.2-208]), offsite chemical storage (Homestead Air Reserve Base [Table 2.2-209]), hazardous materials transported in pipelines (Turkey Point Lateral [Table 2.2-210]), and hazardous materials potentially transported on roadways (Table 2.2-210) were evaluated to ascertain which hazardous materials had a defined flammability range, upper (UFLs) and lower (LFLs) flammability limits, with a potential to explode upon detonation. Whether an explosion is possible depends in large measure on the physical state of a chemical. In the case of liquids, flammable and combustible liquids often appear to ignite as liquids. However, it is actually the vapors above the liquid source that ignite. For flammable liquids at atmospheric pressure, an explosion will occur only if the non-oxidized, energized fluid is in the gas or vapor form at correct concentrations in air. The concentrations of formed vapors or gases have an upper and lower bound known as the UFL and the LFL. Below the LFL, the percentage volume of fuel is too low to sustain propagation. Above the UFL, the percentage volume of oxygen is too low to sustain propagation (Reference 215).

The postulated accidents, involving those hazardous materials determined to have the potential to explode, involve the rupture of a vessel whereby the entire contents of the vessel are released and an immediate deflagration/detonation ensues. That is, upon immediate release, the contents of the vessel are assumed to be capable of supporting an explosion upon detonation (e.g., flammable liquids are present in the gas/vapor phase between the UFL and LFL). The trinitrotoluene (TNT) mass equivalency methodology employed for determining the safe distances, the minimum separation distance required for an explosive force to not exceed 1 psi peak incident pressure, involve a compilation of principles and

criterion from RG 1.91, NUREG-1805, National Fire Protection Association (NFPA) Code, and pertinent research papers.

The allowable and actual safe distances for hazardous materials transported or stored were determined in accordance with RG 1.91, Revision 1. RG 1.91 cites 1 psi (6.9 kilopascal) as a conservative value of positive incident over pressure below which no significant damage would be expected. RG 1.91 defines this safe distance by the Hopkinson Scaling Law Relationship:

$$R \geq kW^{1/3} \qquad \text{(Equation 2)}$$

Where R is the distance in feet from an exploding charge of W pounds of equivalent TNT and k is the scaled ground distance constant at a given overpressure (for 1 psi, the value of the constant k is 45 $ft/lb^{1/3}$).

The methodology for calculating, W, and hence the safe distance, R, is dependent on the phase—solid, atmospheric liquid, or pressurized or liquefied gas—of the chemical during storage and/or transportation.

Solids

For a solid substance not intended for use as an explosive but subject to accidental detonation, RG 1.91 states that it is conservative to use a TNT mass equivalent (W) in Equation 2 equal to the cargo mass.

Atmospheric Liquids

RG 1.91 states that it is *limited to solid explosives and hydrocarbons liquefied under pressure,* and the guidance provided in determining W, the mass of the substance that will produce the same blast effect as a unit mass of TNT, is specific to solids. Therefore, the guidance for determining the TNT mass equivalent, W, in RG 1.91, where the entire mass of the solid substance is potentially immediately available for detonation, is not applicable to atmospheric liquids, where only that portion in the vapor phase between the UFL and LFL is available to sustain an explosion.

The methodology employed conservatively considers the maximum gas or vapor volume within the storage vessel as explosive. Thus, for atmospheric liquid storage, this maximum gas or vapor would involve the container to be completely empty of liquid and filled only with air and fuel vapor at UFL conditions in accordance with NUREG-1805. Therefore, for atmospheric liquids, the TNT mass equivalent, W, was determined following guidance in NUREG-1805, where

$$W = (M_{vapor} * \Delta H_c * Y_f) / 2000 \qquad \text{(Equation 3)}$$

Where M_{vapor} is the flammable vapor mass (lbs), ΔH_c is the heat of combustion of the substance (Btu/lb), 2000 is the heat of combustion of TNT (Btu/lb), and Y_f is the explosion yield factor. The yield factor is an estimation of the explosion efficiency, or a measure of the portion of the flammable material participating in the explosion. Conservatively, an explosion yield factor of 100 percent was applied to account for a confined explosion (NUREG-1805). In reality, only a small portion of the vapor within the flammability limits would be available for combustion and potential explosion, and a 100 percent yield factor is not achievable (Reference 216).

Pressurized or Liquefied Gases

For liquefied and pressurized gases, the entire mass is conservatively considered as a flammable gas/vapor because a sudden tank rupture could entail the rapid release and mixing of a majority of the contents and a confined explosion could possibly ensue. For example, in the case of liquefied gases, the liquefied gas would violently expand and mix with air while changing states from the liquid phase to a vapor/aerosol phase. Therefore, in the case of pressurized or liquefied gases, the entire mass is conservatively considered as available for detonation, and the equivalent mass of TNT, W, is calculated in accordance with NUREG-1805 (Equation 3) where the M_{vapor} is the flammable mass (pounds) and the entire mass of the pressurized or liquefied gas is considered flammable. Again, an explosion yield factor of 100 percent was conservatively assumed to account for a confined explosion (NUREG-1805).

2.2.3.1.1.2 Boiling Liquid Expanding Vapor Explosions

A boiling liquid expanding vapor explosion (BLEVE) is an additional concern with closed storage tanks that contain substances that are gases at ambient conditions but are stored in a vessel under pressure in its saturated liquid/vapor form. The NFPA defines a BLEVE as the failure of a major container into two or more pieces, occurring at a moment when the contained liquid is at a temperature above its boiling point at normal atmospheric pressure. If the chemical is above its boiling point when the container fails, some or all of the liquid will flash-boil, that is, instantaneously become a gas. This phase change forms blast waves with energy equivalent to the change in internal energy of the liquid/vapor. This phenomenon is called a BLEVE. If the chemical is flammable, a burning gas cloud called a fireball may occur if a significant amount of the chemical flash-boils. Because

thermal radiation impacts a greater area than the overpressure, it is the more significant threat, and therefore, thermal heat flux values are presented for substances capable of producing a BLEVE (NUREG-1805).

The onsite chemicals (Units 1 through 5 [Table 2.2-207] and site-specific chemicals associated with Units 6 & 7 [Table 2.2-208]), offsite chemical storage (Homestead Air Reserve Base, [Table 2.2-209]), hazardous materials transported in pipelines (Turkey Point Lateral [Table 2.2-210]), and hazardous materials potentially transported on roadways (Table 2.2-210) were evaluated to ascertain which hazardous materials had a defined flammability range, upper and lower flammability limits, with a potential to produce a BLEVE. That is, those chemicals stored in their saturated liquid form but are gases at ambient conditions. The Areal Locations of Hazardous Atmospheres (ALOHA) model was used to model the worst-case accidental BLEVE for each chemical identified as capable of producing a BLEVE, calculated as the thermal heat flux at the nearest safety-related structure. To model the worst-case BLEVE in ALOHA, the meteorological conditions presented in Table 2.2-212 were used as inputs and the determined worst-case meteorological case for each substance was used as site atmospheric input for the BLEVE analysis.

Other inputs/assumptions for the BLEVE analysis using the ALOHA model include:

- “Open Country” was selected for the ground roughness. The degree of atmospheric turbulence influences how quickly a pollutant cloud moving downwind will mix with the air around it and be diluted. In the case of a BLEVE, the movement of a vapor cloud is not a consideration.

- The “Threat at Point” function was selected with no crosswind in the ALOHA modeling runs. This effectively models the chemical release as a direct-line source from the spill site to the point of concern, the nearest safety-related structure for Units 6 & 7.

- The “Level of Concern” selected was 5.0 kilowatts per square meter (kW/m^2). At 5.0 kW/m^2, second-degree burns are expected to occur within 60 seconds (Reference 217). Further, the EPA has selected 5.0 kW/m^2 for 40 seconds as its level of concern for heat from fires in EPA’s Risk Management Program Guidance for Offsite Consequence Analysis (Reference 220). Regarding damage to structures, as a point of reference, the ignition threshold for wood is 40 kW/m^2 (NUREG-1805).

In each of the explosion scenario analyses in the subsequent subsections, the described TNT mass equivalency methodology or BLEVE methodology was employed to determine the safe distances. The effects of these explosion events from both internal and external sources are summarized in Table 2.2-213, and are described in the following subsections relative to the release source.

2.2.3.1.1.3 Onsite Chemical Storage/Units 1 through 5

Units 6 & 7 are located close to the existing Units 1 through 5 chemical storage locations. The hazardous materials stored on site that were identified for further analysis with regard to explosion potential were acetylene, ammonium hydroxide, hydrazine, hydrogen, and propane. A conservative analysis using the TNT equivalency methods described in Subsection 2.2.3.1.1.1 was used to determine safe distances for the identified hazardous materials. The results indicate that the safe distances are less than the minimum separation distance from the nearest safety-related structure, the Unit 6 auxiliary building, to each storage location. The safe distance for acetylene is 1416 feet; for ammonium hydroxide, 296 feet; for hydrazine, 170 feet; for hydrogen, 269 feet; and for propane, 1299 feet (Table 2.2-213). Acetylene is stored approximately 4300 feet; ammonium hydroxide approximately 5079 feet; hydrazine approximately 2727 feet; hydrogen approximately 3966 feet; and propane 4168 feet; from the nearest safety-related structure for Units 6 & 7—the Unit 6 auxiliary building. Therefore, an explosion from any of the onsite hazardous materials evaluated will not adversely affect the safe operation or shutdown of Units 6 & 7.

Additionally, propane was identified for further analysis with regard to its potential for forming a BLEVE. The propane tank located at Turkey Point site is determined to bound propane storage at the Homestead Air Reserve Base due to the large distance separating propane storage at the Homestead Air Reserve Base and Units 6 & 7. A conservative analysis using the ALOHA model described in Subsection 2.2.3.1.1.2 is used to determine the safe distance—the distance to the thermal heat flux of 5 kW/m^2 from the formation of a fireball. Inputs to the ALOHA model also included the dimensions of the propane tank with a diameter of 3.08 feet and a length of 9.92 feet. The safe distance for propane is 603 feet. Propane is stored 4168 feet from the nearest safety-related structure for Units 6 & 7—the Unit 6 auxiliary building. The thermal radiation heat flux at the nearest safety-related structure is 0.0878 kW/m^2 and the calculated burn duration is 5 seconds. Therefore, the thermal radiation heat flux resulting from a BLEVE from the storage of propane will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.1.4 Onsite Chemical Storage/Units 6 & 7

The site-specific chemical associated with Units 6 & 7 that is identified for further analysis with regard to explosion potential is methanol. A conservative analysis using the TNT equivalency methods described in Subsection 2.2.3.1.1.1 was used to determine the safe distance. The result indicates that the safe distance for methanol is 344 feet, which is less than the minimum separation distance from the nearest safety-related structure—the Unit 7 auxiliary building (Table 2.2-213). Methanol is stored at the FPL reclaimed water treatment facility approximately 5387 feet from the nearest safety-related structure for Units 6 & 7—the Unit 7 auxiliary building. Additionally, each standard AP1000 chemical stored at Turkey Point Units 6 & 7 is stored at a distance greater than the minimum safe distance for explosion indicated in DCD Table 2.2-1. Therefore, an explosion from any of the onsite hazardous materials evaluated will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.1.5 Nearby Facilities/Homestead Air Reserve Base

The Homestead Air Reserve Base, located approximately 4.76 miles (25,133 feet) from the nearest safety-related structure for Units 6 & 7, the Unit 6 auxiliary building, is the identified facility of concern within the vicinity of the Turkey Point site as determined in Subsection 2.2.2.2.2. The hazardous materials stored at the Homestead Air Reserve Base identified for further analysis were: gasoline, hydrazine, jet fuel, and propane. A conservative analysis using the TNT equivalency methods described in Subsection 2.2.3.1.1.1 is used to determine safe distances for the identified hazardous materials. The results indicate that the safe distances are less than the minimum separation distances from the Unit 6 auxiliary building to the storage locations for any of the identified chemicals (Table 2.2-213). Propane resulted in the largest safe distance, 5,513 feet, which is less than the distance of 4.76 miles (25,133 feet) to the nearest safety-related structure for Units 6 & 7. Therefore, damaging overpressures from an explosion resulting from a complete failure of the total stored quantity for each chemical evaluated at Homestead Air Reserve Base would not adversely affect the operation or shutdown of Units 6 & 7.

2.2.3.1.1.6 Transportation Routes/Roadways

The safety-related structure located closest to identified transportation routes/roadways, the Unit 6 auxiliary building, is located approximately 2054 feet (at its closest point of approach) from the onsite transportation delivery route for gasoline. As detailed in Subsections 2.2.3.1.1.4 and 2.2.3.1.1.5, deliveries of

chemicals to the site were screened and determined to be bounded by the evaluation performed for the onsite storage quantities. The maximum quantity of gasoline assumed to be transported is 50,000 pounds (9,000 gallons) in accordance with RG 1.91. An evaluation was conducted using the TNT equivalency methodologies described in Subsection 2.2.3.1.1.1. The results indicate that the safe distance for this quantity of gasoline is 266 feet, which is less than the minimum separation distance from the Unit 6 auxiliary building identified above and in Table 2.2-213. Therefore, an explosion from potentially transported hazardous materials on site will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.1.7 Transportation Routes/Pipelines

As described in Subsection 2.2.2.3, the Florida Gas Transmission Company owns and operates a high-pressure natural gas transmission pipeline system that serves FPL and other customers in south Florida. Two of the pipelines in this system are located within 5 miles of Units 6 & 7. The closest pipeline, the Turkey Point Lateral, represents the bounding condition. The nearest safety-related structure, the Unit 6 auxiliary building, is 4535 feet away from the analyzed release point, the closest approach of the nearest natural gas transmission pipeline.

Experiments conducted in Germany (Reference 218) and by the Institution of Gas Engineers (Reference 219) have indicated that detonations of mixtures of methane (greater than 85 percent) with air do not present a credible outdoor explosion event (Reference 216). Further, there have been no reported vapor cloud explosions involving natural gas with high methane content—there have been numerous reports of vapor clouds igniting resulting in flash fires without overpressures (Reference 216). In evaluating similar research, Y. D. Jo and Ahn report that when leaked natural gas is not trapped and immediate ignition occurs, only a jet fire will develop. Thus, the dominant hazards from natural gas pipelines are from the heat effect of thermal radiation from a sustained jet fire and from explosions where the natural gas vapor cloud becomes confined either outside or by migration inside a building (Reference 245). Even though the immediate ignition of natural gas resulting in overpressure events resulting from a ruptured gas pipeline is considered an unlikely event, an evaluation was conservatively conducted to evaluate a potential explosion from the natural gas transmission pipeline.

The worst case scenario considered the immediate deflagration/detonation of the released natural gas. That is, upon immediate release, the contents of the pipeline

are assumed to be capable of supporting an explosion upon detonation (i.e., the gas is present in concentrations between the UFL and LFL). In this scenario, it was assumed that the pipe had burst open, leaving the full cross-sectional area of the pipe completely exposed to the air. It was also assumed that the ignition source existed at the break point. The safe distance to 1 psi overpressure is calculated by determining the mass of natural gas released, whereby the TNT mass equivalency methodology can then be employed as described in Subsection 2.2.3.1.1.1.

In order to determine the mass of natural gas release, the maximum release rate was determined. The release rate from a hole in a pipeline will vary over time; however for safety assessments, it is useful to calculate the maximum release rate of gas from the pipeline. A standard procedure for representing the maximum discharge is to represent the discharge through the pipe as an orifice. The orifice method always produces a larger value than the adiabatic or isothermal pipe methods, ensuring a conservative safety design.

Once it was verified that choke flow conditions would occur for a postulated break in the Florida Gas Transmission pipeline modeled, the maximum gas discharge rate from the break in the pipeline was calculated using the following equation which represents the release from the pipeline as an orifice.

$$Q_{max} = CAP_0\sqrt{\frac{\gamma g_c MW}{RT}\left(\frac{2}{\gamma+1}\right)^{\left(\frac{\gamma+1}{\gamma-1}\right)}} \qquad \text{(Equation 4)}$$

where

C = discharge coefficient (equals 1 for maximum case)
A = area of the hole, ft^2
g_c = gravitational constant, $ft \cdot lb_m / lb_f \cdot s^2$
MW = molecular weight, lb/lb_{mol}
R = ideal gas constant, $ft \cdot lb_f / lb_{mol} \cdot °R$
T = initial pipeline temperature, °R

Upon a complete pipeline rupture, the release rate of the gas (lb/s) will initially be very large, but within seconds the release rate will drop to a fraction of the initial release rate. Therefore, to estimate the amount of gas discharged for an instantaneous release, the maximum discharge rate was conservatively assumed to occur for a period of 5 seconds. This duration maintains the intent of the instantaneous detonation as applied in the TNT analysis—any longer and atmospheric dispersion effects will predominate resulting in a traveling vapor cloud—while maximizing the amount of gas released for the TNT analysis. This is also a conservative assumption given that the discharge rate will begin to

decrease significantly immediately after the break occurs. The amount of gas released was then determined by:

$$\text{Mass (lb)} = Q_{max}\ \text{(lb/s)} \times \text{time (s)} \qquad \text{(Equation 5)}$$

Using the flammable mass calculated by the above methodologies, the equivalent mass of TNT can be calculated using Equations 2 and 3.

The results indicate that the safe distance, the distance to 1 psi, is less than the minimum separation distance from the Unit 6 auxiliary building to the pipeline break (Table 2.2-213). The safe distance of 3097 feet is less than the minimum separation distance to the pipeline, 4535 feet. Therefore, the overpressure at the nearest safety related structure, the Unit 6 auxiliary building, resulting from an explosion due to immediate deflagration of natural gas vapor resulting from a pipeline rupture is not significant. The results indicate that overpressures from an explosion from a rupture in the Florida Gas Transmission Company Turkey Point Lateral natural gas transmission pipeline will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.2 Flammable Vapor Clouds (Delayed Ignition)

Flammable materials in the liquid or gaseous state can form an unconfined vapor cloud that can drift towards the plant before an ignition event. When a flammable chemical is released into the atmosphere and forms a vapor cloud, it disperses as it travels downwind. The portion of the cloud with a chemical concentration within the flammable range (i.e., between the LFL and UFL) may burn if the cloud encounters an ignition source. If the cloud burns fast enough to create a detonation, an explosive force is generated. The speed at which the flame front moves through the cloud determines whether it is considered a deflagration or a detonation. Two possible events are evaluated—thermal radiation effects from either a flash fire resulting from the ignition of a flammable vapor cloud or a jet fire resulting from the rapid release of gas from a pipeline, and pressure effects resulting from a vapor cloud explosion.

2.2.3.1.2.1 Flammable Vapor Cloud—Thermal Radiation

The onsite chemicals, Units 1 through 5 (Table 2.2-207) and site-specific chemicals associated with Units 6 & 7 (Table 2.2-208); offsite chemical storage, Homestead Air Reserve Base, (Table 2.2-209); hazardous materials transported in pipelines, Turkey Point Lateral (Table 2.2-210); and hazardous materials potentially transported on roadways (Table 2.2-210), were evaluated to ascertain

which hazardous materials had the potential to form flammable vapor clouds. In each scenario, those chemicals with an identified flammability range, the ALOHA Version 5.4.1, air dispersion model was used to determine the distances that the vapor cloud could exist in the flammability range, thus presenting the possibility of ignition and potential thermal radiation effects (Reference 217). The safe distance for flammable vapor clouds was measured as the distance to the outer edge of the LFL section of the cloud.

Conservative assumptions were used in the ALOHA analyses regarding both meteorological inputs and identified scenarios (Tables 2.2-211 and 2.2-212). Each postulated event was evaluated under a spectrum of meteorological conditions to determine the worst-case meteorological condition. The spectrum of meteorological parameters chosen for the meteorological sensitivity analysis was selected based on the defined Pasquill meteorological stability classes (Table 2.2-212). The meteorological sensitivity analysis includes the most stable meteorological class, F, allowable with the ALOHA model. More stable meteorological classes and lower wind speeds will prevent a formed chemical vapor cloud from dispersing before reaching safety-related structures or the control room.

Other assumptions for the ALOHA model include:

- "Open Country" was selected for the ground roughness with the exception of those chemicals stored north of Units 1 through 4 (ammonium hydroxide) where "Urban or Forest" was selected. The degree of atmospheric turbulence influences how quickly a pollutant cloud moving downwind will mix with the air around it and will be diluted. Friction between the ground and air passing over it is one cause of atmospheric turbulence. The rougher the ground surface, the greater the ground roughness and the greater the turbulence that develops. A chemical cloud generally travels farther across open country than over an urban area or forest. The selection of "Open Country" is conservative because the Turkey Point site meets the criteria for "Urban or Forest"—an area with many friction-generating roughness elements, such as trees or small buildings (e.g., industrial areas). The site layout and location of the chemicals stored north of Units 1 through 4 and those stored at the PGS in relation to Units 6 & 7 would entail a vapor cloud travel through or around plant structures, thus "Urban or Forest" was selected for the determined worst-case meteorological conditions.

- The "Threat at Point" function was selected with no crosswind in the ALOHA modeling runs. This effectively models the chemical release as a direct-line

source from the spill site to the point of concern, the nearest safety-related structure for Units 6 & 7. These results represent the worst-case hazard levels that could develop at that distance directly downwind of the source rather than accounting for the prevailing meteorological conditions.

- For each of the identified chemicals in the liquid state, it was conservatively assumed that the entire contents of the vessel leaked, forming a 1-centimeter-thick puddle. This provided a significant surface area from which to maximize evaporation and the formation of a vapor cloud.

- For each of the identified chemicals in the gaseous state, it was conservatively assumed that the quantity released from the vessel/pipeline is released over a 10-minute period into the atmosphere as a continuous direct source (40 CPR 68.25).

Guidance concerning flammable vapor clouds indicates that it is appropriate to consider the distance to the LFL as the safe distance for flammable vapor clouds. Generally, for flash fires the controlling factor for the amount of damage that a receptor will suffer is whether the receptor is physically within the burning cloud. This is because most flash fires do not burn very hot and the thermal radiation generated outside of the burning cloud will generally not cause significant damage due to the short duration (References 229 and 243). However, conservatively, the thermal radiation heat flux was calculated for each formed vapor cloud capable of ignition resulting in a flash fire.

For this calculation, all of the mass of the vapor cloud is considered flammable and at the upper explosive limit. This is a conservative assumption because the upper explosive limit represents the highest percentage of fuel by volume in air (molar fraction) that can propagate a flame (Reference 215). The resulting incident heat flux on the nearest safety-related structure is calculated using the following equation presented in the Society of Fire Protection Engineers Handbook of Fire Protection Engineering (Reference 221):

$$q = \frac{\overline{v} f \tau g^{1/2} \rho_f h_f V_f^{5/6}}{4 \pi r^2} \quad \text{(Equation 6)}$$

Where,

q	=	incident heat flux, kW/m²
$\overline{v}$	=	normalized dimensionless heat transfer rate
f	=	fraction of combustion energy radiated to the environment

τ	=	atmospheric transmissivity
g	=	acceleration due to gravity, m/s²
ρ_f	=	vapor density, kg/m³
h_f	=	heat of combustion, kJ/kg
V_f	=	initial vapor volume of fuel, m³
r	=	the distance between the fireball center and the nearest safety-related structure, m—calculated as:

(Equation 7)

$$r = \left[x^2 + (Z - h)^2\right]^{1/2}$$

Where,

χ	=	horizontal separation of fireball center and nearest safety-related structure, m
Z	=	height of fireball center above ground, m
h	=	nearest safety-related structure height above ground, m

The following assumptions are used when calculating the radiant heat flux from a resulting flash fire:

- The temperature is assumed to be 40°F, the mean extreme annual dry bulb temperature for nearby Homestead Air Reserve Base (Reference 222). This results in a conservative assumption as a lower ambient air temperature corresponds to a denser fuel upon release and thus a larger fuel mass.
- The initial vapor cloud before ignition is assumed to be spherical and located at the lower explosive limit distance away from the point of release—the closest point that the vapor cloud can reach the nearest safety-related structure and still burn.
- The transmissivity of air is conservatively assumed to be one. This is conservative because the water vapor and carbon dioxide will absorb thermal radiation and depreciate the incident heat flux on the nearest safety-related structure. Making the assumption that the transmissivity of air is one results in neglecting those losses.
- The fraction of combustion energy radiated to the environment is assumed to be 20 percent (Reference 221).

- The normalized dimensionless heat transfer rate, $\overline{V}$ is assumed to be 0.0005, the point at which η, non-dimensionless time, becomes asymptotic (Reference 221).
- The nearest safety-related structure is conservatively assumed to be a blackbody—it absorbs all incident radiation.
- It is assumed that once the maximum fireball diameter and height are reached, they are maintained for the duration of the fireball.

2.2.3.1.2.2 Flammable Vapor Cloud—Explosions

Those identified chemicals with the potential to detonate are then evaluated to determine the possible effects of a flammable vapor cloud explosion. ALOHA was used to model the worst-case accidental vapor cloud explosion for the identified chemicals, including the safe distances and overpressure effects at the nearest safety-related structure. To model the worst-case vapor cloud explosion in ALOHA, detonation was chosen as the ignition source. The evaluation was conducted using the identical assumptions presented in Subsection 2.2.3.1.2.1 for the ALOHA model. The safe distance was measured as the distance from the spill site to the location where the pressure wave is at 1 psi overpressure.

The effects of flammable vapor clouds and vapor cloud explosions from internal and external sources are summarized in Table 2.2-214 and are described in following subsections relative to the release source.

2.2.3.1.2.3 Onsite Chemical Storage/Units 1 through 5

The hazardous materials stored on site that were identified for further analysis with regard to forming a flammable vapor cloud capable of delayed ignition following an accidental release of the hazardous material are acetylene, ammonium hydroxide, hydrazine, hydrogen, and propane. As described in Subsection 2.2.3.1.2.1, the ALOHA dispersion model was used to determine the distance a vapor cloud could travel to reach the LFL boundary once a vapor cloud has formed from an accidental release of the identified chemical. It was conservatively assumed that the entire contents of the ammonium hydroxide, hydrazine, and liquid propane vessels leaked forming a one-centimeter-thick puddle; while, for acetylene and hydrogen, it was assumed that the entire contents of the tank are released over a 10-minute period as a continuous direct source. The results indicate that any plausible vapor cloud that could form and mix sufficiently under stable atmospheric conditions would be below the LFL boundary

before reaching the nearest safety-related structure—the Unit 6 auxiliary building. The distance to the LFL boundary for acetylene is 1308 feet; for ammonium hydroxide, 354 feet; for hydrazine, 42 feet; for hydrogen, 1179 feet; and for propane, the distance to the LFL boundary is 738 feet. Acetylene is stored approximately 4300 feet; ammonium hydroxide, approximately 5079 feet; hydrazine, approximately 2727 feet; hydrogen, approximately 3966 feet; and propane approximately 4168 feet from the Unit 6 auxiliary building (Table 2.2-214).

Further, as described in Subsection 2.2.3.1.2.1, the associated heat flux for each flammable vapor cloud was determined from the point at which the vapor cloud reaches the LFL to the nearest safety-related structure. The maximum incident heat flux for acetylene is 0.207 kW/m^2; for ammonium hydroxide, 0.850 kW/m^2; for hydrazine, 0.271 kW/m^2; for hydrogen, 0.054 kW/m^2 and for propane the maximum incident heat flux is 0.092 kW/m^2. These results are less than 5 kW/m^2 level of concern defined by the EPA.

A vapor cloud explosion analysis was also completed following the methodology as detailed in Subsection 2.2.3.1.2.2 in order to obtain safe distances. The results concluded that the safe distance, the minimum distance required for an explosion to have less than a 1 psi peak incident pressure, are less than the shortest distance to the nearest safety-related structure for Units 6 & 7, the Unit 6 auxiliary building, and the storage location of these chemicals. The safe distance for the acetylene cylinders is 1764 feet; for ammonium hydroxide, 963 feet; for one hydrogen tube trailer, 1347 feet; and for liquid propane, 1416 feet. For hydrazine, no explosion occurs because the vapor pressure for hydrazine is sufficiently low that not enough vapor is released from the spill for a vapor cloud explosion to occur. Each of these chemicals is stored at a greater distance from the nearest safety-related structure than the calculated safe distance.

Therefore, a flammable vapor cloud with the possibility of ignition or explosion formed from the onsite chemical storage for Units 1 through 5 analyzed will not adversely affect the safe operation or shutdown of Units 6 & 7 (Table 2.2-214).

2.2.3.1.2.4 Onsite Chemical Storage/Units 6 & 7

The site-specific chemical stored on site that is identified for further analysis with regard to forming a flammable vapor cloud capable of delayed ignition following an accidental release of the hazardous material is methanol. As described in Subsection 2.2.3.1.2.1, the ALOHA dispersion model was used to determine the

distance a vapor cloud could travel to reach the LFL boundary once a vapor cloud has formed from an accidental release of the identified chemical.

The result indicates that any plausible vapor cloud that could form and mix sufficiently under stable atmospheric conditions would be below the LFL before reaching the nearest safety-related structure—the Unit 7 auxiliary building. The distance to the LFL boundary for methanol is 333 feet. Methanol is stored at the FPL reclaimed water treatment facility approximately 5387 feet from the nearest safety-related structure (Table 2.2-214).

Further, as described in Subsection 2.2.3.1.2.1, the associated heat flux for the flammable vapor cloud was determined from the point at which the vapor cloud reaches the LFL to the nearest safety-related structure. The maximum incident heat flux for methanol is 0.669 kW/m^2. This result is less than 5 kW/m^2 level of concern defined by the EPA.

A vapor cloud explosion analysis was also completed as detailed in Subsection 2.2.3.1.2.2 to obtain the safe distance. The result concluded that the safe distance, the minimum distance required for an explosion to have less than a 1 psi peak incident pressure, is less than the shortest distance to the nearest safety-related structure for Units 6 & 7, the Unit 7 auxiliary building, and the storage location of methanol. The safe distance for the methanol is 804 feet from the point of ignition. This chemical is stored at a greater distance from the nearest safety-related structure than the calculated safe distance. Additionally, each standard AP1000 chemical stored at Turkey Point Units 6 & 7 is stored at a distance greater than the minimum safe distance for vapor cloud explosion indicated in DCD Table 2.2-1. Therefore, a flammable vapor cloud with the possibility of ignition or explosion formed from the storage of the onsite chemical storage for Units 6 & 7 analyzed will not adversely affect the safe operation or shutdown of Units 6 & 7 (Table 2.2-214).

2.2.3.1.2.5 Nearby Facilities/Homestead Air Reserve Base

The Homestead Air Reserve Base, located approximately 4.76 miles, 25,133 feet, from the nearest safety-related structure, the Unit 6 auxiliary building, operates within the vicinity of the Turkey Point site. The hazardous materials stored at Homestead Air Reserve Base that were identified for further analysis with regard to the potential for delayed ignition of a flammable vapor cloud formed following the accidental release of a hazardous material are gasoline and propane. For gasoline, it was conservatively assumed that the entire contents of the vessel leaked and formed a 1-centimeter-thick puddle. Because solutions such as

gasoline cannot be modeled in the current version of ALOHA, as recommended by the EPA, gasoline was modeled for flammable vapor cloud and vapor cloud explosion analysis by selecting n-Heptane as a surrogate for gasoline in ALOHA's chemical library. This selection is appropriate as the evaporation curves over a range of temperatures for n-Heptane and gasoline are shown to be similar, and at temperatures below 80°C, the evaporation of n-Heptane occurred at a faster rate (Reference 246). In the case of propane, the entire contents of the tank are assumed to be released over a 10-minute period as a continuous direct source. The results using the methodology described in Subsection 2.2.3.1.2.1 concluded that any plausible vapor cloud that could form and mix sufficiently under stable atmospheric conditions is below the LFL boundary before reaching the Units 6 & 7 site (Table 2.2-214). The greatest distance to the LFL boundary, 2190 feet, was for propane, while the distance to the LFL boundary for gasoline was 678 feet.

Further, as described in Subsection 2.2.3.1.2.1, the associated heat flux for each flammable vapor cloud was determined from the point at which the vapor cloud reaches the LFL to the nearest safety-related structure. The maximum incident heat flux for gasoline is 0.053 kW/m^2; and for propane the maximum incident heat flux is 0.078 kW/m^2. These results are less than 5 kW/m^2 level of concern defined by the EPA (Table 2.2-214).

Because each of the identified chemicals has the potential to explode, a vapor cloud explosion analysis was also performed as described in Subsection 2.2.3.1.2.2. The results of the vapor cloud explosion analysis concluded that the safe distance, the minimum distance required for an explosion to have less than a 1 psi peak incident pressure, is less than the minimum separation distance between the Unit 6 auxiliary building and the release point at Homestead Air Reserve Base. The largest determined safe distance was for propane, 4866 feet, while the determined safe distance for gasoline was 1623 feet. (Table 2.2-214)

Therefore, a flammable vapor cloud with the possibility of ignition or explosion from the storage of chemicals at offsite facilities will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.2.6 Transportation Routes/Roadways

The nearest safety-related structure for Units 6 & 7, the Unit 6 auxiliary building, is located approximately 2054 feet at its closest point of approach from the onsite transportation delivery route for gasoline. The methodology presented in Subsection 2.2.3.1.2.1 was used for determining the distance from the accidental

release site where the vapor cloud is within the flammability limits. It was conservatively estimated that the vessel carried and released 50,000 pounds, 9000 gallons, of gasoline. The results for the 9000-gallon gasoline tanker concluded that any plausible vapor cloud that can form and mix sufficiently under stable atmospheric conditions will have a concentration less than the LFL before reaching the nearest safety-related structure. The distance to the LFL boundary for gasoline is 402 feet.

Further, as described in Subsection 2.2.3.1.2.1, the associated heat flux for the formed flammable vapor cloud was determined from the point at which the vapor cloud reaches the LFL to the nearest safety-related structure. The maximum incident heat flux for the 9000-gallon gasoline tanker is 3.187 kW/m^2. These results are less than 5 kW/m^2 level of concern defined by the EPA.

Gasoline was also evaluated using the methodology presented in Subsection 2.2.3.1.2.2 to determine the effects of a possible vapor cloud explosion. The safe distance, the minimum separation distance required for an explosion to have less than a 1 psi peak incident pressure impact from the drifted gasoline vapor cloud, is less than the shortest distance to the onsite gasoline delivery route. The safe distance for this quantity of gasoline was determined to be 1014 feet (Table 2.2-214).

Therefore, a flammable vapor cloud ignition or explosion from a 9000-gallon gasoline tanker transported on site will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.2.7 Transportation Routes/Pipelines

The Florida Gas Transmission Company owns and operates a high-pressure natural gas transmission pipeline system that serves FPL within the vicinity of Units 6 & 7. At its closest distance, the Turkey Point Lateral pipeline passes within approximately 4535 feet of the nearest safety-related structure for Units 6 & 7—the Unit 6 auxiliary building. To conservatively evaluate the consequences from a potential flammable vapor cloud or vapor cloud explosion from a natural gas transmission pipeline, a worst-case scenario was considered involving the release of natural gas directly into the atmosphere resulting in a vapor cloud. Two scenarios were considered for the postulated natural gas pipeline rupture. The first scenario considered a formed vapor cloud that traveled toward Units 6 & 7. As the vapor cloud travels towards Units 6 & 7, it is plausible that the cloud concentration could become flammable along its path. As described in Subsection 2.2.3.1.2.1, the ALOHA dispersion model was used to determine the

distance a vapor cloud could travel to reach the LFL boundary once a vapor cloud has formed from an accidental release of natural gas (as methane) from the pipeline. The pipeline release source module was selected in the ALOHA program to model the natural gas release. The pipeline characteristics presented in Table 2.2-204 and the gas pipeline temperature for the Turkey Point Lateral, 78°F, are used as inputs to the ALOHA model. It was conservatively assumed that the pipeline was “connected to an infinite tank source” and that the roughness of the pipeline was “smooth” to model the break. The results concluded that under this scenario, the plausible vapor cloud that could form will be below the LFL boundary before reaching the nearest safety related structure for Units 6 & 7—the Unit 6 auxiliary building.

Because of the possibility that the natural gas vapor cloud may become confined either outside or by migration inside a building, a vapor cloud explosion analysis was performed as described in Subsection 2.2.3.1.2.2 and the ALOHA pipeline inputs from the preceding paragraph. The results of the vapor cloud explosion analysis concluded that the safe distance, the minimum distance required for an explosion to have less than 1 psi peak incident pressure, of 3033 feet, is less than the separation distance, 4535 feet, between the Unit 6 auxiliary building and the pipeline break.

As described in Subsection 2.2.3.1.1.7, when leaked natural gas is not trapped and immediate ignition occurs, a jet fire will develop. A jet fire occurs when a flammable chemical is rapidly released from an opening in a vessel or pipeline and an immediate ignition occurs. The jet fire stabilizes to a point that is close to the source of the release and continues to burn until the fuel source is stopped. Thus, the jet fire scenario should be considered for determining safety distances in the vicinity of natural gas pipelines. This is because in addition to producing thermal radiation, the jet fire causes considerable convective heating in the region beyond the flame tip. Additionally, the high velocity of the escaping gas into the jet causes more efficient combustion to occur than in pool fires. Therefore a much higher heat transfer rate could occur for a jet fire than in a pool fire flame.

The safe distance for a jet fire is measured as the distance from the fire to the point where the thermal heat flux reaches 5.0 kW/m^2. For the natural gas pipeline, ALOHA was used to model the worst-case accidental release from a pipeline resulting in a jet fire, including the safe distances and thermal heat flux effects on the nearest safety related structure.

The thermal effect of a jet fire strongly depends on atmospheric conditions and the impact radius for thermal radiation is primarily affected by wind speed, and

increases with decreasing wind speed. Thermal radiation is also affected by atmospheric transmittivity. Atmospheric transmittivity is the measure of how much thermal radiation from a fire is absorbed and scattered by water vapor and other components in the atmosphere. To model the jet fire scenario in ALOHA, the worst case meteorological conditions determined from the vapor cloud flammability and explosion analyses for the pipeline was used as site atmospheric input for the jet fire analysis. Because humidity is used to determine the atmospheric transmittivity in the ALOHA model, the humidity levels were varied to determine the atmospheric worst case in ALOHA for the jet fire scenario. The results of the jet fire analysis concluded that the safe distance, the distance to 5 kW/m^2, of 1035 feet, is less than the separation distance, 4535 feet, between the Unit 6 auxiliary building and the pipeline break. The maximum thermal radiation effects at the nearest safety related structure for modeled jet fire scenario is 0.261 kW/m^2.

Therefore, a jet fire or flammable vapor cloud ignition or explosion from a rupture in the Turkey Point Lateral natural gas transmission pipeline will not adversely affect the safe operation or shutdown of Units 6 & 7 (Table 2.2-214).

2.2.3.1.3 Toxic Chemicals

Accidents involving the release of toxic or asphyxiating chemicals from onsite storage facilities and nearby mobile and stationary sources were considered. Toxic chemicals known to be present on site or in the vicinity of the Turkey Point site, or to be frequently transported in the vicinity, were evaluated.

The onsite chemicals, Units 1 through 5 (Table 2.2-207) and site-specific chemicals associated with Units 6 & 7 (Table 2.2-208); offsite chemical storage, Homestead Air Reserve Base, (Table 2.2-209); hazardous materials transported in pipelines, Turkey Point Lateral (Table 2.2-210); and hazardous materials potentially transported on roadways (Table 2.2-210) were evaluated to ascertain which hazardous materials should be analyzed with respect to their potential to form a toxic or asphyxiating vapor cloud following an accidental release.

The ALOHA air dispersion model was used to predict the concentrations of toxic or asphyxiating chemical clouds as they disperse downwind for all facilities and sources except for the Turkey Point Lateral natural gas pipeline. In the case of a toxic vapor cloud, the maximum distance a cloud can travel before it disperses enough to fall below the *Immediately Dangerous to Life and Health* (IDLH) or other determined toxicity limit concentration in the vapor cloud was determined using ALOHA. Asphyxiating chemicals were evaluated to determine if their release resulted in the displacement of a significant fraction of the control room

air—defined by the Occupational Safety and Health Administration's (OSHA) definition of an oxygen-deficient atmosphere.)

The IDLH is defined by the National Institute of Occupational Safety and Health (NIOSH) as a situation that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects, or prevent escape from such an environment. The IDLHs are determined by NIOSH so that workers are able to escape such environments without suffering permanent health damage. Where an IDLH was unavailable for a toxic chemical, the time-weighted average or threshold limit value, promulgated by OSHA or adopted by the American Conference of Governmental Hygienists, was used as the toxicity concentration level.

The ALOHA model was also used to predict the concentration of the chemical in the control room for those chemicals where the distance to the IDLH limit, asphyxiating limit, or oxygen-enriched limit exceeded the distance to the control room intake following a chemical release to ensure that, under worst-case scenarios, control room operators will have sufficient time to take appropriate action. ALOHA is a diffusion model that permits temporal as well as spatial variations in release terms and concentrations in the control room. The concentrations in the control room are limited to a 60-minute period because, as indicated in RG 1.78, the probability of a plume remaining within a given sector for a long period of time is quite small.

The toxicity/asphyxiation analyses conducted using the ALOHA model was run under a spectrum of standard meteorological conditions (selected stability class, wind speed, time of day, and cloud cover) based on the defined Pasquill meteorological stability classes (Tables 2.2-211 and 2.2-212). The meteorological sensitivity analysis includes the most stable meteorological class, F, allowable with the ALOHA model. The more stable the meteorological class and the lower the wind speed, the less turbulence is generated, and therefore less mixing and dilution of the formed pollutant cloud should occur.

Other atmospheric inputs/assumptions for the ALOHA model include:

- "Open Country" was selected for the ground roughness with the exception of those chemicals stored north of Units 1 through 4 (ammonium hydroxide and sodium hypochlorite) and the sodium hypochlorite stored at the Cooling Towers, where "Urban or Forest" was selected. The degree of atmospheric turbulence influences how quickly a pollutant cloud moving downwind will mix

with the air around it and will be diluted. Friction between the ground and air passing over it is one cause of atmospheric turbulence. The rougher the ground surface, the greater the ground roughness and the greater the turbulence that develops. A chemical cloud generally travels farther across open country than over an urban area or forest. The selection of “Open Country” is conservative because the Turkey Point site meets the criteria for “Urban or Forest”—an area with many friction-generating roughness elements, such as trees or small buildings (e.g., industrial areas). The site layout and location of the chemicals stored north of Units 1 through 4 and those stored at the PGS and the Cooling Tower Area in relation to Units 6 & 7 would entail a vapor cloud travel through or around plant structures, thus “Urban or Forest” was selected for the determined worst-case meteorological conditions.

- The “Threat at Point” function was selected with no crosswind for the ALOHA modeling runs for those chemicals where the distance to the IDLH limit, asphyxiating limit, or oxygen-enriched limit exceeded the distance to the control room intake. This selection effectively models the chemical release as a direct-line source from the spill site to the point of concern, the control room intake. This is conservative because all of the chemicals, with the exception of the site-specific onsite chemicals associated with Units 6 & 7, are stored to the north of Units 6 & 7, and the predominant annual wind direction is from the east with an annual frequency of approximately 17 percent—and when deriving the toxicity level in the control room, RG 1.78 provides an allowance for taking into account the prevailing meteorological conditions at the site.

- For each of the identified chemicals, it was conservatively assumed that the entire contents of the vessel leaked, forming a 1-centimeter-thick puddle.

- For those identified hazardous materials in the gaseous state, it was conservatively assumed that the entire contents of the vessel or pipeline are released over a 10-minute period into the atmosphere as a continuous direct source (40 CFR 68.25).

- In order to model sodium hypochlorite, first the partial vapor pressure was determined as (Reference 220):

$$VP_m = X_r * \text{(Vapor pressure of a pure substance)}$$

  Once the partial vapor pressure was determined, the evaporation rate for sodium hypochlorite solution was calculated as (Reference 220):

$$QR = \frac{0.0035 * U^{0.78} * MW^{2/3} * A * VP}{T}$$

Where,

QR = Evaporation rate (pounds per minute (lbs/min))
U = Wind speed (meters per second (m/s))
MW = Molecular weight
A = Surface area of pool formed by entire quantity of mixture (square feet (ft^2))
VP = Vapor pressure (mmHg)
T = Temperature of released substance (Kelvin (K))

Because sodium hypochlorite has to be modeled as a direct source, a virtual point method was applied to account for the point source release.

The effects of toxic chemical releases from standard AP1000 chemicals are summarized in Table 6.4-201. The effects of toxic chemical releases from Units 6 & 7 site-specific chemicals, onsite chemicals (Units 1 through 5), and external sources are summarized in Table 2.2-215 and are described in the following subsections relative to the release sources.

2.2.3.1.3.1 Onsite Chemical Storage/Units 1 through 5

The hazardous materials stored onsite that were identified for further analysis with regard to the potential of the formation of toxic vapor clouds formed following an accidental release are acetylene (asphyxiant), ammonium hydroxide, argon (asphyxiant), carbon dioxide, chlorine, hydrazine, hydrogen (asphyxiant), muriatic acid, nitrogen gas (asphyxiant), liquid nitrogen (asphyxiant), oxygen (may create an oxygen enriched environment), propane, and sodium hypochlorite. As described in Subsection 2.2.3.1.3, the identified hazardous materials were analyzed using the ALOHA dispersion model to determine whether the formed vapor cloud would reach the control room intake. The concentration of the toxic chemical in the control room is calculated for those chemicals where the distance to the IDLH limit, asphyxiating limit, or oxygen-enriched limit exceeded the distance to the control room intake. The distances to the IDLH, asphyxiating, or oxygen-enriched limits are calculated following a 10-minute release from the largest vessel for acetylene, argon, carbon dioxide, chlorine, hydrogen, nitrogen, and oxygen. For each chemical in the liquid phase (ammonium hydroxide, hydrazine, muriatic acid, liquid nitrogen, propane, and sodium hypochlorite), the worst-case release scenario in each of the analyses included the total loss of the

largest vessel, resulting in an unconfined 1-centimeter-thick puddle. In the case of each of the asphyxiants or toxic gases, distance to the IDLH limit, asphyxiating limit, or oxygen-enriched limit is calculated for acetylene (531 feet), ammonium hydroxide (4,368 feet), argon (144 feet), carbon dioxide (963 feet), chlorine (3,471 feet), hydrazine (2,178 feet), hydrogen (612 feet), muriatic acid (1,983 feet), nitrogen gas (813 feet), liquid nitrogen (1,206 feet), oxygen (147 feet), propane (1,878 feet), and sodium hypochlorite (1,752 feet). All distances to IDLH, asphyxiation, or oxygen-enriched limits are less than the distance to the control room intake with the exception of chlorine. The control room concentration was calculated for chlorine and found to be 2.18 ppm, which is below the IDLH limit of 10 ppm (Table 2.2-215). Consistent with RG 1.78, asphyxiating chemicals should be considered if their release results in a displacement of a significant fraction of control room air—in accordance with the definition of oxygen-deficient atmosphere provided by the OSHA. (Reference 230) Therefore, the formation of a toxic vapor cloud following an accidental release of the analyzed hazardous materials stored on site will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.3.2 Onsite Chemical Storage/Units 6 & 7

The site-specific chemicals stored on site that were identified for further analysis with regard to the potential of the formation of toxic vapor clouds formed following an accidental release are methanol and sodium hypochlorite (storage at FPL reclaimed water treatment facility and cooling tower). As described in Subsection 2.2.3.1.3, the identified hazardous materials were analyzed using the ALOHA dispersion model to determine whether the formed vapor cloud would reach the control room intake. The concentration of the toxic chemical in the control room is calculated for those chemicals where the distance to the IDLH limit, asphyxiating limit, or oxygen-enriched limit exceeded the distance to the control room intake. The worst-case release scenario included the total loss of the largest vessel, resulting in an unconfined 1-centimeter-thick puddle. The chemical analyses indicate that the control room would remain habitable for the determined worst-case release scenario based on the distance to IDLH limit for all chemicals with the exception of sodium hypochlorite located at the reclaimed water treatment facility and cooling towers. Control room concentrations were calculated for sodium hypochlorite at the reclaimed water treatment facility (3.62 ppm) and the cooling towers (6.90 ppm) – both concentrations are below the 10 ppm IDLH limit for chlorine. (Table 2.2-215). Additionally, Table 6.4-201 provides specific information concerning the toxicity analysis associated with the standard AP1000 chemicals for Units 6 & 7. Each standard AP1000 chemical stored at Turkey Point

Units 6 & 7 is stored at distances greater than the evaluated minimum distance to the main control room intake indicated in Table 6.4-201. Therefore, the formation of a toxic vapor cloud following an accidental release of the analyzed hazardous materials stored on site would not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.3.3 Nearby Facilities/Homestead Air Reserve Base

The Homestead Air Reserve Base is approximately 4.76 miles, 25,133 feet, from the Turkey Point site. The hazardous materials stored at Homestead Air Reserve Base that are identified for further analysis with regard to the potential for forming a toxic vapor cloud following an accidental release and traveling to the control room are Halon 1301, oxygen (potential for creating an oxygen enriched environment), gasoline, and propane. For Halon 1301 and gasoline, the worst-case release scenario included the total loss of the largest vessel, resulting in an unconfined 1-centimeter-thick puddle. Because solutions such as gasoline cannot be modeled in the current version of ALOHA as recommended by the EPA, gasoline was modeled for toxicity analysis by selecting n-Heptane as a surrogate for gasoline in ALOHA's chemical library. This selection is appropriate as the evaporation curves over a range of temperatures for n-Heptane and gasoline are shown to be similar, and at temperatures below 80°C, the evaporation of n-Heptane occurred at a faster rate (Reference 246). The distances to the oxygen-enriched limit and IDLH limit are determined for oxygen and propane, respectively, following a 10-minute release of the total quantity onsite. In the case of oxygen, the distance to the oxygen-enriched limit under the determined worst-case meteorological condition, 309 feet, is less than the distance to the control room and would not displace enough air for the control room to become an oxygen enriched environment. The chemical analysis indicates that the distance the Halon 1301, gasoline, or propane vapor cloud could travel before falling below the selected toxicity limit was less than the distance to the control room for each meteorological condition analyzed (Table 2.2-215). Therefore, the formation of a toxic vapor cloud following an accidental release of the analyzed hazardous materials stored at an offsite facility will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.3.4 Transportation Routes/Roadways

The nearest control room for Units 6 & 7 is approximately 2084 feet at its closest point of approach, from the onsite transportation delivery route for gasoline. As detailed in Subsection 2.2.2.5, delivery of chemicals other than gasoline to the Units 1 through 5 site are screened and determined to be bounded by the

evaluation performed for the Units 1 through 5 onsite storage quantities. The methodology presented in Subsection 2.2.3.1.3 was used for determining the distance from the release site to the point where the toxic vapor cloud reaches the IDLH boundary. For gasoline, the time-weighted average (TWA) toxicity limit was conservatively used because no IDLH is available for this hazardous material. The TWA is the average value of exposure over the course of an 8-hour work shift. Gasoline was modeled for toxic analysis by selecting n-Heptane in ALOHA's chemical library. In this scenario, it was conservatively estimated that the transport vehicle lost the entire contents—50,000 pounds, or 9000 gallons. The results concluded that the distance to the TWA toxicity limit for any vapor cloud that forms following an accidental release of gasoline at the closest approach from the onsite transportation delivery route is less than the distance to the control room intake (Table 2.2-215). Therefore, the formation of a toxic vapor cloud following an accidental release of gasoline transported onsite will not adversely affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.3.5 Transportation Routes/Pipelines

The Florida Gas Transmission Company owns and operates a high pressure natural gas transmission pipeline system that serves FPL. At its closest distance, the Turkey Point Lateral pipeline passes within approximately 4535 feet of the nearest control room for Units 6 & 7, the Unit 6 control room. Natural gas or its main constituent, methane, is not considered toxic and there is no IDLH or other toxicity limit identified. However, natural gas is considered an asphyxiant. Therefore, an analysis is necessary for the natural gas transmission pipeline to determine whether an oxygen-deficient environment exists in the control room from the displacement of air. Utilizing the methodology and inputs described in Subsections 2.2.3.1.3 and 2.2.3.1.2.7, natural gas (as methane) was analyzed using the ALOHA dispersion model to determine whether the formed vapor cloud would reach the control room intake in concentrations such that methane would displace enough oxygen to create an oxygen-deficient environment. The distance to the asphyxiating limit, under the determined worst-case meteorological conditions, was determined to be 426 feet, less than the distance to the control room intake. Therefore, a break in the natural gas pipeline will not displace enough oxygen for the control room to become an oxygen-deficient atmosphere.

2.2.3.1.4 Fires

Accidents were considered in the vicinity of the Turkey Point site that could lead to high heat fluxes or smoke, and nonflammable gas or chemical-bearing clouds from the release of materials as a consequence of fires. Fires in adjacent

industrial plants and storage facilities—chemical, oil and gas pipelines; brush and forest fires; and fires from transportation accidents—are evaluated as events that could lead to high heat fluxes or to the formation of such clouds.

The nearest industrial site is the Homestead Air Reserve Base, located approximately 4.76 miles from Units 6 & 7. Each of the chemicals stored at Units 1 through 5, the site-specific chemicals associated with Units 6 & 7, and the Homestead Air Reserve Base along with the nearest natural gas transmission pipeline, the Turkey Point Lateral, are evaluated in Subsection 2.2.3.1.2 for potential effects, including heat fluxes where appropriate, of accidental releases leading to a delayed ignition and/or explosion of any formed vapor cloud. For each of the stored or transported hazardous materials evaluated, the results concluded that any formed vapor cloud will dissipate below the LFL before reaching the control room. Further, an evaluation of the heat flux from the formed vapor cloud capable of ignition concluded that the resulting heat flux from a flash fire or jet fire (Florida Gas Transmission pipeline) will be below the 5 kW/m^2 threshold (Table 2.2-214). Therefore, it is not expected that there will be any hazardous effects to Units 6 & 7 from fires or heat fluxes associated with the operations at these facilities, transportation routes, or pipelines.

Further, the potential for an onsite fire from the residual fuel oil storage facilities located at the Turkey Point site was evaluated to estimate the resulting heat flux. Subsection 2.2.3.1.2 does not include an evaluation of the heat flux from the formation of a vapor cloud because the low vapor pressure of residual fuel oil makes this a non-credible event. The incident heat flux was calculated using the solid flame model presented in NUREG-1805. The solid flame model is based on the assumption that the fire is a solid vertical cylinder that emits thermal radiation laterally. The incident heat flux calculated from the solid flame model requires that the average emissive power at the flame surface (kW/m^2) and the configuration factor along with the flame height be calculated. The methodology used to calculate the average emissive power, flame height, configuration factor and resultant incident heat flux is as follows:

Emissive Power

The emissive power (E) is the total surface radiation of the fire per unit area per unit time (NUREG-1805).

$$E(kW/m^2) = 58\,(10^{-0.00823D}) \qquad \text{(Equation 8)}$$

Where, D is the effective diameter of the pool fire for a noncircular pool and is calculated from the surface area of the pool (A_f) and is given by the following equation:

$$D= (4A_f/\pi)^{1/2} \qquad \text{(Equation 9)}$$

Flame Height

For open pool burning with no fire growth, the following correlation can be used to determine the flame height of the fire (NUREG-1805).

$$H_f(m)= 0.235\,Q^{0.4} - 1.02\,D \qquad \text{(Equation 10)}$$

Where, D is the effective diameter of the fire (m) and Q is the heat release of the fire determined by the following relationship:

$$Q = m^n\,\Delta H_{c,eff}\,A_f\,(1-e^{-k\beta D}) \qquad \text{(Equation 11)}$$

Where, m^n is the mass loss rate per unit area per unit time (kg/m^2-s); $\Delta H_{c,\,eff}$ is the heat of combustion (kJ/kg); A_f is the surface area of the pool (m^2); and kβ is an empirical constant (m^{-1}).

Configuration Factor

The configuration factor (F_{1-2}) is a geometric quantity that accounts for the fraction of the radiation leaving one surface that strikes another surface directly. The configuration factor is a sum of the horizontal and vertical vectors and is a value between 0 and 1. The factor approaches 1 as the distance between the point of interest and the flame is decreased (NUREG-1805).

$$F_{1-2} = (F^2_{1-2,H} + F^2_{1-2,V})^{1/2} \qquad \text{(Equation 12)}$$

Incident Heat Flux

The incident heat flux, Q''_{inc}, to the target is given by (NUREG-1805):

$$Q''_{inc}\,(kW/m^2) = EF_{1-2} \qquad \text{(Equation 13)}$$

The following inputs and assumptions were used in determining the incident heat flux:

- It was conservatively assumed that the entire contents of one of the residual fuel oil storage tanks, 268,000 barrels, completely ruptures spilling the entire contents into the bermed area.

- The terrain between the fire and the closest plant structure is assumed to be flat with no obstructions.

- It is assumed that it is an open pool fire and the entire surface of the fuel oil in the bermed area is involved. The pool is assumed to be circular with an area equivalent to the bermed area.

- The fire is assumed to be a perfect black body with an emissivity of 1.

- The transmissivity of air is assumed to be 1—this assumes that no thermal radiation is absorbed by air.

- The Unit 6 service building, located 3668 feet from the postulated fuel oil fire, was conservatively used as the separation distance between the fire and nearest building—although the service building is not a safety-related structure, it was conservatively chosen as the structure of concern for Units 6 & 7.

Using the method described above the incident heat flux for a postulated pool fire involving the entire contents of the storage vessel would result in an incident heat flux of 0.0625 kW/m^2 at the Unit 6 service building—below the selected 5.0 kW/m^2 level of concern for heat from fires. Further, a dispersion analysis study concluded that airborne pollutant concentration levels resulting from the postulated fire will be below established ambient air quality standards before reaching Units 6 & 7.

Brush and forest fires were also considered consistent with RG 1.206. Units 6 & 7 are built on fill material to an elevation of approximately 25-26 feet NAVD 88. The plant area consists of approximately 218 acres providing a cleared area consisting of limited vegetative fuel for a fire of at least 600 feet wide surrounding the Units 6 & 7 site safety-related structures. This provides a substantial defensible zone in the unlikely event of a fire originating as a result of onsite or offsite activities. Additionally, Units 6 & 7 is located south of Units 1 through 5 and are within the cooling canals. These canals, which are approximately 100–150 feet wide, encircle the Units 6 & 7 plant area. The canals are deep, primary return, water canals leading to Units 1 through 4 cooling water intakes. Therefore, the zone surrounding Units 6 & 7 is of sufficient size, especially when considering the

canals surrounding the plant area, to afford protection in the event of a fire. The Florida Department of Agriculture and Consumer Services, Division of Forestry recommends a defensible space of 30 feet (minimum) to 100 to 200 feet be maintained around structures for protection against wildfires. In addition, California has adopted regulations requiring a fire break of at least 30 feet and a fuel break to 100 feet (References 231 and 232). The safety zone around Units 6 & 7 greatly exceeds these recommended distances, and therefore, it is not expected that there will be any hazardous effects to Units 6 & 7 from fires or heat fluxes associated with wild fires, fires in adjacent industrial plants, or from onsite storage facilities.

2.2.3.1.5 Collisions with Intake Structure

Because Units 6 & 7 are located near a navigable waterway, an evaluation was performed that considered the probability and potential effects of impacts on the plant cooling water intake structure and enclosed pumps. The Units 6 & 7 makeup water system consists of either reclaimed water provided from the Miami-Dade Water and Sewer Department or saltwater makeup water from the radial collector wells to the circulating water cooling system. The radial collector wells consist of a central reinforced concrete caisson, extending below the Biscayne Bay seabed. The wells are designed to induce infiltration from the nearby surface water source (Biscayne Bay), combining the desirable features of extremely high well yields with induced seabed filtration of suspended particulates. Thus, there is no intake structure associated with either the reclaimed water pipeline or radial collector well system that would be damaged as a result of navigable waterway activities that would affect the safe shutdown of Units 6 & 7.

2.2.3.1.6 Liquid Spills

The accidental release of oil or liquids that may be corrosive, cryogenic, or coagulant was considered to determine if the potential exists for such liquids to be drawn into the plant’s makeup water intake structure and circulating water system or otherwise affect the plant’s safe operation. In the event that these liquids would spill into the Biscayne Bay, they would not only be diluted by the large quantity of Biscayne Bay water, but the only material shipped by barge, residual fuel oil, has a specific gravity less than water and would float on top of the water. Therefore, any spill in the Biscayne Bay will not affect the water supplied by the radial collector wells and will not affect the safe operation or shutdown of Units 6 & 7.

2.2.3.1.6.1 Radiological Hazards

The hazard due to the release of radioactive material from Units 3 & 4 as a result of normal operations or an unanticipated event will not threaten safety of the new units. Smoke detectors, radiation detectors, and associated control equipment are installed at various plant locations as necessary to provide the appropriate operation of the systems. Radiation monitoring of the main control room environment is provided by the radiation monitoring system. The habitability systems for Units 6 & 7 are capable of maintaining the main control room environment suitable for prolonged occupancy throughout the duration of the postulated accidents that require protection from external fire, smoke, and airborne radioactivity. Automatic actuation of the individual systems that perform a habitability systems function is provided. In addition, safety-related structures, systems, and components for Units 6 & 7 have been designed to withstand the effects of radiological events and the consequential releases which will bound the contamination from a release from either of these potential sources.

The effect on the control rooms of Turkey Point Units 6 & 7 of a postulated design basis accident (DBA) in Turkey Point Unit 3 or 4 was evaluated based on a LOCA in Unit 3 or 4, at uprated conditions, using the releases produced from the alternative source term (AST) methodology. The dose at the Units 6 & 7 control rooms were determined considering the time-dependent source terms, the atmospheric dispersion factors (*X/Q* values), the assumed occupancy rates, and the operator breathing rates. A composite set of limiting *X/Q* values from the containment leakage point (Unit 4 Equipment Hatch) and the emergency core cooling system leakage point (Auxiliary Building Vent V-10) to the Unit 6 and 7 control rooms was developed based on the ARCON96 computer program *X/Q* analysis using the 2005–2009 meteorological dataset. For this analysis, the receptor was assumed to be outside the control rooms at the locations of the air intakes and the occupancy factor for the control room was conservatively assumed to be 1.0 (100 percent). The receptor was assumed to be breathing at 3.5E-04 m^3/sec for the duration of the accident. The resultant dose from this analysis is less than the GDC 19 limit.

2.2.3.2 Effects of Design Basis Events

As concluded in the previous subsections, no events were identified that had a probability of occurrence on the order of magnitude of 1E-07 or greater; and potential consequences serious enough to affect the safety of the plant to the extent that the guidelines in 10 CFR Part 100 could be exceeded. Thus, there are

no accidents associated with nearby industrial, transportation, or military facilities that are considered design basis events.

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2.2.4 COMBINED LICENSE INFORMATION

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This COL item is addressed in Subsections 2.2 through 2.2.3.

2.2.5 REFERENCES

201. Florida Power & Light Company, *Site Certification Application, Turkey Point Uprate Project*, January 2008.

202. U.S. Air Force, Homestead Air Reserve Base. Available at www.homestead.afrc.af.mil/, accessed July 18, 2008.

203. Air Force Reserve Command Headquarters, *Air Installation Compatible Use Zone (AICUZ) Study for the Homestead Air Reserve Base*, Florida, October 2007.

204. Not Used.

205. Florida Power & Light Company, *Turkey Point Plant Operations Manual for Fuel Oil Unloading*, July 2005.

206. U.S. Army Corps of Engineers, Institute of Water Resources, *Waterborne Commerce of the United States, Part 1—Waterways and Harbors Atlantic Coast*, 2005.

207. Rand McNally, *Miami-Dade County Street Guide*, 2008.

208. Homestead Air Reserve Base, *Response to Freedom of Information Act Request*, FOIA#2008-002, May 2008.

209. Airnav.com. Available at http://www.airnav.com/, accessed February 15, 2008.

210. GCR & Associates, Inc., Airport IQ5010. Available at http://www.gcr1.com/5010web/, accessed February 15, 2008.

211. The National Airspace System. Available at http://www.faa.gov/library/manuals/aviation/instrument_flying_handbook/media/faa-h-8083-15-2.pdf, accessed November 16, 2006.

212. U.S. Department of Energy, *Accident Analysis for Aircraft Crash into Hazardous Facilities*, DOE Standard, DOE-STD-3014-96, October 1996, Reaffirmation May 2006.

213. Miami-Dade.gov, Adopted 2015-2025, *Land Use Plan Map*. Available at http://www.miamidade.gov/planzone/CDMP_landuse_map.asp, accessed October 23, 2008.

214. National Fire Protection Agency, *Guide for Venting of Deflagrations*, NFPA 68, 2002.

215. National Fire Protection Agency, *Guide for Fire and Explosion Investigations*, NFPA 921, 2008.

216. Factory Mutual Insurance Company, FM Global, *Guidelines for Evaluating the Effects of Vapor Cloud Explosions Using a TNT Equivalency Method*, May 2005.

217. National Oceanic and Atmospheric Administration, *Areal Locations of Hazardous Atmospheres*, Ver. 5.4.1, February 2006.

218. Geiger, W., *Generation and Propagation of Pressure Waves Due to Unconfined Chemical Explosions and Their Impact on Nuclear Power Plant Structures*, Nuclear Engineering and Design, Vol. 27, 1974.

219. Harris, R., and M. Wickens, *Understanding Vapor Cloud Explosions — An Experimental Study*, The Institution of Gas Engineers, Special Projects Division, Communication 1408, 55th Autumn Meeting, Kensington Town Hall, November 1989.

220. U.S. Environmental Protection Agency, *Risk Management Program Guidance for Offsite Consequence Analysis,* EPA 550-B-99-009, April 1999.

221. DiNenno, P., *The SFPE Handbook of Fire Protection Engineering*, 2d ed., Society of Fire Protection Engineers, June 1995.

222. American Society of Heating, *Refrigerating and Air-Conditioning Engineers, Design Conditions for Homestead AFB*, Florida, WMO# 722025, ASHRAE Handbook-Fundamentals, 2005.

223. U.S. Department of Transportation, Federal Aviation Administration National Aeronautical Charting Office, *United States Government Flight Information Publication IFR Enroute Low Altitude—U.S., Panel L–19*, August 2007.

224. South Florida Regional Planning Council, Emergency Management, Kunish, D., R*esponse to Freedom of Information Act Request*, SARA Title III, Tier II Reports, reporting year 2006, March 2008.

225. U.S. Environmental Protection Agency, Enviromapper database. Available at http://134.67.99.109/wme/myWindow.asp?xl=80.501104333 3333&yt=25.4872705&xr=-80.4531043333333&yb=25.4512705, accessed September 29, 2008 and November 6, 2008.

226. U.S. Environmental Protection Agency, Chemical Emergency Preparedness and Prevention Office, Belke, J., *Chemical Accident Risks in U.S. Industry- A Preliminary Analysis of Accident Risk Data from U.S. Hazardous Chemical Facilities*, September 25, 2000.

227. Sugano, T. et al., *Local Damage to Reinforced Concrete Structures Caused by Impact of Aircraft Engine Missiles*, Nuclear Engineering and Design 140, pp. 387–423, 1993.

228. Mizuno, J. et al., *Investigation on Impact Resistance of Steel Plate Reinforced Concrete Barriers against Aircraft Impact: Part 3 Analyses of Full-Scale Aircraft Impact*, 18th International Conference on Structural Mechanics in Reactor Technology, August 2005.

229. Uijt de Haag P.A.M., and Ale, B.J.M., *1999 Guideline for Quantitative Risk Assessment*, Purple Book, CPR 18E, December 2005.

230. Occupational Safety and Health Administration, *Occupational and Health Standards, Hazardous Materials, Hazardous Waste Operations and*

Emergency Response Definitions, Title 29 Code of Federal Regulations Part 1910.120(a)(3), April 3, 2006.

231. Florida Department of Agriculture and Consumer Services, Division of Forestry, *Firewise Landscaping*. Available at http://www.fl-dof.com/wildfire /firewise _landscaping.html, accessed November 19, 2008.

232. Defensible Space, 2005, California Code of Regulations Title 14 CCR, Division 1.5, Chap. 7 Fire Protection, Subchapter 3, Article 3. *Fire Hazard Reduction Around Buildings and Structures Defensible Space*. § 1299. Available at http://www.fire.ca.gov/CDFBOFDB/pdfs/Defensible SpaceRegulationsfinal12992_17_06.pdf, accessed March 22, 2007.

233. National Institute for Occupational Safety and Health, Center for Disease Control and Prevention, NIOSH, *Pocket Guide to Chemical Hazards*, September 2005.

234. U.S. Coast Guard, *Chemical Hazards Response Information System*, Commandant Instruction 16465.12C, 1999.

235. U.S. Environmental Protection Agency and the National Oceanic and Atmospheric Administration's Office of Response and Restoration, *Computer-Aided Management of Emergency Operation*.

236. Matheson Tri-Gas, *Liquid Nitrogen Material Safety Data Sheet*, January 2007.

237. Mallinckrodt Baker, Inc., *Sodium Molybdate Material Safety Data Sheet*, August 2005.

238. International Programme on Chemical Safety, *Argon Data Sheet*, May 2003.

239. Seinfeld, J., *Atmospheric Chemistry and Physics of Air Pollution*, John Wiley & Sons, Inc., 1986.

240. U.S. Department of Transportation, Federal Aviation Administration National Aeronautical Charting Office, *United States Government Flight Information Publication IFR Enroute High Altitude—U.S., Panel H-8*, May 2007.

241. U.S. Department of Transportation, Federal Aviation Administration, *Terminal Area Forecast: National Forecast 2006 (1)—Airport Operations, Miami International.* Available at http://tafpub.itworks-software.com/OperationsListPrint.asp?TABLE_NAME=airportOperations&DisplayAll=undefined, accessed February 15, 2008.

242. Ocean Reef Club Airport. Available at http://www.oceanreef.com/index.cfm?fuseaction=aboutus.airport&, accessed December 16, 2008.

243. Canadian Society for Chemical Engineering, *Risk Assessment -Recommended Practices for Municipalities and Industry,* ISBN No. 0-920804-92-6, 2004.

244. Florida Power & Light Company, *Ten-Year Power Plant Site Plan 2009–2018*, Miami, Florida. Available at http://www.fpl.com/about/ten_year/pdf/plan.pdf_plan.shtml, accessed May 21, 2009.

245. Jo, Y., and B. Ahn, *Analysis of Hazard Areas Associated with High—Pressure Natural Gas Pipelines*.

246. Fardad, D. and N. Ladommatos, *Evaporation of Hydrocarbon Compounds, including Gasoline and Diesel Fuel, on Heated Metal Surfaces*, Department of Mechanical Engineering, Brunel University, Uxbridge, United Kingdom, Proc Instn Mech Engrs, Vol. 213, Part D, 1999.

247. The Chlorine Institute, Inc., *Sodium Hypochlorite Manual Pamphlet 96*, 2d ed., May 2000.

248. Accepta Ltd., *Accepta 2047 MSDS: Water Treatment Flocculant: High Molecular Weight Anionic Liquid Polymer,* January 6, 2004.

249. Accepta Ltd., *Accepta 2065 MSDS: Carbohydrazide Based Oxygen Scavenger Boiler Water Treatment*, January 6, 2004.

250. Accepta Ltd., *Accepta 2090 MSDS: Flocculant: High Molecular Weight Liquid Cationic Polymer*, January 6, 2004.

251. Nalco Company, *pHREEdom® 5200M Scale/Deposit Inhibitor Product Bulletin*, March 30, 2006.

252. Nalco Company, *3D TRASAR 3DT102 Material Safety Data Sheet*, June 27, 2005.

253. Nalco Company, *3D TRASAR 3DT195 Material Safety Data Sheet*, March 21, 2007.

254. Mallinckrodt Baker, Inc., *Sodium Molybdate Material Safety Data Sheet*, May 19, 2008.

255. Nalco Company, *3D TRASAR 3DT155 Material Safety Data Sheet.*

256. Chemical Safety Associates, Inc., RoClean P111 NSF MSDS, January 2006.

257. Chemical Safety Associates, Inc., RoClean P303 NSF MSDS, October 2007.

258. Langevin, C., *Simulation of Ground-Water Discharge to Biscayne Bay*, Southeastern Florida, U.S. Geological Survey, Water-Resources Investigations Report 00–4251, 2001.

259. Wingard, G. et al., *Ecosystem History of Southern and Central Biscayne Bay: Summary Report on Sediment Core Analyses* — Year Two, U.S. Geological Survey, Open-File Report 2004–1312, October 2004.

260. Swarzenski, P. et al., *Novel Geophysical and Geochemical Techniques used to Study Submarine Groundwater Discharge in Biscayne Bay*, Florida, U.S. Geological Survey, Fact Sheet 2004–3117, September 2004.

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Table 2.2-201
Description of Facilities — Products and Materials

Site	Concise Description	Primary Function	Number of Persons Employed	Major Products or Materials
Units 1 through 5	Units 1 & 2 are gas/oil-fired steam electric generating units; Units 3 & 4 are nuclear powered steam electric generating units; and Unit 5 is a natural gas combined-cycle plant.	Power Production	977	Electrical Power
Homestead Air Reserve Base	Homestead Air Reserve Base is a fully combat-ready unit capable of providing F-16C multipurpose fighter aircraft, along with mission ready pilots and support personnel, for short-notice worldwide deployment.	Military Installation	2365	N/A — Military Installation

Source: References 201, 202, and 203

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Table 2.2-202 (Sheet 1 of 4)
Onsite Chemical Storage Units 1 through 7

Material	Toxicity Limit IDLH[(a)]	Maximum Quantity in Largest Container	Primary Storage Location
Units 1 through 5			
Acetylene Gas	Asphyxiant	150 pound cylinders (3,000 pounds total)	Welding Gas House
Ammonium Hydroxide	300 ppm	(2) 20,000 gallon above ground storage tanks	East Side Unit 5 for SCR
Argon Gas	Asphyxiant	150 pound cylinders (3,000 pounds total)	Welding Gas House
Boric Acid	None Established	Fiber drums (66,660 pounds total)	Units 3 & 4 Central Receiving Warehouse/ Boric Acid Room
Carbon Dioxide	40,000 ppm	150 pound cylinders (9,000 pounds total)	Compressed Gas House
Chlorine	10 ppm	150 pound cylinder	Nuclear Sewage Treatment Area
Citric Acid	None Established	500 pounds	Water Treatment Area (Units 1 & 2)
Hydrated Lime (Calcium Hydroxide)	5 mg/m^3[(b)]	35,000 pounds	Fossils Storage Building
Hydrazine	50 ppm	1,100 gallons (2,215 gallons total)	Stores Drum Storage Area (Units 3 & 4)
Hydrogen Gas	Asphyxiant	58,000 standard cubic feet (2 Hydrogen Tube Trailers - 36 tubes total)	Stored in two Hydrogen Tube Trailers (Units 3 & 4)
Hydrogen Peroxide	75 ppm	5 gallon	Primary Chemical Addition Area
Lead (in battery)	100 mg/m^3 (as lead)	174,000 pounds	Units 1 through 5 Battery Rooms/Land Utilization Fleet Service Shop
Lithium Hydroxide	None Established	5 gallons	Primary Chemical Addition Area
Lube Oil	None Established	14,800 gallon storage tank (122,548 gallons total)	Units 3 & 4 Lube Oil Storage Tank/Lube Oil Reservoirs
Magnesium Oxide	750 mg/m^3	20,000 pounds	Fossils Storage Building
Mineral Oil	2,500 mg/m^3	(2) 16,180 gallons (48,997 gallons total)	Unit 1 Main Transformer/Unit 2 Main Transformer
Muriatic Acid (Hydrochloric Acid)	50 ppm	110 gallons	Units 1 & 2 Water Treatment Area
Nitrogen Gas	Asphyxiant	100,000 cubic feet	Gas House/Trailer
Nitrogen– Liquid	Asphyxiant	3,500 gal	Units 3 & 4 N_2 Dewar Tanks
Number 2 Fuel Oil/Diesel Fuel	None Established	4,300,000 gallon above ground storage tank (4,510,632 total)	Unit 5 Southeast Corner

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Table 2.2-202 (Sheet 2 of 4)
Onsite Chemical Storage Units 1 through 7

Material	Toxicity Limit IDLH[(a)]	Maximum Quantity in Largest Container	Primary Storage Location
Number 6 Fuel Oil (Residual Fuel Oil)	None Established	(2) 268,000 barrel (11,256,000 gallon) above ground storage tanks	Fossil Fuel Tank Farm-NE corner of site
Organometallic Magnesium Complex	None Established	134,000 pounds	Units 1 & 2 East Side Chem Feed Area
Oxygen Gas	May displace air and cause an oxygen enriched environment	150 pound cylinders (3,000 pounds total)	Welding Gas House
Propane	2,100 ppm	500 Gallons	Units 1 & 2-NE of Metering Tanks
Silicone	None Established	568 gallons (1,136 gallons total)	Unit 1 Power Potential Transformer/Unit 2 Power Potential Transformer
Sodium Bicarbonate	None Established	50 pound bags (10,000 pounds total)	Unit 1 Boiler Dry Storage Warehouse
Sodium Hydroxide	10 mg/m^3	Fiber drums (1,900 pounds total)	Units 1 & 2 Water Treatment Plant/Units 3 & 4 Central Receiving Warehouse
Sodium Hypochlorite	10 ppm as chlorine	6,000 gallon tank	Unit 5 South of Cooling Tower
Sodium Molybdate	5 mg/m^3 (as Mo)	80 gallons	Unit 3 Condensate Polisher Bldg
Sodium Nitrite	None Established	80 gallons	Unit 3 Condensate Polisher Bldg
Sodium Tetraborate	1 mg/m^{3}[(b)]	22,000 pounds	Units 3 & 4 Dry Stores
Sulfuric Acid	15 mg/m^3	6,000 gallons (12,500 gallons total)	Units 3 & 4 Water Treatment Plant/ Unit 5 South of Cooling Tower
Sulfuric Acid (Station Batteries)	15 mg/m^3	2,913 pounds	Units 1 & 2 Station Battery Rooms
Trisodium Phosphate-Liquid	None Established	300 gallons	Unit 5- North of Steam Turbine
Unleaded Gasoline	300 ppm[(b)]	2,000 gallon split tank (7,000 gallons total)	Vehicle Refueling Area/Land Utilization Vehicular Fuel Tank
Units 6 & 7			
Anionic polymer	None Established	900 gallons	FPL Reclaimed Water Treatment Facility
Ferric Chloride (47% Solution)	1 mg/m^{3}[(c)]	90,250 gallons	FPL Reclaimed Water Treatment Facility
Lime ($Ca(OH)_2$)	5 mg/m^{3}[(c)]	23,000 gallons	FPL Reclaimed Water Treatment Facility

PTN COL 2.2-1

Table 2.2-202 (Sheet 3 of 4) Onsite Chemical Storage Units 1 through 7

Material	Toxicity Limit IDLH[(a)]	Maximum Quantity in Largest Container	Primary Storage Location
Sulfuric Acid (93% Solution)	15 mg/m^3	33,600 gallons	FPL Reclaimed Water Treatment Facility/ Cooling Tower/ Turbine Building[(e)]
Methanol	6,000 ppm	25,000 gallons	FPL Reclaimed Water Treatment Facility
Sodium Hypochlorite (40% Solution)	10 ppm (as chlorine)	20,000 gallons	FPL Reclaimed Water Treatment Facility/ Cooling Tower/ Turbine Building[(e)]
Alum (49% Solution)	None Established	30,000 gallons	FPL Reclaimed Water Treatment Facility
Sodium Bisulfite (40% Solution)	5 mg/m^3[(c)]	15,000 gallons	FPL Reclaimed Water Treatment Facility
Sodium Hydroxide	None Established	15,000 gallons	FPL Reclaimed Water Treatment Facility
Polymer (25% Solution)	None Established	275 gallon tote	FPL Reclaimed Water Treatment Facility
Proprietary Scale Inhibitor[(d)]-Saltwater (Sodium salt of phosphonomethylate diamine)	None Established	10,000 gallons	Cooling Towers
Proprietary Scale Inhibitor[(d)]-Saltwater (Calcium phosphate, zinc, iron, manganese)	None Established	12,200 gallons	Cooling Towers
Proprietary Scale Inhibitor[(d)]-Transition from Saltwater to Reclaimed (Silica based scale inhibitor)	None Established	400 gallon tote	Cooling Towers
Proprietary Scale Inhibitor[(d)]-Reclaimed (High Stress Polymer with PSO)	None Established	12,000 gallons	Cooling Towers
Proprietary Scale Inhibitor[(d)] (17.9% phosphoric acid)	1,000 mg/m^3	800 gallons	Turbine Building
Proprietary Dispersant[(d)] (Calcium phosphate, zinc, iron, manganese)	None Established	800 gallons	Turbine Building
Proprietary Scale Inhibitor[(d)] (30% phosphoric acid)	1,000 mg/m^3	800 gallons	Turbine Building
Sodium Bisulfite (25% solution)	5 mg/m^3[(c)]	80 gallons	Turbine Building

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Table 2.2-202 (Sheet 4 of 4)
Onsite Chemical Storage Units 1 through 7

Material	Toxicity Limit IDLH[a]	Maximum Quantity in Largest Container	Primary Storage Location
Proprietary Reverse Osmosis Cleaning Chemical[d] (EDTA Salt, Percarbonate Salt, Phosphonic Acid, Tetrasodium Salt)	None Established	Fiber Drums	Turbine Building
Proprietary Reverse Osmosis Cleaning Chemical[d] (Hydroxyalkanoic acid, Inorganic phosphate, EDTA Salt)	None Established	Fiber Drums	Turbine Building
Hydrazine (35% solution)[e]	50 ppm	800 gallons	Turbine Building
Carbohydrazide	None Established	800 gallons	Turbine Building
Morpholine[e]	1,400 ppm	800 gallons	Turbine Building
No. 2 Diesel Fuel Oil[e]	None Established	60,000 gallons	Diesel Generator Day Tanks/Diesel Generator Building/Annex Building
Liquid Nitrogen[e]	Asphyxiant	1,500 gallons	Plant Gas Storage Area
Liquid Hydrogen[e]	Asphyxiant	1,500 gallons	Plant Gas Storage Area
Liquid Carbon Dioxide[e]	40,000 ppm	6 tons	Plant Gas Storage Area
Sodium Molybdate[e]	5 mg/m^3 (as Mo-TLV)	45 gallons	Turbine Building
Ethylene Glycol	None Established	45 gallons	Turbine Building

(a) Immediately dangerous to life and health.
(b) Threshold limit value/time-weighted average (TLV-TWA).
(c) Time-weighted average (TWA)
(d) Main constituents of proprietary treatment chemicals are listed.
(e) Standard AP1000 chemical.

Source: References 233, 234, 235, 236, 237, 248, 249, 250, 251, 252, 253, 254, 255, 256, and 257

PTN COL 2.2-1

Table 2.2-203
Offsite Chemical Storage — Homestead Air Reserve Base

Material	Toxicity Limit (IDLH)	Maximum Quantity in Largest Container[(a)] (pounds)
Bromotrifluoromethane (Halon 1301)	40,000 ppm	5,440
Diethylene Glycol Monobutyl Ether	None Established	30,625
Diesel Fuel Oil (High Sulfur)	None Established	158,752
Gasoline	300 ppm[(b)]	137,104
Hydrazine	50 ppm	1,437
Jet Fuel	200 mg/m^3[(b)]	23,251,606
Nitrogen (gas)	Asphyxiant	21,648
Oxygen	May displace air and cause an oxygen enriched environment	36,561
Propane	2,100 ppm	185,865

(a) Actual amount of compound in these cases is the maximum of the reported range on the SARA Title III, Tier II report. This range envelopes an order of magnitude and represents the greatest amount present at the facility during the reporting period.
(b) Threshold limit value/time-weighted average (TLV-TWA).

Source: References 224, 233, 234, and 235

PTN COL 2.2-1

Table 2.2-204
Units 6 & 7 Pipeline Information Summary

Operator	Product	Pipeline Diameter	Pipeline Age	Operating Pressure	Depth of Burial	Distance Between Isolation Valves
Florida Gas Transmission Company-Turkey Point Lateral	Natural Gas Transmission	24 inches	1968	722 psig	3.5 feet	11.8 miles
Florida Gas Transmission Company-Homestead Lateral	Natural Gas Transmission	6.625 inches	1985	722 psig	3.5 feet	NA[a]

(a) Due to the proximity and diameter of the Turkey Point lateral pipeline in comparison to the Homestead lateral pipeline, the Turkey Point lateral pipeline presents a greater hazard, and as such, the Turkey Point lateral pipeline analysis is bounding and no further analysis of the Homestead lateral pipeline is warranted.

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Table 2.2-205
Hazardous Chemical Waterway Freight, Intracoastal Waterway, Miami to Key West, Florida

Material	Toxicity Limit (IDLH)	Total Quantity (short tons)
Residual Fuel Oil	None established	611,000

Source: References 206 and 234

PTN COL 2.2-1

Table 2.2-206
Aircraft Operations — Significant Factors

Airport	Number of Operations	Distance from Site	Significance Factor[(a)]
Turkey Point Heliport	79	0.6 miles	N/A[(b)]
Homestead Air Reserve Base	36,429	4.76 miles	N/A[(b)]
Ocean Reef Club Airport[(c)]	Sporadic	7.41 miles	27,454
Miami International Airport[(c)]	386,681 (2005 operations) 545,558 (2025 projected)	25.5 miles	651,832

(a) $500d^2$ movements per year for sites within 5 to 10 miles and $1000d^2$ movements per year for sites outside 10 miles.
(b) Consistent with RG 1.206, airports with a plant-to-airport distance less than 5 miles from the site is considered regardless of the projected annual operations.
(c) Because the projected number of operations is less than the calculated significance factor, an evaluation for this airport was not conducted.

Source: References 208, 209, 210, and 241

PTN COL 2.2-1

Table 2.2-207 (Sheet 1 of 3)
Units 1-5 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Acetylene Gas	Asphyxiant	2.5–100 percent	Vapor may explode	51.370 psi at –76˚F	Toxicity Analysis—consider as asphyxiant
					Flammability Analysis
					Explosion Analysis
Ammonium Hydroxide	300 ppm (as ammonia)	15–28%	None listed	854,548 Pa at 293.15˚K	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Argon Gas	Asphyxiant	Not flammable	None listed	1,044.630 Pa @117.32˚K	Toxicity Analysis—consider as asphyxiant
Boric Acid	None Established	Not flammable	None listed	N/A-solid	No further analysis required
Carbon Dioxide	40,000 ppm	Not flammable	None listed	907.299 psi @ 75˚F	Toxicity Analysis and consider as asphyxiant
Chlorine	10 ppm	Not flammable	None listed	74.040 psi @ 50˚F	Toxicity Analysis
Citric Acid	None Established	0.28 kg/m^3 (dust)–2.29 kg/m^3 (dust)	None listed	N/A-solid	No further analysis required-low vapor pressure[(a)]
Hydrated Lime (Calcium Hydroxide)	5 mg/m^3[(b)]	Not flammable	Noncombustible Solid in solution	Solid—in a solution	No further analysis required[(c)]
Hydrazine	50 ppm	4.7–100 percent	Vapor may explode	14.4 mm Hg @ 77˚F	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Hydrogen Gas	Asphyxiant	4.0–75 percent	Vapor may explode	1.231 psi @ –434˚F	Toxicity Analysis—consider as asphyxiant
					Flammability Analysis
					Explosion Analysis
Hydrogen Peroxide	75 ppm	Not flammable	None listed	0.200 psi @ 90˚F	Toxicity—screened from further analysis using criteria in RG 1.78—low volume
Lead (In battery)	100 mg/m^3 (as lead)	Not flammable	None listed	N/A-solid	No further analysis required

PTN COL 2.2-1

Table 2.2-207 (Sheet 2 of 3)
Units 1-5 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Lithium Hydroxide	None Established	Not flammable	None listed	N/A-Solid in solution	No further analysis required
Lube Oil	None Established	Combustible-No flammable limits listed	None listed	0.100 psi @ 100˚F	No further analysis required—low vapor pressure[(a)]
Magnesium Oxide	750 mg/m^3	Not flammable	None listed	N/A-solid	No further analysis required—low vapor pressure[(a)]
Mineral Oil	2,500 mg/m^3	Combustible-No flammable limits listed	None listed	<0.5mm Hg @ 68˚F	No further analysis required—low vapor pressure[(a)]
Muriatic Acid (Hydrochloric Acid)	50 ppm	Not flammable	None listed	5.975 psi@ 90˚F	Toxicity Analysis
Nitrogen Gas	Asphyxiant	Not flammable	None listed	1.931 psi @ –344˚F	Toxicity Analysis—consider as asphyxiant
Nitrogen- Liquid	Asphyxiant	Negligible	None listed	1.931 psi @ –344˚F	Toxicity Analysis—consider as asphyxiant
Number 2 Fuel Oil/Diesel Fuel	None Established	1.3–6.0 percent	None listed	0.100 psi @ 100˚F	No further analysis required—low vapor pressure[(a)]
Number 6 Fuel Oil (Residual Fuel Oil)	None Established	1–5 percent	None listed	0.100 psi @ 100˚F	No further analysis required—low vapor pressure[(a)]
Organometallic Magnesium Complex	None Established	Not flammable	None listed	N/A-solid	No further analysis required
Oxygen	May displace air and cause an oxygen-enriched environment	Not flammable	None listed	363, 385 Pa at 104.47˚K	Toxicity Analysis—consider for oxygen-enriched environment
Propane	2,100 ppm	2.1–9.5 percent	Vapor may explode	837,489 Pa at 293.15˚K	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis/BLEVE
Silicone	None Established	Not flammable	None listed	Not available	No further analysis required
Sodium Bicarbonate	None Established	Not flammable	None listed	N/A-solid	No further analysis required
Sodium Hydroxide	No established IDLH for solution	Not flammable	Noncombustible Solid in solution	Solid—in solution	No further analysis required—low vapor pressure[(d)]

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Table 2.2-207 (Sheet 3 of 3)
Units 1-5 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Sodium Hypochlorite	10 ppm as chlorine	Not flammable	None listed	31.1 mmHg @ 89.6˚F (12.5% weight percent)	Toxicity Analysis[(e)]
Sodium Molybdate	5 mg/m^3 (as Mo)[(b)]	Not flammable	None listed	N/A-solid	No further analysis required[(f)]
Sodium Nitrite	None Established	Not flammable	None listed	1.818 psi @ 100˚F	No further analysis required
Sodium Tetraborate	1 mg/m^3[(b)]	Not flammable	None listed	N/A-solid	No further analysis required[(a)]
Sulfuric Acid	15 mg/m^3	Not flammable	None listed	0.001 mmHg @ 68˚F	No further analysis required—low vapor pressure[(a)]
Sulfuric Acid (Station Batteries)	15 mg/m^3	Not flammable	None listed	0.001 mmHg @ 68˚F	No further analysis required—low vapor pressure[(a)]
Trisodium Phosphate-Liquid	None Established	Not flammable	None listed	Not available	No further analysis required
Unleaded Gasoline[(g)]	300 ppm[(b)]	1.4–7.4 percent	Vapor may explode	4,703.3 Pa @ 293.15˚K	No further analysis required[(g)]

(a) Solids and chemicals with vapor pressures this low are not very volatile. That is, under normal conditions, chemicals cannot enter the atmosphere fast enough to reach concentrations hazardous to people and, therefore, are not considered to be an air dispersion hazard.

(b) Threshold limit value/ time-weighted average (TLV-TWA).

(c) Lime (calcium hydroxide) is listed as a noncombustible solid and with a very low—approximate vapor pressure of 0 mmHg. The toxicity data provided by NIOSH provides the following basis for the standard established by OSHA for general industry: "8 hour time-weighted average 15 mg/m^3, total dust" and "5 mg/m^3, respirable fraction." Thus, this toxicity limit was established for the exposure to the solid form. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a l kely route of exposure.

(d) Sodium hydroxide in its pure form is a noncombustible solid and therefore has a very low vapor pressure. The IDLH documentation provided by NIOSH provides the following description of the substance—"colorless to white, odorless solid (flakes, beads, granular form)" and provides the following basis for establishing the 10 mg/m^3 IDLH limit for the solid form—"the revised IDLH for sodium hydroxide is 10-mg/m^3 based on acute inhalation toxicity data for workers [Ott et al. 1977]" where the reference for Ott et. al gives the following description "Mortality among employees chronically exposed to caustic dust". Thus, this toxicity limit was established for the exposure to the solid form is not applicable to the solution. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.

(e) Sodium hypochlorite does not have a determined IDLH value listed in NIOSH; however, MSDS have listed a toxicity limit for sodium hypochlorite as 10 ppm—as chlorine. Speculation exists on the exact chlorine species that are present in the vapor. The vapor pressures of sodium hypochlorite solutions are less than the vapor pressure of water at the same temperature. However, because of the potential for sodium hypochlorite to decompose and release chlorine gas upon heating, sodium hypochlorite was conservatively evaluated for toxicity.

(f) Sodium molybdate is a noncombustible solid and therefore has a very low vapor pressure. There is no IDLH or other toxicity limits for sodium molybdate. There are, however, IDLH, PEL and TLVs for Molybdenum. These exposure limits are based upon dusts, inhalable and respirable fractions. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.

(g) Onsite Gasoline is bounded by Onsite Transport of Gasoline.

Source: References 217, 233, 234, 235, 236, 237, and 238

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Table 2.2-208 (Sheet 1 of 4)
Units 6 & 7 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
FPL Reclaimed Water Treatment Facility					
Anionic polymer	None Established	Not Flammable	None Listed	Solution	No further analysis required—skin/eye irritant only.
Ferric Chloride (47% Solution)	1 mg/m^3 [(a)]	Not Flammable	Noncombustible solid	Solid—in a solution	No further analysis required—TWA established for solid salts—not applicable to solution.[(b)]
Lime ($Ca(OH)_2$)	5 mg/m^3 [(a)]	Not Flammable	Noncombustible solid in solution	Solid—in a solution	No further analysis required.[(c)]
Sulfuric Acid (93% Solution)	15 mg/m^3	Not Flammable	None Listed	0.001 mm Hg @ 68°F	No further analysis required.[(d)]
Methanol (Denitrification)	6,000 ppm	6–36 percent	Vapor may explode	96 mmHg @ 68°F	Toxicity Analysis Flammability Analysis Explosion Analysis
Sodium Hypochlorite (40% Solution) Disinfection	10 ppm as Cl_2	Not Flammable	None Listed	31.1 mmHg @ 89.6°F (12.5% Weight Percent)	Toxicity Analysis [(e)]
Alum (49% Solution) (Phosphorus Removal)	None established	Not Flammable	None Listed	Solid—in a solution	No further analysis required.
Sodium Bisulfite (40% Solution) (Dechlorination)	5 mg/m^3 [(a)]	Not Flammable	None Listed	Solid—in a solution	No further analysis required. TWA established for solid—not applicable to solution.[(f)]
Sodium Hydroxide (50% Solution)	10 mg/m^3	Not Flammable	Noncombustible solid in solution	Solid—in a solution	No further analysis required. TWA established for solid—not applicable to solution. [(g)]
Polymer (25% Solution)	None established	Not Flammable	None Listed	Solution	No further analysis required—skin/eye irritant only.
Circulating Water System					
Sodium Hypochlorite—(12 Trade Percent)	10 ppm as Chlorine	Not Flammable	None Listed	31.1 mmHg @ 89.6°F (12.5% Weight Percent)	Toxicity Analysis [(e)]
Sulfuric Acid (93% Solution)—Saltwater	15 mg/m^3	Not Flammable	None Listed	0.001 mm Hg	No further analysis required.[(d)]
Proprietary Scale Inhibitor—Saltwater (Sodium salt of phosphonomethylate diamine)	Does not contain any substance that has an exposure limit	Not Flammable	None Listed	Inhalation not a likely route of exposure	No further analysis required.

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Table 2.2-208 (Sheet 2 of 4)
Units 6 & 7 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Circulating Water System (cont.)					
Proprietary Scale Inhibitor—Saltwater (Calcium phosphate, zinc, iron, manganese)	None Established	Not Flammable	None Listed	Inhalation not a likely route of exposure	No further analysis required.
Proprietary Scale Inhibitor—Transition from Saltwater to Reclaimed (Silica based scale inhibitor)	None Established	Not expected to burn unless all water is boiled away—remaining organics may be ignitable	None Listed	Solution	No further analysis required.
Proprietary Scale Inhibitor—Reclaimed (High Stress Polymer with PSO)	Does not contain any substance that has an exposure limit	Not Flammable	None Listed	16 mmHg @ 100°F	No further analysis required.
Service Water System					
Sulfuric Acid (93% Solution) (pH Addition)	15 mg/m^3	Not Flammable	None Listed	0.001 mm Hg	Table 6.4-201 (AP1000 Standard Chemical)
Proprietary Scale Inh bitor (17.9% Phosphoric Acid)	1,000 mg/m^3	Not Flammable	None Listed	water/phosphoric acid=0.03mmHg	No further analysis required.[h]
Proprietary Dispersant (Calcium phosphate, zinc, iron, manganese)	None Established	Not Flammable	None Listed	Inhalation not a likely route of exposure	No further analysis required.
Sodium Hypochlorite (12 Trade Percent)	10 ppm as Cl_2	Not Flammable	None Listed	31.1 mmHg @ 89.6°F (12.5% Weight Percent)	Table 6.4-201 (AP1000 Standard Chemical)
Demineralized Water System					
Proprietary Scale Inhibitor—(30% Phosphoric Acid)	1,000 mg/m^3	Not Flammable	None Listed	water/phosphoric acid=0.03mmHg	No further analysis required.[h]
Sodium Bisulfite (25% Solution)	5 mg/m^3 [a]	Not Flammable	None Listed	Solid—in a solution	No further analysis required. TWA established for solid—not applicable to solution.[f]
Sulfuric Acid (93% Solution)	15 mg/m^3	Not Flammable	None Listed	0.001 mm Hg	Table 6.4-201 (AP1000 Standard Chemical)
Reverse Osmosis (RO) Cleaning Chemicals					
Proprietary Reverse Osmosis Cleaning Chemical (EDTA Salt, Percarbonate Salt, Phosphonic Acid, Tetrasodium Salt)	None established	Not Flammable	None Listed	Solid—in a solution	No further analysis required.

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Table 2.2-208 (Sheet 3 of 4)
Units 6 & 7 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Reverse Osmosis (RO) Cleaning Chemicals (cont.)					
Proprietary Reverse Osmosis Cleaning Chemical (Hydroxyalkanoic acid, Inorganic phosphate, EDTA Salt)	None established	Not Flammable	None Listed	Solid—in a solution	No further analysis required.
Steam Generator Blowdown System					
Hydrazine-oxygen scavenger (35% solution)	50 ppm	4.7–100 percent	Vapor may explode	14 mmHg @ 77°F	Table 6.4-201 (AP1000 Standard Chemical)
Carbohydrazide—oxygen scavenger (Shut Down)	None established	Not flammable-unless water is boiled away and chemical is heated	None Listed	12 mm Hg @ 20°C	No further analysis required.
Morpholine	1,400 ppm[i]	1.4–11.2 percent	Vapor may explode	6 mmHg @ 68°F	Table 6.4-201 (AP1000 Standard Chemical)
Standby Diesel Fuel Oil System					
No. 2 Diesel Fuel Oil-Diesel Generator Day Tank	None Established	1.3–6.0 percent	None Listed	0.100 psi @ 100°F	Table 6.4-201 (AP1000 Standard Chemical)
No. 2 Diesel Fuel Oil-Ancillary Diesel Generator	None Established	1.3–6.0 percent	None Listed	0.100 psi @ 100°F	Table 6.4-201 (AP1000 Standard Chemical)
No. 2 Diesel Fuel Oil-Diesel Fire Pump Day Tank	None Established	1.3–6.0 percent	None Listed	0.100 psi @ 100°F	Table 6.4-201 (AP1000 Standard Chemical)
Fire Protection System					
No. 2 Diesel Fuel Oil	None Established	1.3–6.0 percent	None Listed	0.100 psi @ 100°F	Table 6.4-201 (AP1000 Standard Chemical)
Plant Gas System					
Nitrogen-Liquid	Asphyxiant	Negligible	None Listed	1.931 psi @ -344°F	Table 6.4-201 (AP1000 Standard Chemical)
Nitrogen Gas	Asphyxiant	Not Flammable	None Listed	1.931 psi @ -344F°	Table 6.4-201 (AP1000 Standard Chemical)
Hydrogen-Liquid	Asphyxiant	4.0-75 percent	Vapor may explode	1.231 psi @ -434°F	Table 6.4-201 (AP1000 Standard Chemical)
Carbon Dioxide-Liquid	40,000 ppm	Not Flammable	None Listed	907.299 psi @ 75°F	Table 6.4-201 (AP1000 Standard Chemical)

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Table 2.2-208 (Sheet 4 of 4)
Units 6 & 7 Onsite Chemical Storage — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Central Chilled Water System					
Sodium Molybdate (Corrosion Inhibitor)	5 mg/m^3 (as Mo) (l)	Not Flammable	None Listed	Solid in a solution	Table 6.4-201 (AP1000 Standard Chemical)
Ethylene Glycol	None Established	3.2–15.3 percent	Vapor may explode	0.003 psi @ 90°F	No further analysis required—low vapor pressure.[n]

(a) Time Weighted Average (TWA)
(b) Ferric chloride in its pure form is a noncombustible solid and therefore has a very low vapor pressure. The IDLH documentation provided by NIOSH provides the following basis for establishing the 1 mg/m^3 TWA limit—"The ACGIH…considers the salts to be irritants to the respiratory tract when inhaled as dusts and mists." Thus, this toxicity limit was established for the exposure to the solid form. Note, there is no IDLH established for this chemical. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.
(c) Lime (calcium hydroxide) is listed as a noncombustible solid and with a very low– approximate vapor pressure of 0 mmHg. The toxicity data provided by NIOSH provides the following basis for the standard established by OSHA for general industry: "8 hour time-weighted average 15 mg/m^3, total dust" and "5 mg/m^3, respirable fraction." Thus, this toxicity limit was established for the exposure to he solid form. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.
(d) Sulfuric acid has a very low vapor pressure and therefore an air dispersion hazard resul ing from the formation of a toxic vapor cloud is not a likely route of exposure.
(e) Sodium hypochlorite does not have a determined IDLH value listed in NIOSH; however, MSDS have listed a toxicity limit for sodium hypochlorite as 10 ppm—as chlorine. Speculation exists on he exact chlorine species that are present in the vapor. The vapor pressures of sodium hypochlorite solutions are less than the vapor pressure of water at the same temperature. However, because of the potential for sodium hypochlorite to decompose and release chlorine gas upon heating, sodium hypochlorite was conservatively evaluated for toxicity.
(f) Sodium bisulfite in its pure form is a noncombustible solid and herefore has a very low vapor pressure. The IDLH documentation provided by NIOSH provides the following basis for establishing the 5 mg/m^3 TWA limit—"the 5-mg/m^3 limit was proposed because it represents a limit below that established for physical irritant particulates, and this limit reflects the irritant properties of sodium bisulfite. And, in the judgement of the ACGIH "inhalation of or contact with the dust would result in high local concentrations [of sodium bisulfite] in contact with high local concentrations of sensitive tissue. Thus, this toxicity limit was established for the exposure to the solid form is not applicable to the solution. Note, there is no IDLH established for this chemical. Therefore, an air dispersion hazard resul ing from the formation of a toxic vapor cloud is not a likely route of exposure.
(g) Sodium hydroxide in its pure form is a noncombustible solid and therefore has a very low vapor pressure. The IDLH documentation provided by NIOSH provides the following descrip ion of the substance—"colorless to white, odorless solid (flakes, beads, granular form)" and provides the following basis for establishing the 10 mg/m^3 IDLH limit for the solid form—"the revised IDLH for sodium hydroxide is 10-mg/m^3 based on acute inhalation toxicity data for workers [Ott et al. 1977]" where the reference for Ott et. al gives the following descrip ion "Mortality among employees chronically exposed to caustic dust". Thus, this toxicity limit was established for the exposure to the solid form is not applicable to the solution. Therefore, an air dispersion hazard resulting from the forma ion of a toxic vapor cloud is not a likely route of exposure.
(h) Phosphoric acid in its pure form is a noncombustible solid and therefore has a very low vapor pressure. The IDLH documentation provided by NIOSH provides the following basis for the original IDLH of 10,000 mg/m^3—according to the Manufacturing Chemists Association, phosphoric acid does not cause any systemic effect and the chance of pulmonary edema from mist or spray inhalation is very remote. And, the basis for the revised IDLH for phosphoric acid, 1,000 mg/m^3, is based on acute oral toxicity data in animals. Therefore, an air dispersion hazard resulting from the formation of a toxic vapor cloud is not a likely route of exposure.
(i) The IDLH documentation provided by NIOSH states that based on health considerations and acute inhalation toxicity data in humans and animals, a value of 2000 ppm would have been appropriate for morpholine. However, the revised IDLH for morpholine is 1400 ppm based strictly on safety considerations (i.e., being 10% of the lower explosive limit of 1.4%)
(j) Not used.
(k) Not used.
(l) Threshold Limit Value (TLV)
(m) Not used.
(n) Ethylene glycol has a low vapor pressure and therefore an air dispersion hazard resulting from the formation of a flammable vapor cloud is not a likely route of exposure.

Source: References 217, 233, 234, 235, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, and 257

PTN COL 2.2-1

Table 2.2-209
Offsite Chemicals, Disposition — Homestead Air Reserve Base

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Bromotrifluoromethane (Halon 1301)	40,000 ppm	Not flammable	None listed	1,436,150 Pa at 293.15˚K	Toxicity Analysis
Diesel Fuel Oil (High Sulfur)	None Established	1.3–6.0 percent	None listed	0.100 @ 100˚F	No further analysis required-low vapor pressure[a]
Diethylene Glycol Monobutyl Ether	None Established	Not flammable	None listed	0.159 @ 220˚F	No further analysis required
Gasoline	300 ppm[b]	1.4–7.4 percent	Vapor may explode	4,703.3 Pa @ 293.15˚K	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis
Hydrazine[c]	50 ppm	4.7–100 percent	Vapor may explode	14.4 mm Hg @ 77˚F	No further analysis required[c]
Jet Fuel	200 mg/m^3[b]	0.6–4.9 percent	Vapor may explode	0.1 psi @ 100˚F	Explosion Analysis—no flammability/toxicity analysis required low vapor pressure[a]
Nitrogen Gas[c]	Asphyxiant	Not flammable	None listed	1.93 psi @ –344˚F	No further analysis required[c]
Oxygen	May displace air and cause an oxygen enriched environment	Not flammable	None listed	363,385 Pa at 104.47˚K	Toxicity Analysis-consider for oxygen enriched environment
Propane	2,100 ppm	2.1–9.5 percent	Vapor may explode	837,489 Pa at 293.15˚K	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis

(a) Solids and chemicals with vapor pressures this low are not very volatile. That is, under normal conditions, chemicals cannot enter the atmosphere fast enough to reach concentrations hazardous to people and, therefore, are not considered to be an air dispersion hazard.
(b) Threshold limit value/ time-weighted average (TLV-TWA).
(c) Homestead Air Reserve Base storage of hydrazine and nitrogen is bounded by Turkey Point onsite storage of hydrazine and nitrogen.
Source: References 217, 233, 234, and 235

PTN COL 2.2-1

Table 2.2-210
Transportation — Navigable Waterway, Turkey Point Lateral Pipeline, and Onsite Transportation Route — Disposition

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard	Vapor Pressure	Disposition
Navigable Waterway					
Residual Fuel Oil	None established	1–5 percent	None listed	0.100 psi @ 100°F	No further analysis required—hazard analysis bounded by residual fuel storage at Units 1–5 [(a) (c)]
Turkey Point Lateral Pipeline					
Natural Gas (methane)	Asphyxiant	5–15 percent	Vapor may explode	258,574.0 mm Hg @ 100°F	Toxicity Analysis-consider as asphyxiant
					Flammability Analysis
					Explosion Analysis
Onsite Transportation Route					
Unleaded Gasoline	300 ppm[(b)]	1.4–7.4 percent	Vapor may explode	4,703.3 Pa @ 293.15°K	Toxicity Analysis
					Flammability Analysis
					Explosion Analysis

(a) Solids and chemicals with vapor pressures this low are not very volatile. That is, under normal conditions, chemicals cannot enter the atmosphere fast enough to reach concentrations hazardous to people and, therefore, are not considered to be an air dispersion hazard.
(b) Threshold limit value/ time-weighted average (TLV-TWA).
(c) As described in Subsection 2.2.2.4, because of the storage of residual fuel oil at the Turkey Point site, (2) 268,000 barrel tanks exceeds the quantity transported by a barge, the analysis of residual fuel oil located in the storage tanks is bounding and, therefore, no further analysis is required.
Source: References 217, 233, 234, and 235

PTN COL 2.2-1

Table 2.2-211
Atmospheric Input data for the ALOHA Model

Menu	Parameter	Input	Basis
Site Atmospheric Data			
Site Data	Number of Air Exchanges	1.0 air exchanges per hour	Outdoor air exchange rate for control room.
Site Data	Date and Time	June 21, 2007/ June 20, 2008 See Table 2.2-212 for Times	June 21, 2007/June 20, 2008 at 12 noon was chosen because temperatures are highest in the summer during midday. Higher temperatures lead to a higher evaporation rate and thus a larger vapor cloud. The position of the sun for the date and time is used in determining the solar radiation, thus the summer solstice date will provide the most conservative assumption for solar radiation. June 21, 2007/June 20, 2008 at 5 am was chosen for those Pasquill classes defined as “nighttime.”
Setup/Atmospheric	Wind Measurement Height	10 meters	ALOHA calculates a wind profile based on where the meteorological data is taken. ALOHA assumes that the meteorological station is at 10 meters. The National Weather Service usually reports wind speeds from a height of 10 meters. Wind rose data for this project was also taken at a height of 10 meters. Additionally, the surface wind speeds for determining the Pasquill Stability Class are defined at 10m.
Setup/Atmospheric	Air Temperature	90.4ºF	Air temperature influences ALOHA’s estimate of the evaporation rate from a puddle surface (the higher the air temperature, the more the puddle is warmed by the air above it, the higher the liquid’s vapor pressure is, and the faster the substance evaporates).
Setup/Atmospheric	Inversion Height	None	An inversion is an atmospheric condition that serves to trap the gas below the inversion height thereby not allowing it to disperse normally. Inversion height has no effect on the heavy gas model. And, most inversions are at heights much greater than ground level.
Setup/Atmospheric	Humidity	50%	ALOHA uses the relative humidity values to estimate the atmospheric transmissivity value; estimate the rate of evaporation from a puddle; and make heavy gas dispersion computations. Atmospheric transmissivity is a measure of how much thermal radiation from a fire is absorbed and scattered by the water vapor and other atmospheric components.

Source: References 217 and 240

PTN COL 2.2-1

Table 2.2-212
ALOHA Meteorological Sensitivity Analysis Inputs

Stability Class	Surface Wind Speed (m/s)	Cloud Cover	Date/Time
A	1.5	0%	June 21, 2007/12 noon or June 20, 2008/12 noon
B	1.5	50%	June 21, 2007/12 noon or June 20, 2008/12 noon
B	2	0%	June 21, 2007/12 noon or June 20, 2008/12 noon
C	3	70%	June 21, 2007/12 noon or June 20, 2008/12 noon
E	2	50%	June 21, 2007/5 am or June 20, 2008/5 am
F	1	0%	June 21, 2007/5 am or June 20, 2008/5 am
F	2	0%	June 21, 2007/5 am or June 20, 2008/5 am
F	3 (only modeled for vapor clouds taking greater than 1 hour to reach the control room)	0%	June 21, 2007/5 am or June 20, 2008/5 am
C	3	50%	June 21, 2007/12 noon or June 20, 2008/12 noon
D	3	50%	June 21, 2007/5 am or June 20, 2008/5 am
C	5.5	0%	June 21, 2007/12 noon or June 20, 2008/12 noon
D	5.5	50%	June 21, 2007/12 noon or June 20, 2008/12 noon

Source: References 217 and 239

PTN COL 2.2-1

Table 2.2-213
Design Basis Events — Explosions

Source	Chemical Evaluated	Quantity	Heat of Combustion	Distance to Nearest Safety-Related Structure	Safe Distance for Explosion to have less than 1 psi of Peak Incident Pressure	Thermal Radiation Heat Flux Resulting from a BLEVE
Road: Onsite Transport	Gasoline	50,000 pounds	18,720 Btu/lb	2,054 feet	266 feet	N/A
Pipeline: Turkey Point Lateral	Natural Gas	30,302 pounds[(a)]	21,517 Btu/lb	4,535 feet	3,097 feet	N/A
Onsite (Includes Units 1 through 5)	Acetylene	3,000 pounds	20,747 Btu/lb	4,300 feet	1,416 feet	N/A
	Ammonium Hydroxide	40,000 gallons	7,992 Btu/lb	5,079 feet	296 feet	N/A
	Hydrazine	1,100 gallons	8,345 Btu/lb	2,727 feet	170 feet	N/A
	Hydrogen	1,615 standard cubic feet[(b)]	50,080 Btu/lb	3,966 feet	269 feet	N/A
	Propane	500 gallons	19,782 Btu/lb	4,168 feet	1,299 feet	0.0878 kW/m^2
Site-specific Onsite (Includes Units 6 & 7)	Methanol	25,000 gallons	8,419 Btu/lb	5,387 feet	344 feet	N/A
Offsite (Homestead Air Reserve Base)	Gasoline	137,104 pounds	18,720 Btu/lb	25,133 feet	372 feet	N/A
	Jet Fuel	23,251,606 pounds	18,540 Btu/lb		2,232 feet	N/A
	Propane	185,865 pounds	19,782 Btu/lb		5,513 feet	N/A

(a) Quantity of natural gas released over 5 seconds after a postulated pipeline rupture.

(b) The simultaneous detonation of all the tubes contained in a 58,000 scf trailer stored at Units 1–5 is not a plausible scenario; therefore, an explosion involving the largest single tube, 1615 scf, was evaluated.

PTN COL 2.2-1

Table 2.2-214
Design-Basis Events, Flammable Vapor Clouds (Delayed Ignition) and Vapor Cloud Explosions

Source	Chemical Evaluated & Quantity	Distance to Nearest Safety-Related Structure	Distance to LFL	Safe Distance for Vapor Cloud Explosions	Thermal Radiation Heat Flux at Nearest Safety-Related Structure
Road: Onsite Transport	Gasoline (50,000 pounds)	2,054 feet	402 feet[e]	1,014 feet[e]	3.187 kW/m^2
Pipeline: Turkey Point Lateral	Natural Gas	4,535 feet	750 feet[a]	3,033 feet[a]	0.261 kW/m^2[b]
Onsite (Includes Units 1 through 5)	Acetylene (3,000 pounds)	4,300 feet	1,308 feet[e]	1,764 feet[e]	0.207kW/m^2
	Ammonium Hydroxide (40,000 gal)	5,079 feet	354 feet[c][a][g]	963 feet [c][a][g]	0.850 kW/m^2
	Hydrazine (1,100 gal)	2,727 feet	42 feet[a]	No Detonation[d]	0.271 kW/m^2
	Hydrogen (58,000 scf)	3,966 feet	1,179 feet[e]	1,347 feet[e]	0.054 kW/m^2
	Propane (500 gal)	4,168 feet	738 feet[f]	1,416 feet[a]	0.092 kW/m^2
Site-specific Onsite (Includes Units 6 & 7)					
	Methanol (25,000 gal)	5.387 feet	333 feet[e]	804 feet[e]	0.669 kW/m^2
Offsite (Homestead Air Force Base)	Gasoline (137,104 lb)	25,133 feet	678 feet[e]	1,623 feet[e]	0.053 kW/m^2
	Propane (185,865 lb)		2,190 feet[a]	4,866 feet[e]	0.078 kW/m^2

(a) Worst-case scenario meteorological condition was F stability class at two meters per second
(b) Thermal radiation heat flux resulting from a jet fire at the pipeline break.
(c) Urban or Forest ground roughness selected
(d) “No detonation” is listed when ALOHA reports hat there is no detonation of the formed vapor cloud-that is no part of the cloud is above the LEL at any time.
(e) Worst-case scenario meteorological condition was F stability class at one meters per second
(f) Worst-case scenario meteorological condition was F stability class at one meters per second at 78°F
(g) 40,000 gallons of ammonium hydroxide were released within an area of 44,415 ft^2. This is conservative because the analyzed puddle expands greater than the dike area surrounding the ammonium hydroxide tanks. The analyzed puddle expands to nearby drains.

PTN COL 2.2-1

Table 2.2-215 (Sheet 1 of 2)
Design-Basis Events, Toxic Vapor Clouds

Source	Chemical	Quantity	IDLH[(a)]	Distance to Nearest Control Room (feet)	Distance to IDLH (feet)[(l)]	Maximum Control Room Concentration (ppm)[(k)]
Road: Onsite Transport	Gasoline	50,000 pounds	300 ppm[(b)]	2,084	1,962[(d)]	—
Pipeline: Turkey Point Lateral	Natural Gas	2,036,620 pounds	Asphyxiant	4,535	426[(d)]	—
Onsite (Includes Units 1 through 5)	Acetylene	3,000 pounds	Asphyxiant	4,331	531[(g)(l)]	—
	Ammonium Hydroxide[(c)]	40,000 gallons	300 ppm	5,110	4,368[(d)]	—
	Argon	3,000 pounds	Asphyxiant	4,001	144[(g)(j)]	—
	Carbon Dioxide	9,000 pounds	40,000 ppm	4,001	963[(g)]	—
	Chlorine	150 pounds	10 ppm	2,994	3,471[(g)]	2.18
	Hydrazine	1,100 gallons	50 ppm	2,758	2,178[(d)]	—
	Hydrogen	58,000 scf	Asphyxiant	4,001	612[(g)(j)]	—
	Muriatic Acid	110 gallons	50 ppm	4,429	1,983[(g)]	—
	Nitrogen Gas	100,000 scf	Asphyxiant	3,596	813[(g)(j)]	—
	Nitrogen Liquid	3,500 gallons	Asphyxiant	3,596	1,206[(d)(j)]	—
	Oxygen	3,000 pounds	May displace air and cause an oxygen enriched environment	4,329	147[(g)(j)]	—
	Propane	500 gallons	2100 ppm	4,198	1,878[(g)]	—
	Sodium Hypochlorite	6,000 gallons	10 ppm as Chlorine	5,232	1,752 [(c)(d)]	—

PTN COL 2.2-1

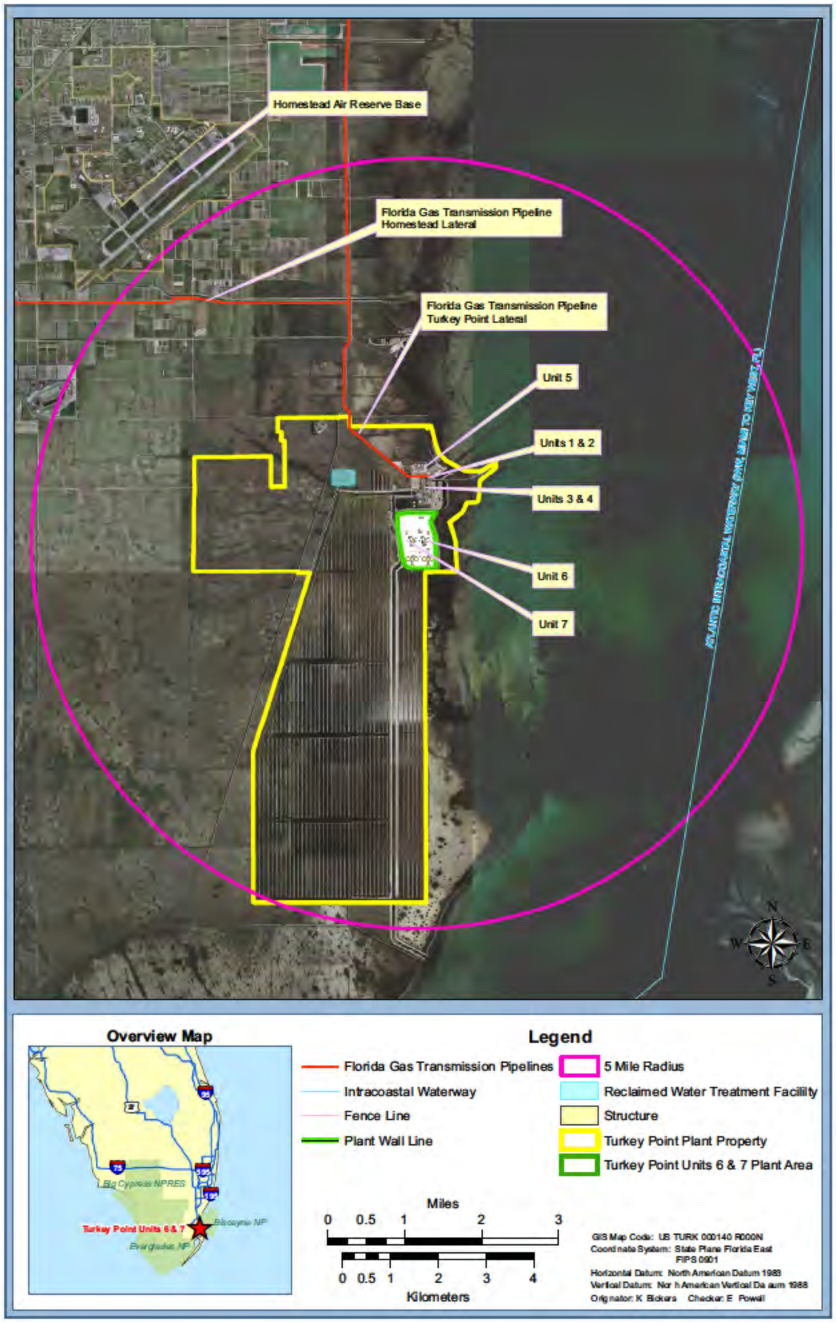
Table 2.2-215 (Sheet 2 of 2)
Design-Basis Events, Toxic Vapor Clouds

Source	Chemical	Quantity	IDLH[(a)]	Distance to Nearest Control Room (feet)	Distance to IDLH (feet)[(l)]	Maximum Control Room Concentration (ppm)[(k)]
Site-specific Onsite (Includes Units 6 & 7)						
	Methanol	25,000 gallons	6,000 ppm	5,470	1,131[(d)]	—
	Sodium Hypochlorite (Reclaimed Water Treatment Facility)	20,000 gallons	10 ppm as Chlorine	5,470	6,864	3.62[(d)]
	Sodium Hypochlorite (Cooling Tower)	12,000 gallons	10 ppm as Chlorine	807	2,622	6.90[(d)]
Offsite (Homestead Air Reserve Base)	Halon 1301	5,440 pounds	40,000 ppm	25,133	99[(e)]	—
	Gasoline	137,104 pounds	300 ppm[(b)]		2,199[(f)]	—
	Oxygen	36,561 pounds	May displace air and cause an oxygen enriched environment		309[(e)(j)]	—
	Propane	185,865 pounds	2,100 ppm		6,864[(e)]	—

(a) Immediately Dangerous to Life or Health (IDLH)
(b) Threshold Limit Value/ Time-Weighted Average (TLV-TWA)
(c) Calculation was modeled selecting the Urban or Forest for Ground Roughness
(d) Worst-case scenario meteorological condition was F stability class at two meters per second
(e) Worst-case scenario meteorological condition was F stability class at three meters per second
(f) Worst-case scenario meteorological condition was D stability class at 5.5 meters per second
(g) Worst-case scenario meteorological condi ion was F stability class at one meters per second
(h) Not used.
(i) 40,000 gallons of ammonium hydroxide were released within an area of 2,590 ft^2 (he area of the storage dike) for worst-case meteorological conditions.
(j) Distance to the asphyxiating limit. Note that, for oxygen, the asphyxia ing limit is bounding for the oxygen-enriched limits.
(k) The control room concentration is calculated only for chemicals whose distance to their IDLH limit, asphyxiating limit, or oxygen-enriched limit is greater than the distance to the control room intake.
(l) The distance to IDLH provided for each chemical corresponds to the worst-case control room concentrations.

PTN COL 2.2-1

Figure 2.2-201 Site Vicinity Map



PTN COL 2.2-1

Figure 2.2-202 Airport and Airway Map

SECTION 2.3: METEOROLOGY
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SECTION 2.3 LIST OF FIGURES (CONT.)

2.3 METEOROLOGY

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

PTN SUP 2.3-1 The meteorological parameters associated within the approximately 50 mile region surrounding the Units 6 & 7 site and the site itself, as described within this section, are bounded by the site parameters specified in Table 2-1 of the DCD and as compared in Section 2.0 of this FSAR, except as noted.

2.3.1 REGIONAL CLIMATOLOGY

PTN COL 2.3-1 This subsection describes the climate within the approximately 50 mile radius region surrounding the Units 6 & 7 site. Also included in this subsection is a summary of the regional meteorological conditions that provide a basis for the design and operating conditions of Units 6 & 7. A climatological summary of normal and extreme values of relevant meteorological parameters is presented for the first-order National Weather Service (NWS) station (a first order station measures a wide number of meteorological parameters, operates 24 hours-a-day and is maintained by a NWS trained and certified staff) or Automated Surface Observing System stations. Figure 2.3.1-201 shows the locations of these meteorological observation stations with respect to the Units 6 & 7 site.

Subsection 2.3.1.1 identifies data sources used to develop these descriptions. Subsection 2.3.1.2 describes large-scale general climatic features and their relationship to conditions in the region.

Severe weather phenomena considered in the design and operating bases for Units 6 & 7 are described in Subsection 2.3.1.3 and include:

- Subsection 2.3.1.3.1 — Observed and probabilistic extreme wind conditions
- Subsection 2.3.1.3.2 — Tornadoes and related wind and pressure characteristics
- Subsection 2.3.1.3.3 — Tropical cyclones and related effects

- Subsection 2.3.1.3.4 — Observed and probabilistic precipitation extremes
- Subsection 2.3.1.3.5 — Frequency and magnitude of hail, snowstorms, and ice storms
- Subsection 2.3.1.3.6 — Frequency of thunderstorms and lightning
- Subsection 2.3.1.3.7 — Droughts and dust storms

Subsection 2.3.1.4 explains that the ultimate heat sink incorporated in the AP1000 design does not require long-term temperature and atmospheric water vapor characteristics to evaluate that system's performance. Subsection 2.3.1.5 provides design basis dry bulb and wet bulb temperature statistics considered in the design and operating bases of other safety- and nonsafety-related structures, systems, and components.

Subsection 2.3.1.6 characterizes climatological conditions in the region that may affect atmospheric dispersion. Finally, Subsection 2.3.1.7 describes climate changes in the context of the site's design bases (60-year warranted design life of the AP1000) and expected 40-year operating license period by evaluating the record of observations of temperature and rainfall (normals, means, and extremes) as they have varied over the last 70–80 years, and the occurrence of severe weather events in the region.

Climate-related site parameters on which the AP1000 design is based (i.e., wind speed, tornadoes, precipitation, and air temperatures) are identified in DCD Tier 1, Table 5.1-1 and DCD Tier 2, Table 2-1. Site-specific characteristics that correspond to these site parameters are addressed in Subsections 2.3.1.3.1 and 2.3.1.3.3 (for wind speed), 2.3.1.3.3 (for tornadoes), 2.3.1.3.4 (for precipitation), and 2.3.1.3.5 (for air temperatures). Table 2.0-201 compares the applicable site parameters and corresponding site-specific characteristic values.

2.3.1.1 Data Sources

Several sources of data are used to characterize regional climatological conditions pertinent to the Turkey Point site. This includes data acquired by the NWS at its Miami International Airport, Florida first-order station and from 16 other nearby locations in its network of cooperative observer stations, as compiled and summarized by the National Climatic Data Center (NCDC).

These climatological observing stations are located in Broward, Collier, Miami-Dade, and Monroe Counties, Florida. Table 2.3.1-201 identifies the specific

stations and lists their approximate distance and direction from the midpoint between the Units 6 & 7 containment buildings at the site. Figure 2.3.1-201 illustrates these station locations relative to the site for Units 6 & 7. Onsite data sources are not used in describing regional climatology. The primary objective of an onsite meteorological monitoring program is to provide meteorological data representative of the project site that will be suitable for use in dispersion modeling assessments of routine as well as hypothetical radiological releases from the facility. In this regard, onsite data sources are used to prepare monthly and annual average joint frequency distributions of wind speed and wind direction by Pasquill stability category.

The objective of selecting nearby, offsite climatological monitoring stations is to demonstrate that the mean and extreme values measured at those locations are reasonably representative of conditions that might be expected to be observed at the Turkey Point site. The 50-mile radius circle shown in Figure 2.3.1-201 provides a relative indication of the distance between the climate observing stations and the Turkey Point site.

The identification of stations to be included was based on the following general considerations:

- Proximity to the site (i.e., within the nominal 50-mile radius indicated above, to the extent practicable).
- Coverage in all directions surrounding the site (to the extent possible).
- Where more than one station exists for a given direction relative to the site, a station was included if it contributed one or more extreme conditions (e.g., rainfall, snowfall, maximum or minimum temperatures) for that general direction or added context for variation of conditions over the site.

Nevertheless, if an overall extreme precipitation or temperature condition was identified for a station located within a reasonable distance beyond the nominal 50 miles and that event was considered to be reasonably representative for the site, such stations were also included, regardless of directional coverage.

Normals (i.e., 30-year averages), means (mean values of meteorological elements that are computed for a myriad of reasons by organizations and individuals), and extremes of temperature, rainfall, and snowfall are based on the following references:

- *2008 Local Climatological Data, Annual Summary with Comparative Data, Miami, Florida* (Reference 201).
- *Climatography of the United States, N. 20, 1971–2000, Monthly Station Climate Summaries* (Reference 202).
- *Climatography of the United States, No. 81, 1971–2000, U.S. Monthly Climate Normals* (Reference 203).
- *Utah Climate Center, Utah State University, Climate Data Base for Florida* (Reference 204).
- *Period of Record General and Monthly Climate Summaries for Cooperative Reporting Stations in the southeastern United States*, Southeast Regional Climate Center (References 205 and 206).

First-order NWS stations also record measurements, typically every hour, of other weather elements, including winds, several indicators of atmospheric moisture content (i.e., relative humidity, dew point, and wet bulb temperatures), and barometric pressure, as well as other conditions when they occur (e.g., fog, thunderstorms). Occasionally the NWS data may be missing or contain human, instrumentation or computer errors; the NCDC compiles, filters and quality-controls NWS observations, making the data “Official.” Table 2.3.1-202 presents the long-term characteristics of these parameters, excerpted from the NCDC 2008 local climatological data (LCD) summary for the Miami, Florida, NWS station.

Additional data sources were also used in describing the climatological characteristics of the region, including:

- 2005 ASHRAE Handbook, Chapter 28, Climatic Design Conditions (Reference 207).
- Minimum Design Loads for Buildings and Other Structures (Reference 208).
- Historical Hurricane Tracks Storm Query, 1851 through 2007 (Reference 209).
- The Climate Atlas of the United States (Reference 210).
- Climate of Florida, No. 60 (Reference 211).

- Storm Events for Florida, Hail, Snow and Ice, Drought, Tornado, Hurricane and Tropical Storm, and Dust Storm Event Summaries (References 212, 213, and 214).
- Air Stagnation Climatology for the United States (1948-1998) (Reference 215).
- Ventilation Climate Information System (Reference 216).
- Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates, United States East of the 105th Meridian, Hydrometeorological Report No. 53, June 1980 (Reference 217).
- Climatography of the United States, No. 85, Divisional Normals and Standard Deviations of Temperature, Precipitation, and Heating and Cooling Degree Days 1971-2000 (and previous normal periods) (Reference 218).

2.3.1.2 General Climate

Units 6 & 7 are on the lower east coast of Florida within the Atlantic Coastal Ridge which is a flat stretch of land that borders the Atlantic Ocean, including the Gulf of Mexico (see Figure 2.3.1-201). The location of Units 6 & 7 is relatively flat with an elevation of approximately 25.5 feet NAVD 88. Elevations within 50 miles of the site range from 2.49 feet below MSL to the north-northeast to 86.12 feet above MSL to the north. Biscayne Bay is located directly east of the site of Units 6 & 7.

The state of Florida is divided into seven climate divisions. A climate division represents a region within a state that is as climatically homogeneous as possible. Division boundaries generally coincide with county boundaries. The Turkey Point site is located within Climate Division 6 (lower east coast), which includes a majority of Miami-Dade, Broward, Palm Beach, and Martin counties. (Reference 219)

The general climate in this division is classified as subtropical maritime (or humid subtropical) and is characterized by long and warm summers, with abundant rainfall, followed by mild, dry winters (Reference 201). The chief factors that govern the climate are latitude, land and water distribution, prevailing winds, storms, pressure systems, and ocean currents. The wet season, which is hot and humid, lasts from May to October. The wet season gives way to the dry season, which features mild temperatures with some invasions of colder air, which is when the little winter rainfall occurs with the passing of a cold front. (Reference 211)

The Azores-Bermuda high-pressure system exerts a powerful influence on the weather during the winter months. Within high-pressure systems air subsides, and as a consequence, precipitation is suppressed. The Azores-Bermuda high remains over the Sahara Desert throughout the year, but extends over Florida during the winter. As the water around the peninsula warms in the spring, the high-pressure system over Florida weakens and the summer rains begin. In some years, the influence of the Azores-Bermuda high-pressure system is greater than others, so even in the Units 6 & 7 area, rain may fall in the winter. (Reference 211) Because of the clockwise circulation around the western extent of the Azores-Bermuda high-pressure system and the nearness of the Atlantic Ocean, maritime tropical air mass characteristics prevail much of the year. Together, these factors govern late spring, summer, and early fall temperature and precipitation patterns. The climate of southern Florida does not favor the conditions that cause air stagnation.

The marine influence of the Atlantic Ocean is evident by the low daily range of temperature and the rapid warming of cold air masses that pass to the east of the state. The regional area is subject to winds from the east and southeast about half of the time, and in several specific respects has a climate whose features differ from farther inland. One of the features is the annual precipitation for the area. During the early morning hours, more rainfall occurs along the beach areas than at Miami International Airport, while during the afternoon, the reverse situation is true. The Miami International Airport is located approximately 9 miles inland (Reference 201)**.** Monthly precipitation exhibits a cyclical pattern, with the predominant maximum occurring in the summer months and the minimum occurring during the winter months (see Table 2.3.1-202).

An even more striking difference appears in the annual number of days with temperatures reaching 90 degrees or higher, with inland stations having four times more annual days than the beach areas. Minimum temperature contrasts are also particularly marked under proper conditions, with the difference between inland locations and the beach areas frequently reaching to 15 degrees or more, especially in the winter. Freezing temperatures occur occasionally in the inland suburban areas and farming districts, but rarely near the ocean (Reference 201).

The region is subject to sea/land breeze circulations, local winds that are driven by the differential heating of the air over the ocean and over the land surface. Sea breezes are stronger than land breezes because the difference in temperature and air density between the land and the sea is greater during the day than at night. In south Florida the existence and intensity of the sea breeze depends strongly on seasonal and latitudinal factors as well as on the time of day. Sea/land

breeze circulations influence local temperature, humidity, wind speed and wind direction and precipitation. The most notable sea breeze impacts are a shift in wind to the onshore direction, an increase in wind speed, a decrease in temperature and an increase in humidity.

The El Niño-Southern Oscillation is a physical phenomenon that occurs in the equatorial Pacific Ocean where the water temperature oscillates between being unusually warm (El Niño) and unusually cold (La Niña). El Niño and La Niña are among the strongest drivers of the climate of North America, with impacts that vary across different regions. These oceanic events shift the position of the jet streams across the continent, which act to steer the fronts and weather systems. The southeast United States experiences particularly strong long-term weather shifts, with Florida experiencing the greatest impacts. El Niño typically brings 30 to 40 percent more rainfall and cooler temperatures to Florida in the winter, while La Niña brings a warmer and much drier than normal winter and spring. La Niña is frequently a trigger to periodic drought in Florida (Reference 211). El Niño contributes to fewer Atlantic hurricanes, while La Niña contributes to more Atlantic hurricanes.

Florida is only exceeded by Louisiana as the wettest state in the nation. Most of the rain that falls on Florida is convective. It is in the intensity of its precipitation that Florida differs from states farther north. The Panhandle and southeastern Florida are the wettest parts of the state. Coastal locations, including the Keys, receive less rain than those locations nearby but farther in the interior because coastal locations do not provide as good an environment for convectional heating. A large share of Florida’s precipitation falls during periods of torrential rain, which here is defined as three inches or more in a 24-hour period. (Reference 211)

Summer rain is generally in the form of local thunderstorms, or thunderstorms that form in long squall lines created when hot humid air from the Atlantic Ocean converges with equally hot and humid air from the Gulf of Mexico. In southeast Florida, on average, thunderstorms occur most frequently during June and July and the area experiences approximately 69 thunderstorms per year. The state usually leads the nation in lightning deaths because of the large number of people involved in outdoor activities such as swimming, boating, and golfing. The months of June, July, and August have the highest frequency of dangerous lightning events (Reference 201).

Tropical storms in southeast Florida have occurred in the month of February and from May through November. Hurricanes occasionally affect the area with the greatest frequency occurring in September and October.

Florida experiences more tornadoes per 10,000 square miles than any state in the nation. Fortunately, most Florida tornadoes are much lower in intensity than those in the Great Plains and destructive tornadoes are very rare. Funnel clouds are occasionally sighted offshore (waterspouts) during the summer months and a few touch the ground briefly but significant damage is seldom reported (Reference 201). Further information regarding tornadoes and tropical cyclones is presented in Subsections 2.3.1.3.2 and 2.3.1.3.3, respectively.

2.3.1.3 Severe Weather

This subsection addresses severe weather phenomena that affect the Turkey Point region and that are considered in the design and operating bases for the plant. These include:

- Observed and probabilistic extreme wind conditions (Subsection 2.3.1.3.1)
- Tornadoes and related wind and pressure characteristics (Subsection 2.3.1.3.2)
- Tropical cyclones and related effects (Subsection 2.3.1.3.3)
- Observed and probabilistic precipitation extremes (Subsection 2.3.1.3.4)
- The frequencies and magnitude of hail, snowstorms, and ice storms (Subsection 2.3.1.3.5)
- The frequencies of thunderstorms and lightning (Subsection 2.3.1.3.6)
- Droughts and dust (sand) storms (Subsection 2.3.1.3.7)

Included in the information provided in several of these subsections are climate-related site characteristics and their corresponding site parameters in DCD Tier 1, Tables 5.0-1 and Tier 2, Table 2-1; Subsections 2.3.1.3.1, 2.3.1.3.2, 2.3.1.3.3, and 2.3.1.3.4.

2.3.1.3.1 Extreme Winds

From a climatological standpoint, the frequency of peak wind speed gusts can be characterized from information in the *Climate Atlas of the United States* (Reference 210), which is based on observations made over the 30-year period of record from 1961 to 1990. Frequencies of occurrence were developed from values reported as the 5-second peak gust for the day. Mean annual occurrences

of peak gusts greater than or equal to 50 mph, 40 mph, and 30 mph in the Units 6 & 7 site range between 0.5 and 1.4 days per year, less than 9.5 days per year, and between 40.5 and 50.4 days per year, respectively (Reference 210).

Estimating the wind loading on plant structures for design and operating bases considers the “basic” wind speed, which is the “3-second gust speed at 33 feet (10 meters) above the ground in Exposure Category C,” as defined in Sections 6.2 and 6.3 of the ASCE-SEI design standard, *Minimum Design Loads for Buildings and Other Structures* (Reference 208).

The “basic” wind speed is approximately 150 mph, as estimated from the plot of basic wind speeds in Figure 6-1B of ASCE 7-05 (Reference 208) for that portion of the United States that includes the Turkey Point site. The site is located in a hurricane prone region as defined in Section 6.2 of the ASCE-SEI design standard, that is, along the U.S. Atlantic Ocean and Gulf of Mexico coasts where the basic wind speed is greater than 90 mph (Reference 208).

PTN DEP 2.0-1 From a probabilistic standpoint, 150 mph is associated with a mean recurrence interval of 50 years. This value exceeds the design value wind velocity given in DCD Subsection 3.3.1.1. The higher wind velocity does not adversely affect any safety-related systems, structures, and/or components. Section C6.0 (Table C6-3) of the ASCE-SEI design standard provides conversion factors for estimating 3-second gust wind speeds for other recurrence intervals (Reference 208). Based on this guidance, the 100-year return period value is determined by multiplying the 50-year return period value by a scaling factor of 1.07, which yields a 100-year return period 3-second gust wind speed for the site of approximately 161 mph.

For the period of record (1851–2007), there were two Category 5 hurricanes (the unnamed hurricanes of 1935 and 1947). Both hurricanes had maximum 1-minute wind speeds of 140 knots (161 mph) (Reference 209). Hurricane Andrew occurred in 1992 was classified as Category 4 with a 1-minute average wind speed of 130 knots (150 mph) (Reference 225). However, in a post event reanalysis (References 238 and 239) Hurricane Andrew was upgraded to Category 5. The winds at landfall were assigned a sustained 1-minute wind speed of 145 knots (167 mph). The associated 3-second gust wind speed would be 204 mph using a conversion factor from Figure C6-4 of ASCE/SEI 7-05 (Reference 208). Additionally, using the guidance of RG 1.221 (Reference 240), it was determined that the nominal 3-second gust wind speed that can be expected to occur at the Turkey Point site with a return period of 1.0E07 years is

260 mph. The 3-second gust wind speed was determined by digitizing the contours from Figure 1 of RG 1.221, and overlaying the Turkey Point site location.

Subsection 2.3.1.3.3 addresses rainfall extremes associated with tropical cyclones that have passed within 100 nautical miles of the Turkey Point site. It concludes with a description of observed or estimated sustained wind speeds and wind gusts accompanying several of the more intense hurricanes that have made landfall and tracked through this radial area.

This climate-related site characteristic value (i.e., the 3-second gust wind speed) is one of the wind speed-related site parameters listed in DCD Tier 1, Table 5.1-1 and DCD Tier 2, Table 2-1. Refer to Table 2.0-201 for a comparison of the corresponding site parameter values.

2.3.1.3.2 Tornadoes

The design basis tornado characteristics applicable to structures, systems, and components important to safety include the following parameters as identified in RG 1.76 (Reference 220):

- Maximum wind speed
- Translational speed
- Maximum rotational speed
- Radius of maximum rotational speed
- Pressure drop
- Rate of pressure drop

Based on Figure 1 of RG 1.76 and the coordinates for the midpoint between the Units 6 & 7 containment buildings (see Subsection 2.1.1.2), the Turkey Point site is located within Tornado Intensity Region II. The design basis tornado characteristics for Tornado Intensity Region II (Reference 220) that apply to the Turkey Point site are:

- Maximum wind speed = 200 mph
- Translational speed = 40 mph
- Maximum rotational speed = 160 mph

- Radius of maximum rotational speed = 150 feet
- Pressure drop = 0.9 pounds per square inch (psi)
- Rate of pressure drop = 0.4 psi per second

Revision 1 of RG 1.76 retains the same 1E-07 exceedance probability for tornado wind speeds as the original version of that RG. Revision 2 of NUREG/CR-4461 (Reference 221) describes the relationship between the Original Fujita Scale of wind speed ranges for different tornado intensity classifications and the Enhanced Fujita Scale wind speed ranges. NUREG/CR-4461, Rev. 2 was the basis for most of the technical revisions to RG 1.76. The tornado-related site parameter values listed in DCD Tier 1, Table 5.0-1 and DCD Tier 2, Table 2-1 exceed (are more severe than) the design basis tornado characteristics listed above.

Tornadoes observed in a 2-degree latitude and longitude square, centered on the Turkey Point site, are used to characterize their frequency of occurrence from a climatological standpoint, per RG 1.76. The data was obtained from the NCDC *Storm Events* database of tornado occurrences by location, date, and time, starting and ending coordinates, Fujita Scale wind speed classification (or F-scale), Pearson Scale path length and path-width dimensions (or P-scale), and other storm-related statistics (Reference 213).

The 2-degree square area for this evaluation includes all or portions of six counties in Florida that include Broward, Collier, Hendry, Miami-Dade, Monroe, and Palm Beach Counties. All tornado occurrences in the six counties were queried for tornado occurrences in the 2-degree latitude/longitude square. Through the nearly 59-year period from 1950 through July 2008, the records in the database indicate that 297 tornadoes occurred in the 2-degree latitude/longitude square (Reference 213).

Tornado F-scale classifications (with corresponding wind speed range based on the Original Fujita Scale of wind speeds) and respective occurrences are as follows:

Tornado F-scale Classification	Corresponding Wind Speed Range in meters per second	Respective Occurrences
F5	≥117 (261 – 318 mph)	0
F4	93 to 116 (207 – 260 mph)	0
F3	70 to 92 (158 – 206 mph)	4
F2	50 to 69 (113 – 157 mph)	17
F1	33 to 49 (73 – 112 mph)	65
F0	18 to 32 (40 – 72 mph)	211

Twelve of the tornadoes are assigned an undefined F-scale magnitude of “F” in the *Storm Events* database, because the begin location and end location are both unknown and most have no description of the incident available. These events are assumed to be comparable to an F0 classification (Reference 213).

Tornadoes have occurred in the site area during every month of the year with a peak frequency occurring in the summer. On a monthly basis, the greatest number of events has been recorded in June followed by the second-highest count during August followed by the third highest count during May. The lowest percent of the tornadoes have occurred during the winter months (Reference 213).

Tornadoes that occur over a body of water are called waterspouts. Waterspouts probably occur more frequently in the Florida Keys than anywhere else in the world (Reference 222). Waterspouts are generally broken into two categories: fair weather waterspouts and tornadic waterspouts. Tornadic waterspouts are simply tornadoes that form over water, or move from land to water. They have the same characteristics as a land tornado. Fair weather waterspouts are usually a less dangerous phenomena, but quite common over south Florida’s coastal waters from late spring to early fall. Waterspouts can move onshore and become tornadoes and cause significant damage and injury to people. The maximum rotational wind speed of waterspouts has been estimated to be as high as 219 mph (98 m/s) (Reference 222). However, typically, fair weather waterspouts dissipate rapidly when they make landfall, and rarely penetrate far inland (Reference 223).

It is estimated that the Florida Keys area experiences 50 to 500 waterspouts each year. In terms of waterspouts per unit area, the most active region after the Florida Keys is the entire southeast Florida coast from Stuart, Florida to Homestead, Florida (Reference 222). Conventional data reporting sources for the Florida Keys

area likely underestimate the actual yearly waterspout population. The tendency for underreporting in the Florida Keys may be attributed to the fact that much of the population is concentrated in a few areas of much higher density, such as the city of Key West, and the duration of a waterspout is only approximately 14 minutes. This tendency is reflected in the *Storm Events* database compiled by the NCDC for the Florida Keys (Monroe County), which only reports 421 waterspouts for the period of record January 1, 1950 through May 30, 2008 (Reference 213). NCDC data for the same period of record from Miami-Dade, Collier, and Broward counties indicates reports of 112, 38, and 61 waterspouts, respectively. There have been no reports of waterspouts coming on shore in Miami-Dade County and resulting in deaths or property damage (Reference 213).

2.3.1.3.3 Tropical Cyclones

Tropical cyclones include not only hurricanes and tropical storms, but systems classified as tropical depressions, subtropical storms, subtropical depressions, and extratropical storms. This characterization considers “tropical cyclones” (rather than systems classified only as hurricanes and tropical storms) because storm classifications are generally downgraded once landfall occurs and the system weakens, although they may still result in significant rainfall and extreme wind events as they travel through the site region.

Wind speeds (one-minute average) corresponding to each of the Saffir-Simpson hurricane categories are listed below (Reference 209):

Saffir-Simpson Hurricane Categories	
Classification	**Wind Speed (mph)**
Category 1	74–95
Category 2	96–110
Category 3	111–130
Category 4	131–155
Category 5	>155

The National Oceanic and Atmospheric Administration’s (NOAA) Coastal Services Center provides a comprehensive historical database, extending from 1851 through 2007, of tropical cyclone tracks based on information compiled by the National Hurricane Center. This database indicates that 53 tropical cyclone centers or storm tracks (which includes three extratropical storms) have passed within 100 nautical miles of the Turkey Point site during this historical period.

Storm classifications, respective occurrences and frequencies over this 157-year period of record are as follows (Reference 209):

Storm Classification	Occurrences	Frequency (events/yr)
Hurricane – Category 5	3	0.019
Hurricane – Category 4	10	0.064
Hurricane – Category 3	13	0.083
Hurricane – Category 2	8	0.051
Hurricane – Category 1	16	0.102
Extratropical	3	0.019

Tropical cyclones in this 100-nautical-mile radius have occurred as early as February and as late as November, with the greatest occurrence recorded during October, including classifications at and above tropical depression status. Tropical storms have occurred in February and from May to November (Reference 209).

During August through October, hurricane frequency increases. Three Category 5 hurricanes have been tracked within 100 nautical miles of the Turkey Point site. Two were "no named" hurricanes occurring in September of 1935 and September of 1947. Hurricane Andrew, the third Category 5, occurred in August 1992. Of the 10 Category 4 hurricanes that have occurred in this radial distance, one was recorded in August, seven recorded in September, and two were recorded in October. One Category 3 hurricane occurred in July, two in August, three in September, and seven in October. Most major hurricanes in the Turkey Point site area have occurred from late-summer to early fall (Reference 209).

Tropical cyclones are responsible for at least 14 separate rainfall records among the 17 NWS and cooperative observer network stations listed in Table 2.3.1-203, including eight 24-hour (daily) rainfall totals and six monthly rainfall totals. For example, in mid-September 1960, a 24-hour record was set at the Miami 12 SSW cooperative observing station as a result of Hurricane Donna (10.06 inches) (Reference 204). On August 26, 2005, a 24-hour record was set at the Perrine 4 W cooperative observing station as a result of Hurricane Katrina (15.1 inches) (Reference 204).

Additional monthly station records were established due to contributions from the following tropical cyclones (Reference 204):

- Hurricane Donna and Tropical Storm Florence in September 1960 (21.95 inches at Dania 4 WNW, 27.54 inches at Miami 12 SSW, 24.4 inches at Miami International Airport, and 29.5 inches at Perrine 4 W)

As indicated above, significant amounts of recorded rainfall can be associated with a tropical cyclone once the system moves inland. Wind speed intensity, however, noticeably decreases as the system passes over terrain and is subjected to increased frictional forces. Examples of such effects associated with some of the more intense tropical cyclones that have passed within 100 nautical miles of the Turkey Point site are:

- Not Named Hurricane of 1926 (September 1926). The Category 4 hurricane's eye moved directly over Miami Beach and downtown Miami during the morning hours of September 18, 1926. This cyclone produced the highest sustained winds ever recorded in the United States at the time. A storm surge of nearly 15 feet was reported in Coconut Grove. Many casualties resulted as people ventured outdoors during the half-hour lull in the storm as the eye passed overhead. The great hurricane of 1926 ended the economic boom in South Florida and would be a $90 billion disaster had it occurred in recent times. With a highly transient population across southeastern Florida during the 1920s, the death toll is uncertain because more than 800 people were missing in the aftermath of the cyclone. A Red Cross report lists 373 deaths and 6,381 injuries as a result of the hurricane (Reference 224).

- Hurricane Donna (September 1960). Hurricane Donna (Category 4) was one of the most destructive hurricanes to strike Florida and one of the most damaging to affect the United States. It is also believed to have caused hurricane winds over a greater proportion of the United States coastline than any other known hurricane. Donna came ashore on the southwestern coast of Florida with the eye passing over Naples and Fort Myers as the hurricane turned northward, moved inland, and then continued northeastward to reenter the Atlantic just north of Daytona Beach on September 11. As indicated previously, Donna produced record 24-hour rainfall amounts at Miami 12 SSW cooperative observing station located 16 miles from Turkey Point and contributed to record maximum monthly rainfall at several weather observation stations within 50 miles of the Turkey Point site. The last report from the Tavenier observing station estimated the wind speed to be 135 mph. Wind gusts of 97 mph were reported at the Miami Airport Tower (Reference 225).

- Tropical Storm Florence (September 1960). Florence intensified into a tropical storm on September 18, 1960 north of Puerto Rico and moved westward. Wind speeds reached 50 to 55 mph. The storm weakened the next day as it moved westward to the Florida Straits and just north of Cuba, then moved

slowly northward over southern Florida on September 23 and 24 with accompanying heavy rains before turning northwestward and then into the Gulf of Mexico (Reference 225). This tropical storm was responsible for the 24-hour maximum rainfall (8.4 inches) at the Miami Beach cooperative observing station.

- Hurricane Andrew (August 1992). Hurricane Andrew (Category 5) caused an estimated $26 billion damage in the United States making it the most expensive natural disaster at that time in the United States. Andrew dropped sufficient rain to cause local floods even though the hurricane was relatively small and generally moved rather fast. Rainfall totals in excess of four to seven inches were recorded in southeast Florida. At landfall in southern Miami-Dade County, Florida, the central pressure was 922 millibars, which was the third lowest this century (after the 1935 Florida Keys Labor Day storm and Hurricane Camille in 1969) for a landfalling hurricane in the U.S. The storm devastated Miami-Dade County then moved northwest across the Gulf of Mexico to make a second landfall in a sparsely populated area of south-central Louisiana as a Category 3 storm on August 26 (Reference 225). Hurricane Andrew is historic because this is the first time that a hurricane significantly affected a commercial nuclear power plant. The eye of the storm passed over the Turkey Point site and caused extensive onsite and offsite damage, however, there was no damage to the safety-related systems except for minor water intrusion and some damage to insulation and paint (Reference 226).

  In a post event reanalysis (References 238 and 239) Hurricane Andrew was upgraded to Category 5. The winds at landfall were assigned a sustained 1-minute wind speed of 145 knots (167 mph). The associated 3-second gust wind speed would be 204 mph using a conversion factor from Figure C6-4 of ASCE/SEI 7-05 (Reference 208).

- Hurricane Katrina, (August 2005). Katrina was one of the strongest storms to impact the coast of the United States during the last 100 years. Hurricane Katrina developed initially as a tropical depression on August 23 and strengthened into a tropical storm the next day. It then moved slowly along a northwesterly then westerly track through the Bahamas, increasing in strength during this time. A few hours before landfall in south Florida on August 25, Katrina strengthened to become a Category 1 hurricane. Landfall occurred between Hallandale Beach and North Miami Beach, Florida, with maximum sustained winds of 81 mph. The storm then moved generally southwest

across the tip of the Florida peninsula. Katrina was responsible for the maximum reported 24-hour rainfall (15.1 inches) at the Perrine 4 W cooperative station on August 26, 2005. This observation agrees with an analysis conducted by NOAA's Climate Prediction Center that showed parts of the region received heavy rainfall, more than 15 inches in some locations, which caused localized flooding (Reference 225).

- Hurricane Wilma, (October 2005). Hurricane Wilma was the 25th tropical cyclone and 12th hurricane of the hyperactive 2005 season, and the fifth tropical cyclone in as many months to have a significant impact on the Florida Keys. Hurricane Wilma moved across the extreme southeastern Gulf of Mexico and southern Florida peninsula during the morning hours of October 24, 2005, bringing hurricane-force winds to the Florida Keys and the highest storm surge observed in the Keys since Hurricane Betsy, on September 8, 1965. The core of Category 3 Hurricane Wilma passed just north of the Florida Keys, sparing the Keys island chain from the highest winds and heaviest rain. However, the ocean surrounding the Keys archipelago rose rapidly on the morning of the 24th, inundating many island communities, and causing millions of dollars in property damage (Reference 227).

2.3.1.3.4 Precipitation Extremes

Because precipitation is a localized measurement, assessing the variability of precipitation extremes over the area of the Turkey Point site, in an effort to evaluate whether the available long-term data is representative of conditions at the site, largely depends on station coverage.

Historical precipitation extremes (rainfall and snowfall) are presented in Table 2.3.1-203 for the 17 nearby land-based climatological observing stations listed in Table 2.3.1-201. Based on the maximum 24-hour and monthly precipitation totals recorded among these stations in the area of the Turkey Point site, and, more importantly, the areal distribution of these stations around the site, the data show that these statistics are reasonably representative of the extremes of rainfall and snowfall expected to be observed at the Turkey Point site.

As indicated in Subsection 2.3.1.3.3, almost half of the individual station 24-hour rainfall records (and to a lesser extent the monthly rainfall totals) were established as a result of precipitation associated with tropical cyclones that passed within 100 nautical miles of the Turkey Point site.

Maximum recorded 24-hour rainfall totals range from 7.5 inches at the Tamiami Trail 40 Mile Bend station, 38 miles northwest of the Turkey Point site, to 15.1 inches at the Perrine 4 W observing station approximately 13 miles to the north-northwest. The maximum 24-hour rainfall total on August 26, 2005 at the Perrine 4 W cooperative weather observing station was directly associated with Hurricane Katrina. Maximum monthly rainfall totals range from 17.5 inches at Miami Beach in May 1984, approximately 28 miles to the northeast, to 34.4 inches at the Pompano Beach observing station approximately 57 miles to the north-northeast in October 1965 (References 202, 204, and 205).

Between October 12 and October 15, 1965, a rainstorm of unusually prolonged duration and high intensity struck southern Florida and its surrounding waters. The storm was especially noteworthy for having produced very heavy rainfall in the area between Miami and Palm Beach. The heavy rainfall was associated with a stationary front that brought about lifting of conditionally unstable layers of air to saturation. The adiabatic ascent in this case appeared to constitute a forcing of the convection over a relatively small and prescribed area. The further concentration of heavy rain may have been the result of a local moistening effect on the flow by the Bahama Island chain in combination with a favorable wind regime (Reference 228). The heavy precipitation on October 31 is believed to be attributed to a persistent easterly flow off the ocean that supported convective thunderstorm development over the inland area (Reference 229).

In general, when monthly rainfall records were established at a given observing station, regardless of their cause(s), significant amounts of precipitation were usually measured at most of the other stations in the site area, particularly when associated with the passage of tropical cyclones. This is usually not the case for maximum 24-hour rainfall records because of the occurrence of more local-scale events such as thunderstorms and because of the intense nature of these storms in this coastal area. However, there does not appear to be any clear relationship between the rainfall recorded during such extreme events, whether on a 24-hour or monthly basis, and the distance inland within the area considered around the Turkey Point site (see Figure 2.3.1-201). Therefore, based on the range of the maximum recorded 24-hour and monthly rainfall totals among these stations, the areal distribution of these climatological observing stations around the site, and their proximity to the site, the data shows that rainfall extremes close to the upper limits of the respective maxima can reasonably be expected to occur at the Turkey Point site.

Site characteristic values corresponding to the precipitation (for roof design) site parameters—that is, 1-hour and 5-minute rainfall rates (intensities)—are addressed in Subsection 2.4.2.

Winter storms that produce measurable amounts of frozen precipitation near the Turkey Point site are rare. The only observation of frozen precipitation near the Turkey Point site was a trace (0.05 inch) observed at Homestead, Florida on January 19, 1977 (Reference 204). From a probabilistic standpoint, estimating the design basis snow load on the roofs of safety-related structures considers one or both of these climate-related components:

- The weight of the 100-year return period ground-level snow pack (to be included in the combination of normal live loads).
- The weight of the 48-hour probable maximum winter precipitation (to be included, along with the weight of the 100-year return period ground-level snow pack, in the combination of extreme live loads).

As indicated in Table 2.3.1-203, the 24-hour and monthly maximum snowfall for the climatological stations is zero with the exception of the Homestead Experiment Station. Based on Figure 7-1 of the ASCE-SEI design standard, *Minimum Design Loads for Buildings and Other Structures* (Reference 208), the 50-year return period ground-level snow pack for the Turkey Point site area is 0 pounds per square foot. Section C7.0 of the design standard provides conversion factors for estimating ground-level snow pack values for other recurrence intervals. A 100-year return period value is determined by dividing the 50-year ground-level snow pack by a factor of 0.82. In this case, however, the 50-year and the 100-year return period values would both be 0 pounds per square foot.

Instead of a 100-year return period ground-level snow pack values based on the ASCE-SEI design standard, the weight of the overall maximum snowfall event recorded in the Turkey Point site has been estimated based on the station report. As indicated previously, the highest 24-hour snowfall total (0.05 inches) occurred on January 19, 1977 at the Homestead Experiment Station (Reference 204). It is assumed that the snow remained on the ground for an extended period of time and that a nominal snow density (i.e., the ratio of the volume of melted snow to the volume of snow) of 1:10 applies (Reference 230). This ratio represents a value typically used by the NCDC in estimating liquid precipitation equivalents during snowfall events. Therefore, the liquid equivalent for this maximum snowfall event would be 0.005 inches of water. Based on the relationship of one inch of water

being equivalent to 5.2 pounds per square foot, the estimated weight of the maximum recorded snowfall event would be 0.026 pounds per square foot.

The 48-hour probable maximum winter precipitation component (unadjusted) for evaluating extreme live loads (as indicated above) is derived by logarithmic interpolation on the curve defined by plots of the 6-, 24- and 72-hour, 10-square mile area, monthly probable maximum precipitation estimates as presented in NUREG/CR-1486 (Reference 217). The highest winter season (December through February) probable maximum precipitation values for the Turkey Point site occur in December and are approximately 18, 29, and 37 inches, respectively, for these time intervals (Reference 217). The 24- and 72-hour probable maximum precipitation values for January and February are essentially the same as the December values for these two time intervals (Reference 217).

The 48-hour probable maximum precipitation value (unadjusted), estimated by logarithmic interpolation on the curve defined by the 6-, 24-, and 72-hour probable maximum precipitation values for December, is 34.0 inches liquid depth. The weight of the 48-hour probable maximum winter precipitation is reported and applied in Section 3.8, which addresses the design of Seismic Category I structures.

The climate-related site characteristic values (i.e., the 100-year return period ground snow load [or, in this case, the estimated weight of the maximum recorded snowfall event in the site area in lieu of that value], and the 48-hour probable maximum winter precipitation) are two of the precipitation (for roof design)-related site parameters. Refer to Table 2.0-201 in Section 2.0 for a comparison of the corresponding site parameter values.

2.3.1.3.5 Hail, Snowstorms, and Ice Storms

Frozen precipitation in the Turkey Point site typically occurs in the form of hail. The frequency of occurrence and characteristics of this type of weather event is based on the following two references: the latest version of *The Climate Atlas of the United States* (Reference 210), which has been developed from observations made over the 30-year period of record from 1961 to 1990, and the NCDC *Storm Events* database for Florida (Reference 212) based on observations over the period of January 1950 to May 2008.

Though hail can occur at any time of the year in the site area and is associated with well-developed thunderstorms, it has been observed primarily during late spring and the summer months (May through August), reaching a peak during

May, and occurring least often from late fall through the winter months (December, January, and February) (Reference 212).

The *Climate Atlas* (Reference 210) indicates that most of Miami-Dade County can expect, on average, hail with diameters 0.75 inch or greater approximately 1 day per year. The *Climate Atlas* also shows a similar frequency in the eastern portions of the adjacent Broward County. However, a relatively lower frequency of occurrence is indicated for the west portion of Broward County and the extreme western and southern portions of Miami-Dade County (less than 0.5 days per year). Other nearby counties of Collier and Monroe, which are directly adjacent to the Gulf of Mexico, can expect 0.75-inch or greater hail approximately 0.5 days or less per year. The *Climate Atlas* indicates that the occurrence of hail with diameters greater than or equal to 1.0 inch is relatively less frequent over the site area and confined to the northeastern portion of Miami-Dade County and the southeastern portion of Broward County (Reference 210).

NCDC cautions that hailstorm events are point observations and somewhat dependent on population density. This may explain the areal extent of higher frequencies in the northeastern portion of Miami-Dade County and what could be interpreted as generally lower frequencies of occurrence in the southern coastal portion of the county. The slightly higher annual mean frequency of approximately one to two days per year with hail greater than or equal to 0.75 inch in diameter is considered to be a representative indicator for the Turkey Point site.

Hailstorm events in Miami-Dade and surrounding counties have generally reported maximum hailstone diameters ranging between 1.75 and 4.0 inches. Golf ball-size hail (approximately 1.75 inches in diameter) is not a rare occurrence, having been observed numerous times in Miami-Dade and surrounding counties. However, in terms of extreme hailstorm events, the NCDC *Storm Events* database indicates that grapefruit- to softball-size hail (approximately 4.0 to 4.5 inches in diameter, respectively) was observed on only one occasion within 50 miles of the Turkey Point site—March 29, 1963 (4.0 inches), in Miami-Dade County, approximately 27 miles to the north-northeast of the Turkey Point site (Reference 212).

Winters bring no accumulation of snowfall in southeastern Florida. Snow has never been reported at the Miami International Airport. According to the NCDC (Reference 231), a trace of snowfall was observed at the Homestead Experiment Station once during a period of record of 39 years. The Homestead Experiment Station is within 19 kilometers (12 miles) of Units 6 & 7 (Reference 204). The total snowfall was estimated to be only 0.05 inches (References 204 and 231). The

notes made by the station observer indicate that the snow melted before reaching the ground (Reference 232). This was during one of the worst of the mid-1970s cold waves and snow fell that day in several parts of Miami-Dade County, Florida, but not at the NWS office at the Miami Airport, which is why the official records do not show the snow. The effects of winter precipitation have been addressed in the preceding subsection from a design basis perspective (Reference 212).

The *Storm Events* database for Florida (Reference 212) indicates that ice storms have not been reported in Broward, Collier, Monroe, or Miami-Dade Counties in the period January 1, 1950 through May 31, 2008. In addition, the *Climate Atlas* (Reference 210) indicates that the mean numbers of days per year with frozen precipitation in counties of southeastern Florida is zero.

2.3.1.3.6 Thunderstorms and Lightning

Thunderstorms can occur in the site area at any time during the year. Based on a 61-year period of record, Miami, Florida, averages approximately 73 thunderstorm-days (i.e., days on which thunder is heard at an observing station) per year. On average, August has the highest monthly frequency of occurrence—approximately 15 days. Annually, almost three-quarters (approximately 74 percent) of thunderstorm-days are recorded between early summer and early fall (i.e., from June through September). From November through March thunderstorms have the lowest monthly frequency of occurrence and might be expected to occur approximately 1 day per month (Reference 201).

The mean frequency of lightning strikes to earth can be estimated using a method attributed to EPRI, as reported by the U.S. Department of Agriculture Rural Utilities Service in the publication titled *Summary of Items of Engineering Interest* (Reference 233). This methodology assumes a relationship between the average number of thunderstorm-days per year (T) and the number of lightning strikes to earth per square mile per year (N), where:

$$N = 0.31T$$

Based on the average number of thunderstorm-days per year at Miami, Florida (i.e., 73.0; see Table 2.3.1-202), the frequency of lightning strikes to earth per square mile is approximately 23 per year for the area of the Turkey Point site. This frequency is below the mean of the 10-year (1989 to 1999) lightning flash density for the area that includes the Turkey Point site, as reported by the NWS to be 14 to 16 flashes per square kilometer per year or 4.6 to 5.4 flashes/square mile/year (Reference 234).

The Turkey Point power block and the surrounding area are shown on Figure 2.1-205, which is approximately 30 acres, or approximately 0.047 square miles. Given the estimated annual average frequency of lightning strikes to earth in the area of the Turkey Point site, the frequency of lightning strikes in the power block and surrounding area can be estimated as follows:

> (23 lightning strikes/square miles/year) x (0.047 square miles) = 1.1 lightning strikes/year, or approximately once each year.

2.3.1.3.7 Droughts and Dust (Sand) Storms

Droughts are prolonged periods of very dry weather that cause serious water imbalances in the affected area. 27 drought event(s) are reported in Florida between January 1, 1950 and July 31, 2008; however no drought events are reported in Miami-Dade County during the same period (Reference 213). Statewide, the drought events effects range from reduced topsoil moisture and poor pastures, to wildfire breakouts, to various degrees of water usage restrictions (Reference 213). The southeastern coastal region of Florida, where the Turkey Point site is located, experienced a dry spring in 2007 combined with a prolonged period of below normal rainfall going back to early 2006, producing severe to extreme drought conditions. The drought conditions returned to southwestern Florida, primarily Collier County, in August 2007 and continued into May of 2008. Subsection 2.4.11 describes the effect of droughts on the Turkey Point cooling system. Subsection 2.4.11.3 describes historical low water conditions from droughts and their frequencies in the past.

Dust storms predominantly originate in normally arable regions during periods of drought where dust and sand layers are loosened. Dust storms in the southeastern coastal region of Florida are very rare due to the vegetative cover. Severely reduced visibilities due to large-scale dust storms in Florida occur infrequently. The NCDC *Storm Events* database indicates no occurrences of dust storms in 50-nautical miles of the Turkey Point site from January 1950 through May 2008 (Reference 213). Severely reduced visibilities in southeastern Florida primarily occur as a result of wildfires or brushfires.

2.3.1.4 Meteorological Data for Evaluating the Ultimate Heat Sink

The AP1000 design uses a passive containment cooling system (PCS) to provide the safety-related ultimate heat sink for the plant. The PCS uses a high strength steel containment vessel inside a concrete shield building. The steel containment vessel provides the heat transfer surface that removes heat from inside the

containment by conduction. Heat from the containment surface is transferred to a water film by convection, and from the water film to the air by convection and the evaporation of the water film. Heat removal from the containment vessel is aided by continuous, natural circulation of air (see DCD Tier 2, Subsection 6.2.2).

The use of the PCS in the AP1000 design is not significantly influenced by local weather conditions. Therefore, the identification of meteorological conditions that are associated with maximum evaporation and drift loss of water, as well as minimum cooling by the ultimate heat sink (i.e., periods of maximum wet bulb temperatures) is not necessary.

2.3.1.5 Design Basis Dry and Wet Bulb Temperatures

These climate-related site characteristic values are among the air temperature-related site parameters listed in DCD Tier 2, Table 2-1 as:

- Maximum safety (0 percent exceedance) dry bulb, coincident and noncoincident wet bulb temperatures
- Minimum safety (0 percent exceedance) dry bulb temperature
- Maximum normal (1 percent seasonal corresponding to the 0.4 percent annual) dry bulb, coincident and noncoincident wet bulb temperatures
- Minimum normal (99 percent seasonal corresponding to the 99.6 percent annual) dry bulb temperature

These temperatures are discussed in the following paragraphs.

Maximum and Minimum Safety Temperatures

The DCD indicates that the 0 percent exceedance site parameter values represent conservative estimates of historical high and low temperatures for potential sites. Based on a 30-year period of record (1976–2005) of sequential hourly data for the NWS station at Homestead AFB (the closest station to the site at which coincident dry and wet bulb temperature measurements are made), the 0 percent exceedance historical maximum dry bulb temperature for the Turkey Point site is 98.0°F with a coincident wet bulb temperature of 75.5°F. Over this same period of record, the 0 percent exceedance historical maximum noncoincident wet bulb temperature is 84.8°F; the 100 percent exceedance historical minimum dry bulb temperature is 28.0°F at this station (Reference 207).

The dry bulb temperature component of the maximum dry bulb and coincident wet bulb temperature site characteristic pair is calculated by the 100-year return period maximum dry bulb value. Maximum dry bulb, minimum dry bulb, and maximum wet bulb temperatures corresponding to a 100-year return period were derived through linear regression using annual maximum and minimum dry bulb temperatures, and annual maximum wet bulb temperatures recorded over the 30-year period from 1976 to 2005 at the Homestead AFB station.

Because this 100-year return period dry bulb value is extrapolated from a regression curve on a single parameter, there is no corresponding mean coincident wet bulb temperature. As a result, the coincident wet bulb temperature component had to be derived based on a characteristic relationship between concurrent dry bulb and wet bulb temperatures, that is, as the dry bulb temperature continues to increase, there is a point at which the concurrent wet bulb temperature reaches a maximum and thereafter changes little or even decreases. This characteristic is not unique to this location or climatological setting.

Based on the linear regression analyses of these data sets for a 100-year return period, the maximum dry bulb temperature is 103.0°F, the minimum dry bulb temperature is 17.9°F, and the maximum noncoincident wet bulb temperature is
PTN DEP 2.0-3 87.4°F. This temperature exceeds the DCD site parameter of 86.1°F. The higher maximum safety wet-bulb (noncoincident) air temperature does not affect any safety-related systems, structures, and/or components.

This relationship is exhibited by the annual percent frequency distribution of wet bulb temperature depression for the Miami, Florida, NWS station, as reported in the International Station Meteorological Climate Summary (Reference 235), over the 47-year period from 1949 through 1995. This type of summary is a bivariate distribution of dry bulb temperatures in 2-degree ranges by wet bulb depression (i.e., the difference between concurrent dry bulb and wet bulb observations), also in 2-degree ranges.The Miami station was used for this analysis since ISMCS data is not available for the Homestead AFB station.

For the Miami NWS station, this threshold dry bulb temperature occurs at about 98°F. A cubic polynomial curve was fit to the concurrent maximum dry bulb and maximum wet bulb temperature pairs extracted from this bivariate distribution at and above this threshold dry bulb value. The equation of the curve is an estimation of the trend where the maximum coincident wet bulb temperature can then be determined as a function of the maximum dry bulb temperature in this upper range of dry bulb values. Based on a 100-year return period maximum dry

bulb temperature of 103.0°F, the corresponding wet bulb temperature is estimated to be 75.2°F.

Maximum and Minimum Normal Temperatures

Long-term, engineering-related climatological data summaries, prepared by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) for the Homestead Air Force Base (AFB) observing station (Reference 207), (except as noted) located approximately 5 miles from the site, are used to characterize maximum and minimum normal dry and wet bulb temperatures for the Turkey Point site.

Based on a 19-year period of record from 1982–2001 at Homestead AFB, the maximum normal dry bulb temperature with a 1.0 percent seasonal (corresponding to 0.4 percent annual) exceedance probability is 91.3°F, with a mean coincident wet bulb temperature of 79.3°F. The maximum normal noncoincident wet bulb temperature with a 1.0 percent seasonal (corresponding
PTN DEP 2.0-2 to 0.4 percent annual) exceedance probability is 81.5°F (Reference 207). This temperature exceeds the DCD site parameter of 80.1°F. The higher maximum normal wet-bulb (noncoincident) air temperature does not affect any safety-related systems, structures, and/or components.

For the same period of record, the minimum dry bulb temperatures with 99.0 percent seasonal (corresponding to 99.6 percent annual) exceedance probability is 46.9°F (Reference 207).

Finally, based on a 19-year period of record from 1982–2001 at Homestead AFB, the maximum dry bulb temperature with a 2.0 percent annual exceedance probability is 89.7°F, with a mean coincident wet bulb temperature of 78.8°F. The same ASHRAE summary for Homestead AFB lists the maximum noncoincident wet bulb temperature with a 2.0 percent annual exceedance probability as 80°F.

Refer to Table 2.0-201 in Section 2.0 of this chapter for a comparison between the applicable site characteristic values and the corresponding air temperature-related site parameter values.

2.3.1.6 Restrictive Dispersion Conditions

Atmospheric dispersion can be described as the horizontal and vertical transport and diffusion of pollutants released into the atmosphere. Horizontal and along-wind dispersion is controlled primarily by wind direction variation, wind speed, and atmospheric stability. Subsection 2.3.2.2.1 addresses wind characteristics for the

Turkey Point site based on measurements from the pre-application phase, onsite meteorological monitoring program. The persistence of those wind conditions is described in Subsection 2.3.2.2.2.

In general, lower wind speeds represent less-turbulent air flow, which is restrictive to both horizontal and vertical dispersion. And, although wind direction tends to be more variable under lower wind speed conditions (which increases horizontal transport), air parcels containing pollutants often recirculate within a limited area, thereby increasing cumulative exposure.

Major air pollution episodes are usually related to the presence of stagnating high-pressure weather systems (or anticyclones) that influence a region with light and variable wind conditions for four consecutive days or more. An updated air stagnation climatology has been published with data for the continental United States based on over 50 years of observations—from 1948 through 1998. In this study, stagnation conditions were defined as four or more consecutive days when meteorological conditions were conductive to poor dispersion. Although interannual frequency varies, the data in Figures 1 and 2 of that report indicate that on average, the Turkey Point site region can expect less than 20 days per year with stagnation conditions, or less than four cases per year, with a mean duration of less than 5 days for each case (Reference 215).

Air stagnation conditions primarily occur during an “extended” summer season (May through October). This is a result of the weaker pressure and temperature gradients, and therefore weaker wind circulations, during this period (as opposed to the winter season). Based on Wang and Angell Figures 17 to 67, the highest incidence of air stagnation is recorded between July and September, typically reaching its peak during August, when the Bermuda high-pressure system has become established (Reference 215). As the LCD summary in Table 2.3.1-202 for Miami International Airport, Florida, indicates, this 3-month period coincides with the lowest monthly mean wind speeds during the year (Reference 201). Air stagnation is at a relative minimum in the extended summer season during May and June (Reference 215).

The dispersion of air pollutants is also a function of the mixing height. The mixing height (or depth) is defined as the height above the surface through which relatively vigorous vertical mixing takes place. Lower mixing heights (and wind speeds), therefore, are a relative indicator of more restrictive dispersion conditions. Holzworth reported mean seasonal and annual morning and afternoon mixing heights and wind speeds for the contiguous United States based on observations over the 5-year period from 1960 to 1964 from a network of 62 NWS

stations at which daily surface and upper air sounding measurements were routinely made (Reference 236).

However, an interactive, spatial database developed by the U.S. Department of Agriculture — Forest Service, referred to as the *Ventilation Climate Information System*, is readily available and provides monthly and annual graphical and tabular summaries of relevant dispersion-related characteristics (e.g., morning and afternoon modeled mixing heights, modeled surface wind speeds, and resultant ventilation indices) (Reference 216). The system, although developed primarily for fire management and related air quality purposes, extends the period of record to climatologically representative durations of 30 to 40 years depending on the parameter.

Table 2.3.1-204 summarizes minimum, maximum, and mean morning and afternoon mixing heights, surface wind speeds, and ventilation indices on a monthly, seasonal, and annual basis for the area of the Turkey Point site. As atmospheric sounding measurements are still only made from a relatively small number of observation stations, these statistics represent model-derived values in the interactive data base for a specific location (Reference 237)—in this case, the Turkey Point site. The seasonal and annual values listed in Table 2.3.1-204 were derived as weighted means based on the corresponding monthly values.

From a climatological standpoint, the lowest morning mixing heights occur in the summer and the highest morning mixing heights occur during the spring. As might be expected, the afternoon mixing heights reach a seasonal minimum in the fall and a maximum during the spring due to more intense heating (Reference 216).

The wind speeds listed in Table 2.3.1-204 representing the location of the Units 6 & 7 site are reasonably consistent with the LCD summary for Miami International Airport, Florida, in Table 2.3.1-202, although approximately 0.5 meters per sec (m/sec) lower. Relatively lower daily mean wind speeds (i.e., the average of the morning and afternoon mean values in Table 2.3.1-204) are shown to generally occur during the summer and early fall as in the LCD. (References 201 and 216) This period of minimum wind speeds also coincides with the extended summer season described by Wang and Angell that is characterized by relatively higher air stagnation conditions (Reference 215).

The ventilation index is a measure of the potential of the atmosphere to disperse pollutants and is based on the product of the surface wind speed and the mixing height. Because it uses surface winds instead of higher trajectory winds, the index values represent conservative estimates of ventilation potential. This is more

indicative of the dispersion potential near the ground and, therefore, directly relevant to the release heights of the sources evaluated in Subsections 2.3.4 and 2.3.5.

Based on the classification system for ventilation indices (Reference 216), the morning ventilation indices in Table 2.3.1-204 for the area of the Turkey Point area generally indicate marginal ventilation potential on an annual average basis with the exception of spring and fall when the ventilation indices are “fair”; which is consistent with characteristics reported by Wang and Angell.

Ventilation indices markedly improve during the afternoon with conditions rated as “good” on an annual average basis and for every season except the summer which is classified as “fair” (Reference 216). Mean wind speeds do not vary significantly in the site area over the course of the year. As a result, the relatively better ventilation index classifications are attributable to the higher mixing height values, which for the summer season tends to mask the general potential for more restrictive dispersion conditions during the extended summer referred to by Wang and Angell (Reference 215). Nevertheless, the decrease in the ventilation index values between the summer and fall seasons is still evident and consistent with the monthly variations for air stagnation potential described previously.

Ambient air quality conditions in the area of the Turkey Point site are described in Subsection 2.3.2.2.5.

2.3.1.7 Climate Changes

Climatic conditions change over time and these changes are cyclical in nature on various time and spatial scales. The timing, magnitude, relative contributions to, and implications of these changes are generally more speculative, and are even more so for specific areas or locations.

With regard to the expected 40-year operating license period for Units 6 & 7, it is reasonable to evaluate the record of readily available and well-documented climatological observations of temperature and rainfall (normals, means, and extremes) as they have varied over time (the last 70 to 80 years), and the occurrences of severe weather events, in the context of the plant’s design bases.

Trends of temperature and rainfall normals are identified over a 70-year period for successive 30-year intervals, updated every 10 years, beginning in 1931 (i.e., 1931–1960, 1941–1970, etc.) through the most recent normal period (i.e., 1971–2000) in the NCDC publication *Climatography of the United States,*

No. 85 (Reference 218). The publication summarizes these observations for the 344 climate divisions in the 48 contiguous states.

As Subsection 2.3.1.2 indicates, the Turkey Point site is located in climate Division 6 (lower east coast) in the state of Florida (Reference 219). Summaries of successive annual temperature and rainfall normals, as well as the composite 70-year average are provided below for climate Division 6 (Reference 218).

Period	Temperature (°F)	Rainfall (inches)
1931–2000	74.8	59.79
1931–1960	74.6	59.92
1941–1970	74.5	59.54
1951–1980	74.5	58.28
1961–1990	74.8	57.17
1971–2000	75.4	59.66

This data indicates a slight cooling trend in the climate division of approximately 0.1°F between 1931–1960 and 1951–1980, with an increase of approximately 0.9°F between the 1951–1980 and 1971–2000 normal periods. In general, total annual rainfall increased by 2.49 inches between the 1961–1990 and 1971–2000 normal periods. A decrease of 2.75 inches occurred between the 1931–1960 and 1961–1990 periods. The latest normal period (1971–2000) is slightly less (0.13 inches) in comparison to the 1931–2000 70-year period (Reference 218).

The preceding values represent variations of average temperature and rainfall conditions over time. The occurrence of extreme temperature and precipitation events does not necessarily follow the same trends. However, characteristics about the occurrence of such events over time are indicated by the summaries for observed extremes of temperature, and rainfall and snowfall totals recorded in the Turkey Point area (see Table 2.3.1-203).

Individual station records for maximum temperature have been set between 1934 and 2007 (the overall highest value for the site area having been recorded in 1998), that is, no discernible trend for these extremes exists in the site area. Similarly, record-setting 24-hour rainfall totals were established between 1933 and 2005, with station records for total monthly rainfall being set between 1948 and 1999—again, no clear trend is evident. Cold air outbreaks that result in overall extreme low temperatures occur infrequently; snowfall in the area of the Turkey Point site is even more rare. Nevertheless, station records set for these weather types span a range of 54 years (i.e., 1942 to 1995) for record cold and a trace of snowfall recorded once in 58 years (see Table 2.3.1-203).

The occurrence of tropical cyclones within 100 nautical miles of the Turkey Point site has been somewhat cyclical over the available 157-year period of record when considered on a decadal (10-year basis), having reached a peak of 12 such storms during the period 1900–1910, with secondary peaks of 10 tropical cyclone events in the period 1931–1940, 11 during 1941-1950, and 10 during 1961-1970. In general, the frequency of hurricanes passing within 100 nautical miles of the site has generally decreased since the peak period from 1961–1970. The frequency of tropical storms in recent decades has been less than that during the peak frequency (decades 1900–1910, 1931-1940, 1941-1950 and 1961–1970). On the basis of reported tropical storm wind speeds and barometric pressure, the intensity of tropical storms has been relatively steady since the peak period 1961-1970 (Reference 209). Many of the 24-hour and monthly total rainfall records identified in Table 2.3.1-203 and described in Subsection 2.3.1.3.3 occurred during recent decades. Most of the listed observing stations began operation after the peak tropical cyclone activity; therefore, rainfall records do not reflect data from this period.

In general, the number of recorded tornado events has increased since detailed records were routinely documented beginning around 1950. However, some of this increase is attributable to a growing population, greater public awareness and interest, and technological advances in detection. These changes are superimposed on normal yearly variations.

The regulatory guidance for evaluating the climatological characteristics of a site from a design basis standpoint is not event-specific, but rather is statistically based and for several parameters includes expected return periods of 100 years or more and probable maximum event concepts. These return periods exceed the expected 40-year operating license period of Units 6 & 7. The design basis characteristics determined previously under Subsection 2.3.1.3 are developed consistent with the intent of that guidance and incorporate the readily available, historical data records for locations considered to be representative of the Turkey Point site.

2.3.1.8 References

201 National Climatic Data Center, Local Climatological Data, *Annual Summary with Comparative Data for Miami International Airport*, Florida, February 2009.

202. National Climatic Data Center, *Climatography of the United States*, No. 20, Period of Record: 1971–2000, Monthly Station Climate Summaries, NCDC

for Flamingo Ranger Station, Fort Lauderdale, Hialeah, Miami Beach, Miami International Airport, Pompano Beach, Royal Palm Ranger Station, Tamiami Trail 40 Mile Bend, and Tavernier, National Environmental Satellite Data and Information Service, NOAA, 2004.

203. National Climatic Data Center, *Climatography of the United States*, No. 81, 1971–2000, U.S. Monthly Climate Normals, National Environmental Satellite Data and Information Service, NOAA, February 2002.

204. Utah Climate Center, Utah State University, *Climatological Data Archive,* Florida Climate for Pompano Beach, Dania 4 WNW, Flamingo Ranger Station, Hialeah, Homestead Experiment Station, Miami 12 SSW, Miami International Airport, Oasis Ranger Station, Perrine 4W, Royal Palm Ranger Station, and Tavernier. Available at http://climate.usurf.usu.edu/, accessed June 30, 2008.

205. Southeast Regional Climate Center, *Period of Record General Climate Summaries of Temperature and Precipitation* for Dania 4 WNW, Flamingo Ranger Station, Fort Lauderdale, Fort Lauderdale Experiment Station, Hialeah, Homestead Experiment Station, Kendall 2 E, Miami 12 SSW, Oasis Ranger Station, Perrine 4W, Pompano Beach, Royal Palm Ranger Station, Tamiami Trail 40 Mile Bend, Tavernier, South East Regional Climate Center. Available at http://www.sercc.com, accessed August 19, 2008.

206. Southeast Regional Climate Center, *Period of Record Monthly Climate Summary*, data listings for Flamingo Ranger Station, Fort Lauderdale, Fort Lauderdale Experiment Station, Hialeah, Homestead Experiment Station, Kendall 2 E, Miami 12 SSW, Miami Beach, Oasis Ranger Station, Perrine 4W, Pompano Beach, Royal Palm Ranger Station, and Tamiami Trail 40 Mile Bend, and Tavernier. Available at http://www.sercc.com/, accessed June 16, 2008.

207. American Society of Heating, Refrigerating and Air-Conditioning Engineers, *2005 ASHRAE Handbook — Fundamentals*, Chap. 28, Climatic Design Conditions, CD-ROM, 2005.

208. American Society of Civil Engineers and Structural Engineering Institute, ASCE Standard ASCE/SEI 7–05, *Minimum Design Loads for Buildings and Other Structures*, Revision of ASCE 7–02, 2006.

209. National Oceanic and Atmospheric Administration — Coastal Services Center, *Historical Hurricane Tracks Storm Query*, 1851 through 2007. Available at http://maps.csc.noaa.gov/hurricanes/reports.jsp, accessed March 1, 2009.

210. National Climatic Data Center, Climate Services Division, *Climate Atlas of the United States*, Ver. 2.0 (CD-ROM), September 2002.

211. National Climatic Data Center, *Climatography of the United States*, No. 60, Climate of Florida, February 2006.

212. National Climatic Data Center, *Storm Events f*or Florida, Snow, Hail, Ice, and Fog Events for Broward County, Miami-Dade County, Monroe County, Palm Beach County, and Collier County. Available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms, accessed March 1, 2009.

213. National Climatic Data Center, *Storm Events* for Florida, Tornado, Waterspout, Drought, and Dust Storm Events for Broward County, Hendry County, Miami-Dade County, Monroe County, Palm Beach County, and Collier County. Available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms, accessed March 1, 2009.

214. National Climatic Data Center, *Storm Events* for Florida, Hurricane and Tropical Storm, Events for Broward County, Miami-Dade County, Monroe County, Palm Beach County, and Collier County. Available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms, accessed August 4, 2008.

215. Wang, J., and J. Angell, *Air Stagnation Climatology for the United States (1948–1998)*, NOAA, Air Resources Laboratory Atlas No. 1, Air Resources Laboratory, Environmental Research Laboratories, Office of Oceanic and Atmospheric Research, Silver Spring, Maryland, April 1999.

216. U.S. Department of Agriculture, National Agricultural Statistics Service, Ventilation Climate Information System, U.S. Department of the Interior, U.S. Energy Association Joint Fire Science Program, *Monthly Wind Speed and Mixing Height, 2007*. Available at http://www.fs.fed.us/pnw/airfire/vcis/, accessed July 24, 2008.

217. National Oceanic and Atmospheric Administration, *Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Extremes, United States*

East of the 105th Meridian, NOAA Hydrometerological Report No. 53, NUREG/CR–1486, June 1980.

218. National Climatic Data Center, *Climatography of the United States, No. 85, Divisional Normals and Standard Deviations of Temperature, Precipitation, and Heating and Cooling Degree Days 1971–2000* (and previous normals periods), Section 1, Temperature, and Section 2, Precipitation, National Environmental Satellite, Data and Information Service, NOAA, June 15, 2002.

219. National Oceanic and Atmospheric Administration, *Location of US Climate Divisions*, *State of Florida*. Available at http://www.cdc.noaa.gov/US climate/map.html, accessed August 14, 2008.

220. U.S. Nuclear Regulatory Commission, *Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants*, Regulatory Guide 1.76, Rev. 1, March 2007.

221. U.S. Nuclear Regulatory Commission, *Tornado Climatology of the Contiguous United States*, NUREG/CR-4461, Rev. 2, PNNL-15112, Rev. 1, February 2007.

222. Golden, J., *An Assessment of Waterspout Frequencies Along the US East and Gulf Coasts, American Meteorological Society*, Journal of Applied Meteorology, Vol. 16, pp. 231–236, March 1977.

223. National Weather Service, *About Waterspouts,* Forecast Office Miami-South Florida. Available at www.srh.noaa.gov/mfl/hazards/info/waterspouts.php, accessed August 27, 2008.

224. National Weather Service, Forecast Office Miami-South Florida, *Memorial Web Page for the 1926 Great Miami Hurricane*. Available at http://www.srh.noaa.gov/mfl/newpage/Miami_hurricane.html, accessed November 12, 2008.

225. National Oceanic and Atmospheric Administration – Coastal Services Center,. *Tropical Storm Reports; Reports for Hurricanes Donna, Andrew, and Katrina, and Tropical Storm Florence*, Historical Hurricane Tracks Storm Query, 1851 through 2007. Available at http://maps.csc.noaa.gov/hurricanes/reports.jsp, accessed September 9, 2008.

226. U.S. Nuclear Regulatory Commission, *Effect of Hurricane Andrew on Turkey Point Nuclear Generating Station and Lessons Learned*, NRC Information Notice 93-53, July 20, 1993.

227. National Weather Service, *Hurricane Wilma in the Florida Keys*, Forecast Office, Miami-Key West, Florida. Available at http://www.srh.noaa.gov/key/HTML/wilma/wilma.html, accessed November 12, 2008.

228. Carlson, T., *Isentropic Upslope Motion and an Instance of Heavy Rain over Southern Florida*, National Hurricane Research Laboratory, Environmental Science Services Administration, Miami, Florida, April 1967.

229. National Oceanic and Atmospheric Administration, Central Library, National Oceanic Data Center, *U.S. Daily Weather Map Project, Daily Weather Maps for October 13, 14, and 31*, 1965. Available at http://docs.lib.noaa.gov/rescue/dwm/data_rescue_daily_weather_maps.html, accessed July 24, 2008.

230. Linsley, R., *Hydrology for Engineers*, 2d ed., 1975.

231. National Climatic Data Center, *Snow Climatology,* Monthly/Seasonal Total Snowfall Amount, Homestead Experiment Station, Florida. Available at http://www.ncdc.noaa.gov/ussc/index.jsp, accessed July 14, 2008.

232. National Oceanic and Atmospheric Administration, *Record of Climatological Observations*, Daily Report, January 19, 1977.

233. U. S. Department of Agriculture, *Summary of Items of Engineering Interest*, Rural Utlities Service, p. 8, August 1998.

234. National Severe Storms Laboratory, *10-Year U.S. Flash Density (1989–1999 Average U.S. Flashes Per Square Kilometer Per Year)*, last modified January 10, 2006. Available at http://www.nssl.noaa.gov/primer/lightning/images/ltgflash_density.jpg, accessed July 24, 2008.

235. U.S. Navy, National Climatic Data Center, U.S. Air Force, *International Station Meteorological Climate Summary*, jointly produced by the Fleet Numerical Meteorology and Oceanography Detachment, NCDC, and U.S. Air Force Environmental Technical Applications Center OL-A under authority of the Commander, Naval Meteorology and Oceanography

Command, Department of the Navy, Department of Commerce, Department of the Air Force, CD-ROM Version 4.0, September 1996.

236. Holzworth, G., *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States*, U.S. EPA, Publication No. AP–101, January 1972.

237. Ferguson, S. et al., U.S. Department of Agriculture, Forest Service, *Assessing Values of Air Quality and Visibility at Risk from Wildland Fires, Forest Service, Pacific Northwest Research Station,* Research Paper PNW–RP–550, April 2003.

238. Landsea, C., J. Franklin, C. McAdie, J. Beven II, J. Gross, R. Pasch, E. Rappaport, J. Dunion, and P. Dodge, *A Reanalysis of Hurricane Andrew's Intensity*, Bull. Amer. Meteor. Soc. Vol. 85, No. 11, pp. 1699–1712, 2004.

239. Blake, E., E. Rappaport, and C. Landsea, *The Deadliest, Costliest, and Most Intense United States Tropical Cyclones from 1851 to 2006* (and Other Frequently Requested Hurricane Facts), NOAA Technical Memorandum, 2007.

240. U.S. Nuclear Regulatory Commission, *Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants,* Regulatory Guide 1.221, Rev. 0, October 2011.

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Table 2.3.1-201 NWS and Cooperative Observing Stations Near the Units 6 & 7 Site

Station	County	Approximate Distance (miles)	Direction Relative to Site	Elevation (feet)
Dania 4 WNW	Broward	46	NNE	10
Flamingo Ranger Station	Monroe	41	SW	3
Fort Lauderdale	Broward	47	NNE	16
Fort Lauderdale Experiment Station	Broward	46	N	10
Hialeah	Miami-Dade	27	N	12
Homestead Experiment Station	Miami-Dade	12	NW	11
Kendall 2 E	Miami-Dade	18	NNE	20
Miami Beach	Miami-Dade	28	NE	5
Miami 12 SSW[(a)]	Miami-Dade	16	NNE	10
Miami 12 SSW[(b)]	Miami-Dade	16	NNE	10
Miami International Airport[(c)]	Miami-Dade	25	N	29
Oasis Ranger Station	Collier	53	NW	8
Perrine 4 W	Miami-Dade	13	NNW	10
Pompano Beach	Broward	57	NNE	15
Royal Palm Ranger Station	Miami-Dade	17	WSW	7
Tamiami Trail 40-Mile Bend	Miami-Dade	38	NW	15
Tavernier	Monroe	31	SSW	7

(a) Period of record: 1933–1958
(b) Period of record: 1958–1988
(c) National Weather Service First-Order Station

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Table 2.3.1-202 Local Climatological Data Summary for Miami, Florida

NORMALS, MEANS, AND EXTREMES
MIAMI (KMIA)

LATITUDE: 25 ° 49'N LONGITUDE: 80 ° 17'W ELEVATION (FT): GRND: 6 BARO: 29 TIME ZONE: EASTERN (UTC 5) WBAN: 12839

	ELEMENT	POR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE °F	NORMAL DAILY MAXIMUM	30	76 5	77 7	80 7	83 8	87 2	89 5	90 9	90 6	89 0	85 4	81 2	77 5	84 2
	MEAN DAILY MAXIMUM	61	75 7	77 1	79 8	82 7	85 9	88 1	89 6	89 9	88 3	85 0	80 5	77 0	83 3
	HIGHEST DAILY MAXIMUM	66	88	89	93	96	96	98	98	98	97	95	91	87	98
	YEAR OF OCCURRENCE		1987	2008	2003	1971	2008	1985	1998	1990	1987	1980	2002	1989	JUL 1998
	MEAN OF EXTREME MAXS	61	83 5	85 3	87 7	90 0	91 3	92 8	93 4	93 8	92 3	89 8	86 0	83 7	89 1
	NORMAL DAILY MINIMUM	30	59 6	60 5	64 0	67 6	72 0	75 2	76 5	76 5	75 7	72 2	67 5	62 2	69 1
	MEAN DAILY MINIMUM	61	59 7	61 1	64 4	68 0	72 0	74 9	76 5	76 6	75 9	72 4	66 6	61 9	69 2
	LOWEST DAILY MINIMUM	66	30	32	32	46	53	60	69	68	68	51	39	30	30
	YEAR OF OCCURRENCE		1985	1947	1980	1971	1945	1984	2002	1950	1983	1943	1950	1989	DEC 1989
	MEAN OF EXTREME MINS	61	42 4	45 8	49 3	56 7	64 2	70 0	72 1	72 3	71 9	63 0	52 6	45 5	58 8
	NORMAL DRY BULB	30	68 1	69 1	72 4	75 7	79 6	82 4	83 7	83 6	82 4	78 8	74 4	69 9	76 7
	MEAN DRY BULB	61	67 7	69 1	72 2	75 4	79 0	81 6	83 0	83 3	82 1	78 7	73 6	69 5	76 3
	MEAN WET BULB	25	62 0	63 3	64 8	66 7	71 1	75 0	76 0	76 4	75 8	72 3	67 9	64 1	69 6
	MEAN DEW POINT	25	59 1	60 3	61 7	63 4	68 3	73 0	73 9	74 4	74 0	70 1	65 5	61 2	67 1
	NORMAL NO DAYS WITH														
	MAXIMUM > 90	30	0 0	0 0	0 3	1 7	4 8	10 8	18 0	16 9	10 8	2 6	0 0	0 0	65 9
	MAXIMUM < 32	30	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
	MINIMUM < 32	30	0 1	0 0	*	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 1	0 2
	MINIMUM < 0	30	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
H/C	NORMAL HEATING DEG DAYS	30	52	39	15	1	0	0	0	0	0	0	4	38	149
	NORMAL COOLING DEG DAYS	30	133	154	236	315	442	510	568	568	517	433	291	194	4361
RH	NORMAL (PERCENT)	30	73	71	70	67	71	76	74	76	78	75	74	73	73
	HOUR 01 LST	30	81	80	78	76	79	83	82	83	84	82	81	80	81
	HOUR 07 LST	30	85	84	82	79	80	83	83	85	87	85	84	84	83
	HOUR 13 LST	30	59	57	56	54	58	65	63	65	66	63	63	60	61
	HOUR 19 LST	30	70	68	66	64	69	74	72	75	77	73	72	71	71
S	PERCENT POSSIBLE SUNSHINE	20	66	68	74	76	72	68	72	71	70	70	67	63	70
W/O	MEAN NO DAYS WITH														
	HEAVY FOG(VISBY < 1/4 MI)	45	0 9	0 6	0 5	0 4	0 2	0 2	0 1	0 1	0 2	0 3	0 5	0 7	4 7
	THUNDERSTORMS	61	0 9	1 1	1 8	2 8	6 3	12 5	14 6	15 4	11 4	4 3	1 0	0 6	72 7
CLOUDNESS	MEAN														
	SUNRISE SUNSET (OKTAS)	48	4 3	4 2	4 3	4 2	4 6	5 4	5 1	5 1	5 3	4 6	4 3	4 2	4 6
	MIDNIGHT MIDNIGHT (OKTAS)	32	3 8	3 8	3 8	3 5	4 1	4 9	4 4	4 4	4 7	4 0	3 8	3 6	4 1
	MEAN NO DAYS WITH														
	CLEAR	47	9 2	8 6	8 5	8 4	6 3	3 1	2 6	2 5	2 1	6 6	7 5	8 9	74 3
	PARTLY CLOUDY	47	13 1	12 1	14 1	14 9	15 3	14 3	17 4	17 8	15 5	14 3	14 0	12 9	175 7
	CLOUDY	47	8 7	7 6	8 3	6 7	9 3	12 6	11 0	10 7	12 4	10 1	8 5	9 1	115 0
PR	MEAN STATION PRESSURE(IN)	25	30 10	30 07	30 04	30 00	29 98	30 00	30 04	29 99	29 94	29 96	30 03	30 08	30 02
	MEAN SEA LEVEL PRES (IN)	25	30 12	30 09	30 06	30 02	30 00	30 02	30 06	30 01	29 96	29 98	30 05	30 10	30 04
WINDS	MEAN SPEED (MPH)	25	8 9	9 2	10 1	9 8	9 1	7 8	7 6	7 4	7 8	8 9	9 3	8 6	8 7
	PREVAIL DIR(TENS OF DEGS)	40	35	12	12	11	09	12	12	11	11	06	10	35	12
	MAXIMUM 2 MINUTE														
	SPEED (MPH)	12	30	55	43	37	43	41	41	60	43	69	36	29	69
	DIR (TENS OF DEGS)		09	19	26	16	10	14	10	13	10	15	18	22	15
	YEAR OF OCCURRENCE		1998	1998	2003	2008	1999	2007	2005	2005	1998	2005	1998	1997	OCT 2005
	MAXIMUM 3 SECOND														
	SPEED (MPH)	12	40	104	51	52	63	53	55	78	51	92	44	40	104
	DIR (TENS OF DEGS)		26	19	26	15	33	14	04	12	28	15	31	23	19
	YEAR OF OCCURRENCE		2004	1998	2003	2008	1998	2007	2008	2005	2004	2005	1998	1997	FEB 1998
PRECIPITATION	NORMAL (IN)	30	1 88	2 07	2 56	3 36	5 52	8 54	5 79	8 63	8 38	6 19	3 43	2 18	58 53
	MAXIMUM MONTHLY (IN)	66	6 66	8 07	10 57	17 29	18 54	22 36	13 51	16 88	24 40	21 64	13 84	6 39	24 40
	YEAR OF OCCURRENCE		1969	1983	1986	1979	1968	1968	1947	1943	1960	1991	1992	1958	SEP 1960
	MINIMUM MONTHLY (IN)	66	0 04	0 01	0 02	0 05	0 44	1 81	1 77	1 65	2 63	0 72	0 09	0 12	0 01
	YEAR OF OCCURRENCE		1951	1944	1956	1981	1965	1945	1963	1954	1951	2002	1970	1988	FEB 1944
	MAXIMUM IN 24 HOURS (IN)	66	2 68	5 73	7 07	16 21	11 59	8 20	4 67	6 92	7 58	12 66	8 01	5 26	16 21
	YEAR OF OCCURRENCE		1973	1966	1949	1979	1977	1977	2003	1964	1960	2000	1992	2000	APR 1979
	NORMAL NO DAYS WITH														
	PRECIPITATION > 0 01	30	7 5	6 8	6 2	6 1	10 3	15 6	16 0	18 9	17 4	13 4	9 0	7 3	134 5
	PRECIPITATION > 1 00	30	0 4	0 5	0 8	0 9	1 4	2 7	1 6	2 5	2 7	1 7	0 9	0 5	16 6
SNOWFALL	NORMAL (IN)	30	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
	MAXIMUM MONTHLY (IN)	5	0 0	0 0	0 0	0 0	T	0 0	0 0	0 0	0 0	0 0	0 0	0 0	T
	YEAR OF OCCURRENCE						1998								MAY 1998
	MAXIMUM IN 24 HOURS (IN)	59	0 0	0 0	0 0	0 0	T	0 0	0 0	0 0	0 0	0 0	0 0	0 0	T
	YEAR OF OCCURRENCE'						1998								MAY 1998
	MAXIMUM SNOW DEPTH (IN)	53	0	0	0	0	0	0	0	0	0	0	0	0	0
	YEAR OF OCCURRENCE														
	NORMAL NO DAYS WITH SNOWFALL > 1 0	30	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0

published by NCDC Asheville, NC   3   30 year Normals (1971 2000)

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Table 2.3.1-203 (Sheet 1 of 2)
Climatological Extremes at Selected NWS and Cooperative Observing Stations in the Area of Units 6 & 7

Station	Maximum Temperature (°F)	Minimum Temperature (°F)	Maximum 24-Hour Rainfall (inches)	Maximum Monthly Rainfall (inches)	Maximum 24-Hour Snowfall (inches)	Maximum Monthly Snowfall (inches)
Dania 4 WNW	96[(a)(b)] (10/03/65)	42[(a)(b)] (11/19/51)	9.5[(a)(b)] (10/30/69)	22.0[(a)(b)] (09/60)	0.0[(a)(b)]	0.0[(a)(b)]
Flamingo Ranger Station	104[(c)] (06/24/98)	25[(c)] (12/25/89)	8.2[(c)] (08/18/81)	24.7[(c)] (05/75)	0.0[(c)]	0.0[(c)]
Fort Lauderdale	99[(c)] (07/13/80)	28[(c)] (01/20/77)	14.6[(c)] (04/25/79)	24.4[(c)] (06/92)	0.0[(c)]	0.0[(c)]
Fort Lauderdale Experiment Station	100[(a)(b)] (06/24/77)	26[(a)(b)] (01/20/77)	11.5[(a)(b)] (04/25/79)	21.3[(a)(b)] (06/66)	0.0[(a)(b)]	0.0[(a)(b)]
Hialeah	100[(c)] (07/10/98)	28[(c)] (01/13/81)	10.0[(c)] (05/05/77)	31.9[(c)] (06/99)	0.0[(c)]	0.0[(c)]
Homestead Experiment Station	100 [(a)(b)(d)] (06/24/44)	26[(a)(b)(e)] (02/16/43)	11.5[(a)(b)] (10/05/33)	27.3[(a)(b)] (08/81)	T[(a)(b)] (01/19/77)	T[(a)(b)] (01/77)
Kendall 2 E	N/A	N/A	9.8[(a)(b)] (05/25/58)	23.2[(a)(b)] (08/73)	0.0[(a)(b)]	0.0[(a)(b)]
Miami Beach	98[(c)] (08/29/99)	32[(c)] (12/24/89)	8.4[(c)] (09/23/60)	17.5[(c)] (05/84)	0.0[(c)]	0.0[(c)]
Miami 12 SSW POR 1933-1958	98[(a)(b)(f)] (06/18/34)	28[(a)(b)(g)] (02/06/47)	7.6[(a)(b)] (09/22/48)	23.8[(a)(b)] (09/48)	0.0[(a)(b)]	0.0[(a)(b)]
Miami 12 SSW POR 1958–1988	97[(a)(b)(h)] (08/10/87)	25[(a)(b)] (01/20/77)	10.1[(a)(b)] (09/10/60)	27.5[(a)(b)] (09/60)	0.0[(a)(b)]	0.0[(a)(b)]
Miami International Airport	98[(i)(j)] (07/03/98)	30[(i)(k)] (12/25/89)	14.9[(i)] (04/25/79)	24.4[k(i)] (09/60)	0.0[(c)]	0.0[(c)]
Oasis Ranger Station	103[(a)(b)] (06/18/81)	26[(a)(b)(l)] (02/16/91)	8.1[(a)(b)] (08/24/95)	24.2[(a)(b)] (06/99)	0.0[(a)(b)]	0.0[(a)(b)]
Perrine 4 W	98[(a)(b)] (07/04/98)	29[(a)(b)] (12/24/89)	15.1[(a)(b)] (08/26/05)	29.5[(a)(b)] (09/60)	0.0[(a)(b)]	0.0[(a)(b)]
Pompano Beach	101[(a)] (07/16/81)	21[(a)] (02/09/95)	12.7[(a)] (10/15/65)	34.4[(a)(b)] (10/65)	0.0[(a)]	0.0[(a)]
Royal Palm Ranger Station	102[(a)(m)] (04/28/07)	24[(a)] (01/20/77)	9.6[(a)] (06/09/97)	25.5[(a)(b)] (06/69)	0.0[(a)]	0.0[(a)]
Tamiami Trail 40-Mile Bend	102[(a)] (06/17/81)	28[(a)(n)] (12/25/89)	7.5[(a)(o)] (10/16/99)	23.5[(a)(b)] (06/69)	0.0[(a)]	0.0[(a)]
Tavernier	98[(a)(p)] (09/03/03)	35[(a)(q)] (12/24/89)	13.8[(a)] (06/02/82)	21.8[(a)(b)] (06/67)	0.0[(a)]	0.0[(a)]

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Table 2.3.1-203 (Sheet 2 of 2) Climatological Extremes at Selected NWS and Cooperative Observing Stations in the Area of Units 6 & 7

(a) Subsection 2.3.2, Reference 206
(b) Subsection 2.3.2, Reference 204
(c) Subsection 2.3.2, Reference 202
(d) Occurs on multiple dates: 07/21/42; 06/24/44 (most recent date shown in table).
(e) Occurs on multiple dates: 12/13/34; 03/02/41; 02/16/43 (most recent date shown in table)
(f) Occurs on multiple dates: 07/09/32; 06/18/34 (most recent date shown in table)
(g) Occurs on multiple dates: 01/28/40; 02/06/47 (most recent date shown in table)
(h) Occurs on multiple dates: 05/01/71; 06/25/87 (most recent date shown in table)
(i) Subsection 2.3.2, Reference 201
(j) Occurs on multiple dates: 06/04/85; 07/03/98; 08/01/90 (most recent date shown in table)
(k) Occurs on multiple dates: 01/22/85; 12/25/89 (most recent date shown in table)
(l) Occurs on multiple dates: 01/12/89; 12/25/89; 02/16/91 (most recent date shown in table)
(m) Occurs on multiple dates: 07/22/96; 04/28/07 (most recent date shown in table)
(n) Occurs on multiple dates: 01/22/85; 12/25/89 (most recent date shown in table)
(o) Occurs on multiple dates: 09/23/48; 10/16/99 (most recent date shown in table)
(p) Occurs on multiple dates: 08/14/57; 09/03/63 (most recent date shown in table)
(q) Occurs on multiple dates: 01/13/81;12/24/89 (most recent date shown in table)
N/A — Not Available. This parameter is not measured at this station.
T — Trace

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Table 2.3.1-204
Monthly, Seasonal, and Annual Morning and Afternoon Mixing Heights and Wind Speeds for the Area of Units 6 & 7

Period	Statistic[a]	Mixing Height (m, AGL)[b]		Wind Speed – (m/sec)		Ventilation Index (m²/sec)[c]	
		AM	PM	AM	PM	AM	PM
January	Min Max Mean	252 863 522	858 1400 1105	2.7 4.7 3.5	2.4 4.5 3.2	626 (P) 4674 (G) 2094 (M)	2890 (F) 5724 (G) 3644 (G)
February	Min Max Mean	359 1012 599	910 1458 1239	2.5 4.6 3.5	2.2 4.4 3.3	850 (P) 4510 (G) 2462 (F)	2771 (F) 5732 (G) 4129 (G)
March	Min Max Mean	406 1010 681	1043 1552 1311	2.8 4.8 3.5	2.6 4.6 3.3	1237 (M) 4872 (G) 2797 (F)	3189 (G) 6700 (G) 4394 (G)
April	Min Max Mean	272 1056 668	1128 1689 1412	2.5 4.4 3.3	2.2 4.0 3.1	946 (P) 4897 (G) 2549 (F)	3397 (F) 5894 (G) 4342 (G)
May	Min Max Mean	327 1224 688	881 1618 1338	2.1 4.6 3.1	2.2 4.3 2.9	1032 (P) 5564 (G) 2573 (F)	2566 (F) 5814 (G) 3981 (G)
June	Min Max Mean	327 928 577	725 1464 1165	1.8 4.1 3.1	2.2 4.3 2.9	945 (P) 4094 (G) 2019 (M)	1798 (M) 5256 (G) 3141 (F)
July	Min Max Mean	240 788 474	806 1547 1234	1.8 4.6 2.8	1.9 4.0 2.7	451 (P) 2946 (F) 1597 (M)	1742 (M) 4644 (G) 3423 (F)
August	Min Max Mean	254 774 478	958 1489 1237	2.1 4.4 2.3	2.1 4.0 2.8	824 (P) 3675 (G) 1705 (M)	2431 (F) 5225 (G) 3598 (G)
September	Min Max Mean	234 952 541	868 1430 1139	2.5 4.8 3.4	2.2 5.0 3.2	721 (P) 4502 (G) 2107 (M)	1894 (M) 6092 (G) 3755 (G)
October	Min Max Mean	376 1076 607	868 1556 1184	2.4 4.6 3.6	2.7 4.6 3.6	1433 (M) 4883 (G) 2612 (F)	2325 (M) 6145 (G) 4371 (G)
November	Min Max Mean	343 981 606	768 1406 1138	2.5 5.0 3.6	2.7 4.7 3.4	1296 (M) 5789 (G) 2598 (F)	2440 (F) 5596 (G) 3992 (G)
December	Min Max Mean	292 970 569	886 1486 1128	2.2 4.7 3.4	2.3 5.1 3.4	769 (P) 4723 (G) 2376 (F)	2437 (F) 5386 (G) 3926 (G)
Winter Spring Summer Fall Annual	Mean Mean Mean Mean Mean	563 679 510 585 584	1157 1354 1212 1154 1219	3.5 3.3 2.7 3.5 3.5	3.3 3.1 2.7 3.4 3.1	2306 (M) 2641 (F) 1771 (M) 2441 (F) 2291 (M)	3892 (G) 4238 (G) 3390 (F) 4043 (G) 3891 (G)

(a) Monthly minimum, maximum and mean values are based directly on summaries available from USDA - Forest Service Ventilation Climate Information System (VCIS) (Reference 216). Seasonal and annual mean values represent weighted averages based on the number of days in the appropriate months.

(b) AGL = above ground level.

(c) Classifications of ventilation potential from Ventila ion Index: P = Poor (0 to 1175 m^2/sec); M = Marginal (1176 to 2350 m^2/sec); F = Fair (2351 to 3525 m^2/sec); G = Good (> 3525 m^2/sec).

Figure 2.3.1-201 Climatological Observing Stations Near Units 6 & 7

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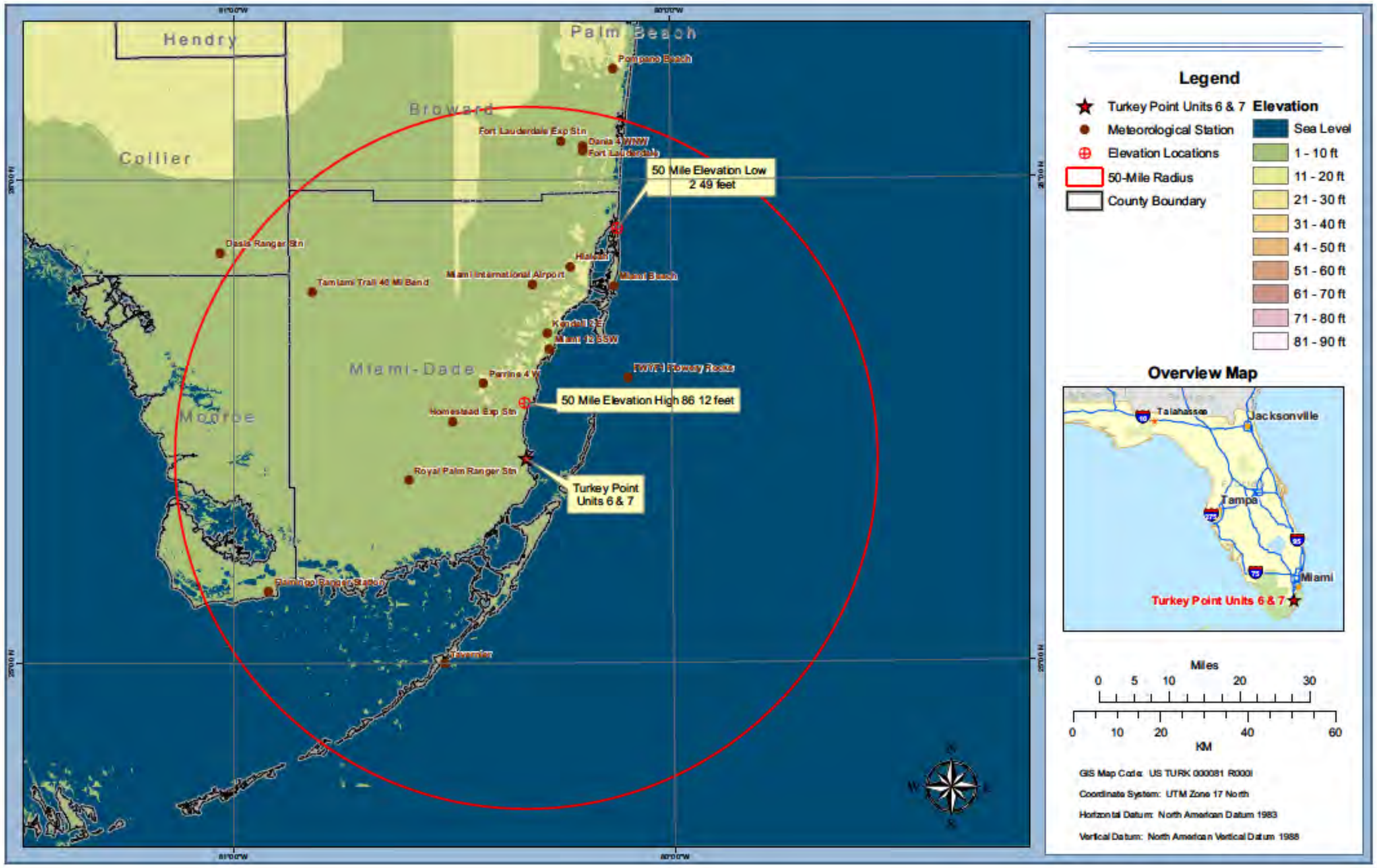

2.3.2 LOCAL METEOROLOGY

PTN COL 2.3-2 This subsection addresses various meteorological and climatological characteristics of the site and vicinity around the Units 6 & 7 site.

Subsection 2.3.2.1 identifies data resources used to develop the climatological descriptions and introduces information about the onsite meteorological monitoring program used to characterize site-specific atmospheric dispersion conditions.

Additionally, information presented in Subsection 2.3.2.1 has site-specific characteristics related to atmospheric transport and diffusion, based on measurements from the onsite meteorological monitoring program operated in support of Units 6 & 7, that are detailed, respectively, in Subsections 2.3.2.1.1 and 2.3.2.1.2 (wind speed and wind direction, and wind direction persistence) and in Subsection 2.3.2.1.3 (atmospheric stability).

Climatological normals, means and extremes (temperature, rainfall, snowfall, and fog), based on long-term records from nearby observing stations, are addressed in Subsections 2.3.2.1.4 through 2.3.2.1.7 and are evaluated to substantiate that observations are representative of conditions that might be expected to occur at the Units 6 & 7 site.

Subsection 2.3.2.2 addresses the potential influence the plant and its related facilities on local meteorology. Included in this description are the effects of changes in local topography, heat dissipation, and a description of current and future air quality conditions based on Units 6 & 7 operation.

Finally, Subsection 2.3.2.3 describes the local meteorological conditions for the design and operating bases of Units 6 & 7.

2.3.2.1 Normal, Mean, and Extreme Values of Meteorological Parameters

The primary sources of data used to characterize local meteorological and climatological conditions representative of the Units 6 & 7 site include long-term summaries from the first-order National Weather Service (NWS) Station at Miami International Airport, Florida, and other nearby cooperative network observing stations. Table 2.3.1-201 identifies the offsite observing stations, including the station at Miami International Airport and others, and provides the approximate

distance and direction of each station relative to the Units 6 & 7 site. Station locations are shown in Figure 2.3.1-201.

The NWS and cooperative observing station summaries were used to characterize climatological normals (30-year averages), and period-of-record means and extremes of temperature, rainfall, and snowfall in the vicinity of the site for Units 6 & 7. In addition, first-order NWS stations record hourly measurements (typically) of other weather elements, including winds, relative humidity, dew point, and wet bulb temperatures, as well as other observations (e.g., fog, thunderstorms). This information was based on the following resources:

- *2008 Local Climatological Data, Annual Summary with Comparative Data for Miami, Florida* (Reference 201)
- *Climatography of the United States, No. 20, 1971–2000, Monthly Station Climate Summaries* (Reference 202)
- *Climatography of the United States, No. 81, 1971–2000*, U.S. Monthly Climate Normals (Reference 203)
- *Period of Record General* and *Monthly Climate Summaries* for Cooperative Reporting Stations in the southeastern United States, Southeast Regional Climate Center (Reference 204)
- Utah Climate Center, Utah State University, *Climate Data Base for Florida* (Reference 206)

Measurements from the tower-mounted meteorological monitoring system that currently supports Units 3 & 4—specifically, wind direction, wind speed, and atmospheric stability—are the basis for determining and characterizing atmospheric dispersion conditions in the vicinity of the site. The data from this monitoring program, used to support Units 6 & 7, includes measurements taken over the three-year period of record during 2002, 2005, and 2006.

Refer to Subsection 2.3.3 for a description of relevant details about the tower location; terrain features and elevations at the meteorological tower and in the vicinity of Units 6 & 7; instrumentation and measurement levels; data recording and processing; system operation, maintenance, and calibration activities.

Wind and atmospheric stability characteristics, based on meteorological data obtained from the monitoring program operated in support of Units 6 & 7, are described in Subsections 2.3.2.2.1 through 2.3.2.2.3. This site-specific data also

provides input to dispersion modeling analyses of impacts, at onsite and offsite receptor locations, because of accidental and routine radiological releases to the atmosphere (see Subsections 2.3.4 and 2.3.5).

Summaries of normals, and period-of-record means and/or extremes for several standard weather elements—that is, temperature, atmospheric water vapor, precipitation, and fog are provided in Subsections 2.3.2.1.4 through 2.3.2.1.7, respectively.

2.3.2.1.1 Average Wind Direction and Wind Speed Conditions

The distribution of wind direction and wind speed is an important consideration when characterizing the dispersion climatology of a site. Long-term average wind motions at the macro- and synoptic scales (on the order of several thousand down to several hundred kilometers) are influenced by the general circulation patterns of the atmosphere at the macro-scale and by large-scale topographic features (land-water interfaces such as coastal areas). These characteristics are addressed in Subsection 2.3.1.2.

Site-specific or micro-scale (on the order of 2 kilometers or less) wind conditions, while they may reflect these larger-scale circulation effects, are influenced primarily by local and, to a lesser extent (in general), by meso- or regional-scale (up to approximately 200 kilometers), topographic features. Wind measurements at these smaller scales are currently available from the meteorological monitoring program operated in support of Units 3 & 4 and, for comparison, from data recorded at the nearby Miami International Airport, NWS Station.

Subsection 2.3.3 includes a description of the monitoring program that provides the onsite meteorological data used. Wind direction and wind speed measurements were made at 10 meters and at 60 meters on a 60-meter instrumented tower.

Figures 2.3.2-201 through 2.3.2-205 present annual and seasonal wind rose plots for the 10-meter level, i.e., graphical distributions of the direction from which the wind is blowing and wind speeds for each of 16, 22.5-degree compass sectors centered on north, north-northeast, and northeast, etc., for the 10-meter level based on measurements during 2002, 2005, and 2006. Figure 2.3.2-206 (Sheets 1 to 12) presents monthly wind rose plots for the 10-meter level during the same period 2002, 2005, and 2006.

The annual wind direction distribution at the 10-meter level generally follows an easterly orientation on an annual basis (see Figure 2.3.2-201). The prevailing

wind (the direction from which the wind blows most often) is from the east: with approximately 41 percent of the winds blowing from the east-northeast through east-southeast sectors. Conversely, winds from the west-southwest through west-northwest sectors occur approximately 7 percent of the time.

Winds from the east direction predominate during the spring, summer and autumn months (see Figures 2.3.2-203, 2.3.2-204, and 2.3.2-205). During the winter, the relative frequency of north-northwest winds during this season is greater (see Figure 2.3.2-202) because of increased cold frontal passages. Winds from the north-northwest quadrant predominate during the winter months (see Figure 2.3.2-202).

Annual and seasonal wind rose plots based on measurements at the 60-meter level are shown in Figures 2.3.2-207 through 2.3.2-211. By comparison, wind direction distributions for the 60-meter level are fairly similar to the 10-meter level wind roses on composite annual and seasonal bases in terms of the predominant directional quadrants and variation over the course of the year. Prevailing winds differ between the two levels by one adjacent direction sector, generally veering (turning clockwise) with height as might be expected. Plots of individual monthly wind roses at the 60-meter measurement level are presented in Figure 2.3.2-212 (Sheets 1 to 12).

Wind information summarized in the local climatological data (LCD) for the Miami International Airport Station (see Table 2.3.1-202) indicates a prevailing east-southeasterly wind direction on an annual basis, as well as seasonal variations (Reference 201), that appear to be similar to the 10-meter level wind flow at the Turkey Point site. Differences between the two wind direction distributions are attributable to many factors: topographic setting; sensor exposure; instrument threshold and accuracy, and length of record.

Table 2.3.2-201 summarizes seasonal and annual mean wind speeds based on measurements from the upper and lower levels of the meteorological tower operated in support of Units 6 & 7 over the 3-year period of record 2002, 2005, and 2006 and from wind instrumentation at the Miami International Airport Station based on a 24-year period of record (Reference 201). The elevation of the wind instruments at the Miami International Airport Station is nominally 33 feet above the ground surface (10 meters), comparable to the lower (10-meter) level measurements at the Turkey Point site.

On an annual basis, mean wind speeds at the 10- and 60-meter levels are 3.8 and 5.6 meters/second, respectively, at the Turkey Point site. The annual mean

wind speed at Miami International Airport (3.9 meters/second) is similar to the 10-meter level at the Turkey Point site, differing by only 0.10 meters/second. Seasonal average wind speeds at Miami International Airport are higher throughout the year except during summer when speeds average approximately 0.07 meters/second lower than those at the Turkey Point site. Seasonal mean wind speeds for both locations follow the same pattern described in Subsection 2.3.1.6 in relation to the seasonal variation of relatively higher air stagnation and restrictive dispersion conditions in the site region.

There were few calm winds recorded by the meteorological monitoring system at the 10-meter level and the 60-meter level during the annual periods in 2002, 2005, and 2006. [Note: Wind speeds greater than 0.5 mph (starting threshold of sensor) are considered non-calm winds. However, 42 hours of actual calm conditions occurred over the 2002, 2005, and 2006 periods. These hours, however, were not considered valid and were not used in the meteorological data set.]

2.3.2.1.2 Wind Direction Persistence

Wind direction persistence is a relative indicator of the duration of atmospheric transport from a specific sector-width to a corresponding downwind sector-width that is 180 degrees opposite. Atmospheric dilution is directly proportional to the wind speed (other factors remaining constant). When combined with wind speed, a wind direction persistence/wind speed distribution further indicates the downwind sectors with relatively more or less dilution potential (higher or lower wind speeds, respectively) associated with a given transport wind direction.

Tables 2.3.2-202 and 2.3.2-203 present wind direction persistence/wind speed distributions (in hours) based on measurements from the Units 6 & 7 monitoring program for the 3-year period of record from 2002, 2005, and 2006. The distributions account for durations ranging from 1 to 48 hours for wind directions from 22.5-degree upwind sectors centered on each of the 16 standard compass radials (i.e., north, north-northeast, northeast, etc.) and for wind speed groups greater than or equal to 5, 10, 15, 20, 25, 30, 35, and 40 mph. Distributions are provided for wind measurements made at the lower (10-meter) and the upper (60-meter) tower levels, respectively, identified in the preceding subsection.

At the 10-meter level, the longest persistence period is 36 hours for winds from the east-northeast and southeast sectors (see Table 2.3.2-202). This duration appears only in the lowest two wind speed groups for wind speeds greater than or equal to 5 and 10 mph. Persistence periods lasting for at least 30 hours are

indicated for several direction sectors for wind speeds greater than or equal to 5 mph, including winds from the northeast, east-northeast, east, and southeast. For wind speeds greater than or equal to 20 mph, maximum persistence is limited to 12 hours from the southeast.

At the 60-meter level, the longest persistence period is 36 hours and occurs for winds from three different direction sectors which include northeast, east-northeast, and north-northwest (see Table 2.3.2-203) for wind speeds greater than or equal to 5 mph and for wind speeds greater than or equal to 10 mph. Winds occur from one sector (i.e., northeast) for wind speeds greater than or equal to 15 mph and for wind speeds greater than or equal to 20 mph for a 36 hour period. For wind speeds greater than or equal to 25 mph, maximum persistence periods are limited to 12 hours for winds from the northeast and east-southeast sectors.

2.3.2.1.3 Atmospheric Stability

Atmospheric stability is a relative indicator for the potential diffusion of pollutants released into the ambient air. Atmospheric stability, as described in this FSAR, was based on the delta-temperature (ΔT) method defined in Table 1 of RG 1.23.

The approach classifies stability based on the temperature change with height (i.e., the difference in °C per 100 meters). Stability classifications are assigned according to the following criteria:

- Extremely Unstable (Class A) $\Delta T \leq -1.9°C$
- Moderately Unstable (Class B) $-1.9°C < \Delta T \leq -1.7°C$
- Slightly Unstable (Class C) $-1.7°C < \Delta T \leq -1.5°C$
- Neutral Stability (Class D) $-1.5°C < \Delta T \leq -0.5°C$
- Slightly Stable (Class E) $-0.5°C < \Delta T \leq +1.5°C$
- Moderately Stable (Class F) $+1.5°C < \Delta T \leq +4.0°C$
- Extremely Stable (Class G) $+4.0°C < \Delta T$

The diffusion capacity is greatest for extremely unstable conditions and decreases progressively through the remaining unstable, neutral, and stable classifications.

For the 3-year period of record from 2002, 2005, and 2006, ΔT was determined from the difference between temperature measurements made at the 60- and 10-meter tower levels. Seasonal and annual frequencies of atmospheric stability class and associated 10-meter level mean wind speeds for this period of record are presented in Table 2.3.2-204.

The data indicates a predominance of neutral stability (Class D) and slightly stable (Class E) conditions throughout the year, 28.5 percent and 36.5 percent of the time for these stability classes, respectively, and 65 percent combined. Extremely unstable conditions (Class A) are more frequent during the spring and occur least often during the summer and autumn months. Such extremely unstable conditions are attributed to relatively lower mean wind speeds and greater insolation in the summer and higher mean wind speeds and lesser insolation in the spring extremely stable conditions (Class G) are most frequent during the winter (approximately 10 percent of the time), owing in part to increased radiational cooling at night, and occur least often during the summer months.

Joint frequency distributions of wind speed and wind direction by atmospheric stability class and for stability classes combined for the 10-meter and 60-meter wind measurement levels are presented in Tables 2.3.2-205 and 2.3.2-206, respectively, based on the 3-year period of record from 2002, 2005, and 2006. The 10-meter level joint frequency distributions are used to evaluate short-term dispersion estimates for accidental atmospheric releases (see Subsection 2.3.4) and long-term diffusion estimates of routine releases to the atmosphere (see Subsection 2.3.5).

2.3.2.1.4 Temperature

Mean monthly normal annual temperatures are based on the average of the mean monthly maximum and minimum temperature values. Annual mean monthly normal temperatures over the site area range from 73.8°F at the Fort Lauderdale Experiment Station (approximately 46 miles north of Units 6 & 7) to 78.4°F at the Hialeah Station (approximately 27 miles to the north) (see Table 2.3.2-207).

Likewise, the mean monthly diurnal (day-to-night) temperature ranges, as indicated by the differences between the mean monthly maximum and minimum temperatures, are fairly comparable, ranging from 9.0°F at Miami Beach (approximately 28 miles to the northeast of the site) to 19.8°F at the Oasis Ranger Station (approximately 53 miles to the northwest) (Reference 205). The breadth of this range reflects each stations' proximity to the Atlantic Ocean. Miami Beach is

located directly on the coast (less temperature variability because of maritime influence), while Homestead Experiment Station is located further inland.

On a monthly basis, the 2008 LCD summary for Miami International Airport, Florida, indicates that the daily maximum normal temperature is highest during July (90.9°F) and August (90.6°F) and reaches a minimum in January (76.5°F) (Reference 201).

Extreme maximum temperatures recorded in the vicinity of the site for Units 6 & 7 have ranged from 96°F to 104°F, with the highest reading observed at the Flamingo Ranger Station (approximately 41 miles to the southwest) on June 24, 1998. As Table 2.3.2-208 and the accompanying description show, individual station extreme maximum temperature records were set at Oasis Ranger Station and Tamiami Trail 40-Mile Bend on adjacent dates in June 1981 (References 202 and 204).

Extreme minimum temperatures in the vicinity of the site for Units 6 & 7 have ranged from 21°F to 42°F, with the lowest reading on record observed at the Pompano Beach Station (approximately 57 miles to the north-northeast) on February 9, 1995. More noteworthy, though, Table 2.3.2-208 and the accompanying notes indicate that record low temperatures were also set at Miami Beach, Miami International Airport, Flamingo Ranger Station, Oasis Ranger Station, Perrine 4 W, Tamiami Trail 40-Mile Bend, and Tavernier on December 24–25, 1989 (References 202 and 204).

The extreme maximum and minimum temperature data indicates that synoptic-scale conditions responsible for periods of record-setting excessive heat as well as significant cold air outbreaks tend to affect the overall area at theTurkey Point site. The similarity of the respective extremes and their dates of occurrence suggest that these statistics are reasonably representative of the temperature extremes that might be expected to be observed at the site for Units 6 & 7.

2.3.2.1.5 Atmospheric Water Vapor

Based on a 25-year period of record, the LCD summary for Miami International Airport (see Table 2.3.1-202) indicates that the mean annual wet bulb temperature is 69.6°F, with a seasonal maximum during the summer months June through September, and a seasonal minimum during the winter months December through February. The highest monthly mean wet bulb temperature is 76.4°F in August (only slightly less during July); the lowest monthly mean value (62°F) occurs during January (Reference 201).

The LCD summary shows a mean annual dew point temperature of 67.1°F, also reaching its seasonal maximum and minimum during the summer and winter, respectively. The highest monthly mean dew point temperature is 74.4°F in August. The lowest monthly mean dew point temperature (59.1°F) occurs during January (Reference 201).

The 30-year normal daily relative humidity averages 73 percent on an annual basis, typically reaching its diurnal maximum in the early morning hours (approximately 0700 local standard time) and its diurnal minimum during the early afternoon hours (1300 local standard time). There is less variability in this daily pattern with the passage of weather systems, persistent cloud cover, and precipitation. Nevertheless, this diurnal pattern is evident throughout the year. The LCD summary indicates that average early morning relative humidity levels are greater than or equal to 85 percent during the months of August, September, October, and January (Reference 201).

2.3.2.1.6 Precipitation

Normal annual rainfall totals for the 17 nearby (within approximately 57 miles) observing stations that report rainfall listed in Table 2.3.2-207 vary greatly, ranging from 44.8 inches at Tavernier Station (approximately 31 miles to the south-southwest of Units 6 & 7) to 66 inches at the Hialeah Station (approximately 27 miles to the north) (Reference 203).

The LCD summary of normal rainfall totals for Miami International Airport, Florida indicates two seasonal maximums, the highest (8.63 inches) during late summer (August) with 8.38 inches early autumn (September), and the second (8.54 inches) during early summer (June). Together, these 3 months account for approximately 44 percent of the annual total of 58.53 inches for the Miami International Airport Florida Station. The overall maximum monthly total rainfall occurs during September (24.4 inches) (Reference 201). Maximum monthly rainfall totals range from 17.5 inches at Miami Beach (approximately 28 miles to the northeast of Units 6 & 7), to 34.4 inches at the Pompano Beach observing station (approximately 57 miles to the north-northeast of Units 6 & 7).

Subsection 2.3.1.3.4 addresses historical precipitation extremes (i.e., rainfall and snowfall), as presented in Table 2.3.2-208 for the 17 nearby climatological observing stations listed in Table 2.3.1-201. Based on the maximum 24-hour and monthly precipitation totals recorded among these stations and, more importantly, the aerial distribution of these stations around the site, the data suggests that

these statistics are reasonably representative of the extremes of rainfall and snowfall that might be expected to be observed at the Turkey Point site.

2.3.2.1.7 Fog

The closest station to the Turkey Point site at which observations of fog are made and routinely recorded is the Miami International Airport Station, approximately 25 miles to the north. The 2008 LCD summary for this station (Table 2.3.1-202) indicates an average of approximately 4.7 days per year of heavy fog conditions, based on a 45-year period of record. The NWS defines heavy fog as fog that reduces visibility to one-quarter mile or less (Reference 201).

Seasonally, heavy fog conditions occur most often during the winter months. It reaches a peak frequency in December and January, averaging 0.7 and 0.9 days per month, respectively. Heavy fog conditions occur least often from May through September, averaging 0.1 days per month (Reference 201).

The frequency of heavy fog conditions for Units 6 & 7 would be expected to be very similar to the Miami International Airport Station observations because of their proximity to each other (approximately 25 miles). This is consistent with the higher frequency of occurrence reported in *Climate Atlas of the United States* (Reference 207), which indicates an annual average frequency of 5.5 to 10.4 days per year in the area that includes the Turkey Point site and the same annual frequency in the area that includes Miami International Airport Station, Florida. The seasonal variation is very similar to that in the 2008 LCD for the Miami International Airport Station (Reference 201).

2.3.2.2 Potential Influence of the Plant and Related Facilities on Meteorology

The operation of Units 6 & 7 could influence the local micrometeorology in the immediate vicinity of the site. These effects could occur as a result of minor changes to the topography and vegetation resulting from land clearing and the construction of additional buildings and infrastructure, as well as the use of mechanical draft cooling towers for system heat rejection to the atmosphere. However, these alterations to the existing terrain are localized and will not represent a significant change to the flat topographic character of the site vicinity or the surrounding site area (see Figure 2.3.2-213). Neither the mean and extreme climatological characteristics of the site area, nor the meteorological characteristics of the site and vicinity, will be affected as a result of plant operation.

Wind flow will be altered in areas immediately adjacent to and downwind of larger site structures. However, these effects will likely dissipate in 10 structure heights downwind of the intervening structure(s). Similarly, while ambient temperatures immediately above any improved surfaces could increase, these temperature effects will be limited in their vertical profile and horizontal extent to alter local-, area-, or regional-scale mean or extreme ambient temperature patterns.

Detailed topographic features within 5 miles of the site for Units 6 & 7, also based on digital map elevations, are shown in Figure 2.3.2-214. Terrain within this radial distance of the site primarily consists of flat plains with little elevation change, relative to nominal plant grade.

The use of mechanical draft cooling towers for system heat rejection will result in visible moisture plumes from the cooling tower during certain atmospheric conditions. The amount of condensation of evaporated water vapor, and thus the formation of visible plumes from the cooling towers, are expected to be greatest during winter months.

Icing conditions caused by freezing condensed water vapor from cooling tower plumes could occur on vertical surfaces (such as buildings and equipment) and on horizontal surfaces (such as roadways) in the immediate vicinity of the cooling towers. However, given the climate in southern Florida, these types of conditions are expected to occur only on rare occasions and only at onsite locations. Because of the large distances from the locations of the cooling towers to areas of public access (such as roadways), the potential for fogging and icing conditions at offsite locations is unlikely.

2.3.2.2.1 Topographic Description

The Turkey Point plant property is on the southeastern coast of Florida, bordering Biscayne Bay and Card Sound, in unincorporated southeast Miami-Dade County. The Turkey Point plant site is located approximately 8 miles east of Florida City and 9 miles southeast of Homestead. The Turkey Point plant site is adjacent to Biscayne National Park, Palm Drive, Biscayne Bay, the Everglades Mitigation Bank, and the cooling canals. The Turkey Point plant property is approximately 9400 acres. The power block for Units 6 & 7 is an area of approximately 6 acres. The Turkey Point power block and surrounding area are shown on Figure 2.1-205.

Terrain features within 50 miles of the site for Units 6 & 7, based on digital map elevations, are illustrated in Figure 2.3.1-201. Terrain elevation profiles along each of the 16 standard 22.5-degree compass radials out to a distance of 50 miles from

the site are shown in Figure 2.3.2-213 (Sheets 1 through 6). Because Units 6 & 7 are relatively close to one another and because of the distance covered by these profiles, the locus of these radial lines is the center point between the Units 6 & 7 reactor buildings.

The finished grade elevation for Units 6 & 7 is 25.5 feet NAVD 88. The Turkey Point plant site and its immediate environs lie on the Floridian Plateau, a partly submerged peninsula of the continental shelf. Terrain within 50 miles of the site for Units 6 & 7 is generally flat and rises very gently from sea level to an elevation of approximately 10 feet NAVD 88 at a point some 8 to 10 miles west of the site. Figure 2.3.1-201 indicates that the highest elevation within 50 miles of the site is approximately 86 feet located north of Turkey Point. Figure 2.3.1-201 also indicates that the lowest elevation within 50 miles of the site, 2.49 feet below MSL, is to the northeast of the Turkey Point site.

2.3.2.2.2 Fogging and Icing Effects Attributable to Cooling Tower Operation

Ground-level fogging and icing impacts attributable to cooling tower operation are not expected to be significant. Although ground-level fogging events could occur in the immediate vicinity of the cooling towers, these events are expected at onsite locations under relatively cold and moist atmospheric conditions and when building wake and downwash effects (i.e., from the cooling tower structures or from nearby plant structures) influence the dispersion of the cooling tower plumes. The vapor plume from the circular mechanical draft circulating water system (CWS) cooling towers (three per unit) could be directed towards the ground under high wind conditions, creating ground-level fogging and icing. However, under high wind conditions the vapor plume would undergo rapid dispersion and result in lower moisture concentration at the ground level. Because of the warm climate in southern Florida, icing at the ground level is expected to be infrequent. For circular mechanical draft cooling towers, fogging and icing usually occur under high wind conditions (wind speed >12 m/s) (Reference 210). Because the CWS cooling towers are located to the south of the plant site, only winds coming from the south-southeast (SSE), south (S), and south-southwest (SSW) sectors would have the potential to create fogging at the switchyard, transformer areas, or transmission lines. Based on the 10-meter level joint frequency distributions (JFDs) provided in Table 2.3.2-205, only 22 hours (about 7 hours per year) have the wind speed greater than 10 m/s coming from SSE, S and SSW sectors. The shortest distance between the transformer areas and the cooling tower is about 1400 feet. Considering this long physical separation and low frequency of the southern winds, the potential fogging impact to the transformer areas, electrical equipment in the switchyard, and transmission lines is minimal.

Extended visible plumes from the cooling towers will likely occur most frequently during periods of high humidity when restricted visibility occurs naturally. Subsection 2.3.2.1.7 describes known and predicted occurrences of natural occurring fog, which served as a prediction of potential time periods when fogging from Units 6 & 7 is expected.

Significant ice formation on structures or at ground level is not expected to occur in the vicinity of the Turkey Point site. Climatological records from the Miami meteorological observing station in Table 2.3.1-202 indicate that the average number of days of below freezing ambient temperatures in the region is less than one day. There are no large safety-related plant structures or other nearby structures adversely affected by icing from the cooling tower plumes under any meteorological conditions that are expected to occur.

2.3.2.2.3 Assessment of Heat Dissipation Effects on the Atmosphere

Mechanical draft cooling towers are used to dissipate heat to the atmosphere from Units 6 & 7. Although the cooling towers do not significantly influence local meteorological conditions, there are some limited periods of time when visible cooling tower plumes may extend short distances from the cooling towers, possibly being visible from selected offsite locations.

Cooling towers evaporate water to dissipate heat to the atmosphere. Evaporation is followed by partial re-condensation, which creates a visible mist or plume. The plume creates the potential for shadowing, fogging, icing, and localized increases in humidity. In addition, small water droplets are blown out of the tops of the cooling towers. These water droplets are referred to as drift and could be deposited, along with any dissolved salts, on vegetation and surfaces surrounding the cooling towers.

The temperature of the exhaust plume from the CWS cooling towers is designed to be 10°F higher than the ambient temperature. With this temperature difference, under low wind conditions, the thermal vapor plume from the cooling tower will be elevated and without direct contact with the transformers, the switchyard equipment, transmission lines, and HVAC air intakes. As discussed in Subsection 2.3.2.2.2, under high wind conditions, the vapor plume would undergo rapid dispersion and result in decreasing moisture in the plume. These factors, together with the low frequency of the southern sector winds, would cause the moisture impact to the transformers, switchyard equipment, and transmission lines from operation of the CWS cooling towers to be minimal. Since the cooling tower plume is only about 2°F higher than the 100-year return dry-bulb

temperature, the plume is not hot enough to exceed the HVAC design temperature, as shown in DCD Table 2-1, and would not adversely impact the control room HVAC intakes.

For Units 6 & 7, the USEPA CALPUFF (Reference 208) and USEPA AERMOD (Reference 209) dispersion models were used to evaluate cooling tower plume behavior and to estimate the frequency of occurrence and length of visible cooling tower plumes. Five years (2001 through 2005) of hourly meteorological data (Miami surface and upper air observations) were used. Physical and performance characteristics of the mechanical draft cooling towers are as follows:

Parameter	Value
Number of Towers (Per Unit)	3
Circulating Water flow (Per Tower)	210,367 gpm
Cycle of Concentrations[a]	1.5 to 4
Approximate Height	67 feet
Approximate Base Diameter	246 feet
Number of cells (Per tower)	12
Number of fan per cell	1
Exit air delivery per fan	1,746,500 actual cubic feet per minute
Drift Rate	0.0005% (of the flow rate)
Heat Rejection Rate (million BTU/hr)	7,628
Solids Concentration (ppm)	50,000

(a) Cycle of Concentrations for saltwater is 1.5 (assume a saltwater salinity of approximately 33,000 ppm).

The analysis of cooling tower plume behavior for the 5-year simulation period (2001–2005) concluded that the predicted plumes would remain primarily on site. Visible vapor plumes would occur approximately 1723 hours per year, or approximately 20 percent of the year. Visible vapor plumes would occur during the winter months (718 hours), the spring (387 hours) and fall (388 hours) months. Table 2.3.2-209 summarizes the results for all hours.

Visible vapor plumes from the cooling towers remain close to each of the towers during the daylight when the plumes are the most visible. The results for daylight hours conclude that for the majority of the time, plume heights are less than 400 meters and plume lengths are less than 300 meters. Plume heights greater than 1000 meters are predicted to occur only one hour per year, while plume lengths in excess of 5000 meters would only occur 40 hours per year. Table 2.3.2-210 summarizes the results for all daylight hours.

Fogging from the cooling towers occurs when the visible plume intersects with the ground, appearing like fog to an observer. An analysis of cooling tower fogging and icing, using USEPA's CALPUFF model, concluded that there were no predicted occurrences of ground-level fogging during the summer season and minimal localized occurrence of fogging during the autumn and spring seasons at the plant area. During the winter season, the analysis concluded that fogging would occur for a total maximum of 5 hours during daylight hours for the entire 5-year simulation period at offsite areas on the eastern and southeastern perimeter of the site.

Salt deposition from the CWS cooling towers has the potential to build up on bushings of electrical equipment such as the Units 6 & 7 transformers, switchyard equipment, and transmission lines. A maximum salt deposition rate of 0.25 mg/cm^2/month was predicted to occur at the Unit 7 transformers, and a rate of approximately 0.20 mg/cm^2/month was predicted to occur at the transmission lines and switchyard, during the summer season. At this maximum monthly predicted salt deposition rate, the environment in the Unit 7 transformer area, due to the contribution of salt deposition from the cooling towers, could be classified as a "Heavy Contamination Level" environment. Whereas the environment at the transmission lines and switchyard areas, due to the contribution of maximum monthly summer salt deposition from the cooling towers, could be classified as a "Medium Contamination Level" environment. Typical equivalent salt deposition density levels, defined by the applicable IEEE Standard, "Guide for Application of Power Apparatus Bushings," are 0.08 - 0.25 mg/cm^2 and 0.25 - 0.6 mg/cm^2 for medium and heavy contamination levels, respectively (Reference 211). However, it is not anticipated that the salt deposition from the CWS cooling towers will accumulate to the point where it would have an adverse effect on electrical equipment based on the following:

- The salt deposition model assumed the radial collector wells were operated on a full-time basis. However, the radial collector well system is a back-up system; the primary CWS cooling makeup water system is reclaimed water, with a lower salinity (total dissolved solids concentration). For example, the maximum measured total dissolved solids value reviewed for Biscayne Bay was 34,000 ppm—accounting for approximately 1.5 cycles of concentration, 50,000 ppm was assumed in the model—versus a total dissolved concentration for the reclaimed water source of 960 ppm—accounting for 4 cycles of concentration, the total dissolved solids concentration for the CWS towers for the reclaimed water source may reach approximately 3840 ppm.

- The salt deposition model assumed the salt was transported as liquid droplets and did not account for evaporation of these droplets—essentially traveling the plume further out from the CWS cooling towers. The model also did not account for wet deposition.

- As depicted in FSAR Figure 2.3.2-204, the transformer, switchyard, and transmission lines are located north/northwest of the CWS cooling towers and the summer season prevailing wind direction is from the east.

It is anticipated that existing equipment condition monitoring programs would be able to recognize any degradation resulting from the cooling towers before it adversely affects the equipment.

Icing from the cooling towers would be the result of ground-level fogging when ambient temperatures are below freezing. However, the CALPUFF model predicted that no ground-level icing will occur as a result of cooling tower operation. Therefore, there will be no ground-level icing impacts as a result of cooling tower operation.

The AERMOD model was used to predict salt deposition from the operation of the Units 6 & 7 cooling towers. The simulation was modeled based on the cooling tower operational parameters and the 2001 through 2005 Miami meteorological data for upper air and surface data. Salt deposition up to 105 kg/ha per month is predicted near the makeup water reservoir.

Beyond the makeup water reservoir, the deposition rates are predicted to decrease rapidly. The monthly salt deposition into the industrial wastewater facility ranges from 1 to 70 kg/ha/month. Salt deposition of more than 10 kg/ha per month is generally confined to the plant property, with the exception of areas adjacent to the southeastern portion of the site.

No combined effects of cooling tower plume mixing with plant releases are expected to occur. Any gaseous effluents released from the plant during operation occur intermittently, at different elevations, and at locations other than the cooling towers. Also, any such releases are at or near ambient temperature and no significant plume rise occurs. Therefore, the potential for the mixing of the plumes is expected to be minimal.

2.3.2.2.4 Current and Projected Site Air Quality

This subsection addresses current ambient air quality conditions in the area of the Turkey Point site and region (e.g., the compliance status of various air pollutants)

that are relevant to plant design, construction, and operating basis. Subsection 2.3.1.3 characterized conditions (from a climatological standpoint) in the site area and region that may be restrictive to atmospheric dispersion.

2.3.2.2.5 Regional Air Quality Conditions

Units 6 & 7 are located in the Southeast Florida Intrastate Air Quality Control Region, which includes Broward, Miami-Dade, Indian River, Martin, Monroe, Okeechobee, Palm Beach, and St. Lucie counties. Attainment areas are areas where the ambient levels of criteria air pollutants are designated as being better than, unclassifiable/attainment, or cannot be classified or better than the EPA-promulgated National Ambient Air Quality Standards (NAAQS). Criteria pollutants are those for which NAAQS have been established: sulfur dioxide, particulate matter (i.e., PM_{10} and $PM_{2.5}$), carbon monoxide, nitrogen dioxide, ozone, and lead.

The Southeast Florida Intrastate Air Quality Control Region is classified as in attainment (unclassifiable) for each criteria pollutant. Smog caused by ozone is not expected to be a significant problem near Units 6 & 7 because of the attainment classification of Miami-Dade County.

Three pristine areas are located in the state of Florida with Class I Areas designated as *Mandatory Class I Federal Areas Where Visibility is an Important Value*. They include Everglades National Park, Chassahowitzka Wilderness Area, and St. Marks Wilderness Area. The Everglades National Park is the closest of the Class I areas and is located approximately 13 miles west of Units 6 & 7. The Chassahowitzka Wilderness Area and the St. Marks Wilderness Area are both more than 250 miles to the northwest.

2.3.2.2.6 Projected Air Quality Conditions

The Units 6 & 7 nuclear steam supply systems and other related systems are not sources of criteria pollutants or other air toxics. Supporting equipment (e.g., diesel generators, fire pump engines), and other emission-generating sources (e.g., storage tanks and related equipment) operate intermittently and are not significant sources of criteria (common) pollutant emissions. Therefore, these emission sources will not impact ambient air quality levels in the vicinity of Units 6 & 7. Likewise, because of the relatively long distance of separation from Units 6 & 7, visibility at any Class I federal areas will not be impacted.

Emission sources are regulated by the Florida Department of Environmental Protection (FDEP) depending on the source type, source emissions, and permitting requirements for construction and operation.

2.3.2.3 Local Meteorological Conditions for Design and Operating Bases

Design and operating bases, such as tornado parameters, temperature, and precipitation extremes are statistics that, by definition and necessity, are based on long-term regional records. Although data collected by the onsite meteorological monitoring system is representative of site conditions, only 3 years of onsite data has been analyzed. Therefore, the design and operating basis conditions were based on regional meteorological data, as previously described in Subsection 2.3.1.

2.3.2.4 References

201. National Climatic Data Center, *Local Climatological Data, Annual Summary with Comparative Data*, Miami, Florida, NESDIS, NOAA, 2008.

202. National Climatic Data Center, *Climatography of the United States, No. 20, 1971–2000*, Monthly Station Climate Summaries, Data Summaries for Flamingo Ranger Station, Fort Lauderdale, Hialeah, Miami Beach, Miami International Airport, Pompano Beach, Royal Palm Ranger Station, Tamiami Trail 40 Mile Bend, and Tavernier, Florida, CD-ROM, NESDIS, NOAA, July 2005.

203. National Climatic Data Center, *Climatography of the United States, No. 81,* 1971–2000, U.S. Monthly Climate Normals, CD-ROM, NCDC, NESDIS, NOAA, February 2002.

204. Southeast Regional Climate Center, *Period of Record General Climate Summaries of Temperature and Precipitation for Dania 4 WNW, Flamingo Ranger Station, Fort Lauderdale, Fort Lauderdale Experiment Station, Hialeah, Homestead Experiment Station, Kendall 2 E, Miami 12 SSW, Oasis Ranger Station, Perrine 4W, Pompano Beach, Royal Palm Ranger Station, Tamiami Trail 40 Mile Bend, and Tavernier,* August 19, 2008.

205. Southeast Regional Climate Center. *Period of Record Monthly Climate Summary*, Data Listings for Dania 4 WNW, Flamingo Ranger Station, Fort Lauderdale, Fort Lauderdale Experiment Station, Hialeah, Homestead Experiment Station, Kendall 2 E, Miami 12 SSW, Miami Beach, Miami International Airport, Oasis Ranger Station, Perrine 4W, Pompano Beach,

Royal Palm Ranger Station, and Tamiami Trail 40 Mile Bend, and Tavernier, June 30, 2008.

206. Climatological Data Archive, *Florida Climate for Dania 4 WNW, Flamingo Ranger Station, Hialeah, Homestead Experiment Station, Miami 12 SSW, Miami International Airport, Oasis Ranger Station, Perrine 4W, Pompano Beach, Royal Palm Ranger Station, and Tavernier*, Utah State University, Utah Climate Center. Available at http://climate.usurf.usu.edu/, accessed June 30, 2008.

207. National Climatic Data Center, Climate Services Division, *Climate Atlas of the United States*, Ver. 2.0 (CD-ROM), September 2002.

208. U.S. Environmental Protection Agency, *CALPUFF Modeling System*, Ver. 6.262. TRC Environmental Corp., Lowell, Massachusetts, 2007 Available at www.src.com/calpuff/calpuff1.htm.

209. U.S. Environmental Protection Agency, *AERMOD Modeling System*, EPA-454/B-03-001, September 2004. Available at http://www.epa.gov/scram001dispersion_ prefrec. htm# aermod.

210. Electric Power Research Institute, User's Manual, *Cooling-Tower-Plume Prediction Code*, EPRI Report CS-3403-CCM, Prepared by Argonne National Laboratory, April 1984.

211. Institute of Electrical and Electronics Engineers, *Guide for Application of Power Apparatus Bushings*, Reaffirmed December 9, 2003, Institute of Electrical and Electronics Engineers Standards Board, Reaffirmed April 26, 2004, American National Standards Institute, IEEE Standard C57.19.100-1995 (R2003).

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Table 2.3.2-201
Seasonal and Annual Mean Wind Speeds Units 6 & 7 (2002, 2005, and 2006)

Primary Tower Elevation	Location	Winter	Spring	Summer	Autumn	Annual
Upper Level (60 m) (m/sec)	Units 6 & 7 Site	6.1	5.9	4.8	5.5	5.6
Lower Level (10 m) (m/sec)	Units 6 & 7 Site	3.7	4.0	3.5	3.7	3.8
Single Level (10 m) (m/sec)	Miami International Airport[a]	4.0	4.3	3.4	3.9	3.9

(a) Reference 201

Notes:

Winter December, January, February
Spring March, April, May
Summer June, July, August
Autumn September, October, November

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Table 2.3.2-202 (Sheet 1 of 3) Wind Direction Persistence/Wind Speed Distributions for the Units 6 & 7 Site 10-Meter Level

Number of Sectors Included: 16, Width in Degrees: 22.5

Measurement Height, m: 10, Speed Sensor: 1, Direction Sensor: 1

Speed Greater than or Equal to: 5.00 mph

	Direction															
Hours	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	997	395	1465	2359	3979	3009	1836	1323	960	587	397	313	300	306	539	1554
2	527	144	1004	1553	2870	2007	1205	806	554	303	191	135	136	136	251	1008
4	170	27	593	852	1710	1034	642	350	230	104	71	40	42	46	73	519
8	23	0	268	345	722	324	265	72	49	9	11	4	7	6	6	177
12	6	0	129	178	294	101	137	7	13	0	0	0	1	1	0	62
18	0	0	47	79	71	6	44	0	1	0	0	0	0	0	0	20
24	0	0	15	51	17	0	19	0	0	0	0	0	0	0	0	8
30	0	0	3	29	6	0	10	0	0	0	0	0	0	0	0	0
36	0	0	0	15	0	0	4	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Speed Greater than or Equal to: 10.00 mph

	Direction															
Hours	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	202	157	889	1114	1771	1398	861	583	429	312	205	102	76	74	97	379
2	99	73	667	750	1196	933	602	342	233	186	117	39	25	43	42	233
4	33	15	432	402	628	493	351	131	84	59	42	6	4	16	11	105
8	10	0	193	171	201	156	152	27	13	2	4	0	0	1	0	22
12	2	0	87	99	46	52	84	3	1	0	0	0	0	0	0	4
18	0	0	27	57	17	1	29	0	0	0	0	0	0	0	0	0
24	0	0	9	31	6	0	15	0	0	0	0	0	0	0	0	0
30	0	0	3	15	0	0	8	0	0	0	0	0	0	0	0	0
36	0	0	0	7	0	0	2	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Speed Greater than or Equal to: 15.00 mph

	Direction															
Hours	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	16	16	165	115	225	227	203	75	66	74	63	21	4	10	11	58
2	6	9	117	69	132	144	143	38	42	41	31	7	2	5	3	32
4	1	4	69	29	57	75	92	12	18	13	8	0	0	3	0	11
8	0	0	24	3	12	17	38	0	3	0	0	0	0	0	0	0
12	0	0	13	0	3	6	18	0	0	0	0	0	0	0	0	0
18	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table 2.3.2-202 (Sheet 2 of 3) Wind Direction Persistence/Wind Speed Distributions for the Units 6 & 7 Site 10-Meter Level

Speed Greater than or Equal to: 20.00 mph																
Direction																
Hours	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**
1	0	1	7	3	15	31	36	16	8	12	6	4	0	1	0	3
2	0	0	5	1	5	19	24	8	5	7	1	1	0	0	0	0
4	0	0	3	0	2	9	16	2	3	2	0	0	0	0	0	0
8	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Speed Greater than or Equal to: 25.00 mph																
Direction																
Hours	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**
1	0	0	0	2	5	8	16	9	5	2	1	1	0	0	0	0
2	0	0	0	1	3	3	13	6	4	1	0	0	0	0	0	0
4	0	0	0	0	1	1	7	2	2	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speed Greater than or Equal to: 30.00 mph																
Direction																
Hours	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**
1	0	0	0	0	2	0	7	8	4	0	0	0	0	0	0	0
2	0	0	0	0	1	0	2	6	3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table 2.3.2-202 (Sheet 3 of 3) Wind Direction Persistence/Wind Speed Distributions for the Units 6 & 7 Site 10-Meter Level

Speed Greater than or Equal to: 35.00 mph																
	Direction															
Hours	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	0	0	0	0	0	0	0	7	2	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Speed Greater than or Equal to: 40.00 mph																
	Direction															
Hours	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table 2.3.2-203 (Sheet 1 of 3) Wind Direction Persistence/Wind Speed Distributions for the Units 6 & 7 Site 60-Meter Level

Number of Sectors Included: 16, Width in Degrees: 22.5
Measurement Height, m: 60, Speed Sensor: 2, Direction Sensor: 2
Speed Greater than or Equal to: 5.00 mph
Direction

Hours	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	1506	594	1762	2539	3822	3326	2123	1537	1109	753	544	383	489	580	711	1527
2	984	208	1208	1697	2683	2268	1396	948	651	424	287	165	249	308	382	1051
4	481	39	703	914	1530	1171	738	421	283	168	115	51	93	112	129	593
8	154	1	320	354	569	375	302	84	72	25	33	6	12	17	18	244
12	48	0	155	199	217	115	147	16	27	1	7	1	4	2	0	114
18	5	0	70	105	37	8	38	0	6	0	0	0	0	0	0	38
24	0	0	36	58	0	0	8	0	0	0	0	0	0	0	0	18
30	0	0	18	28	0	0	0	0	0	0	0	0	0	0	0	8
36	0	0	9	9	0	0	0	0	0	0	0	0	0	0	0	2
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Speed Greater than or Equal to: 10.00 mph
Direction

Hours	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	1122	371	1403	2023	2965	2346	1476	965	760	513	383	234	290	344	447	1232
2	740	150	1035	1416	2113	1574	1028	603	459	290	221	110	160	188	250	881
4	385	32	640	803	1205	830	600	278	196	110	86	34	65	81	85	514
8	133	1	303	335	454	286	266	63	41	14	24	4	12	15	11	224
12	40	0	152	197	176	94	134	11	10	0	2	0	4	2	0	104
18	5	0	69	105	28	7	36	0	1	0	0	0	0	0	0	35
24	0	0	36	58	0	0	8	0	0	0	0	0	0	0	0	18
30	0	0	18	28	0	0	0	0	0	0	0	0	0	0	0	8
36	0	0	9	9	0	0	0	0	0	0	0	0	0	0	0	2
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Speed Greater than or Equal to: 15.00 mph
Direction

Hours	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	438	137	923	921	1073	785	609	387	233	226	185	109	92	107	189	591
2	263	62	719	650	726	530	435	243	132	135	104	50	34	55	103	382
4	117	15	482	387	406	282	272	113	51	51	38	14	3	20	28	186
8	38	0	244	185	144	99	123	24	7	2	7	0	0	5	5	50
12	11	0	123	114	49	38	63	2	1	0	1	0	0	1	0	13
18	1	0	52	58	11	4	20	0	0	0	0	0	0	0	0	0
24	0	0	30	22	0	0	6	0	0	0	0	0	0	0	0	0
30	0	0	18	5	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table 2.3.2-203 (Sheet 2 of 3)
Wind Direction Persistence/Wind Speed Distributions for the Units 6 & 7 Site 60-Meter Level

Speed Greater than or Equal to: 20.00 mph																
	Direction															
Hours	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	55	26	345	209	153	125	151	92	54	57	61	19	13	26	29	104
2	25	9	267	135	89	74	102	48	31	30	30	6	5	15	12	55
4	4	0	179	73	43	30	61	13	13	7	7	0	1	6	2	17
8	0	0	87	28	13	6	32	1	1	0	0	0	0	1	0	1
12	0	0	44	13	4	2	16	0	0	0	0	0	0	0	0	0
18	0	0	28	7	0	0	6	0	0	0	0	0	0	0	0	0
24	0	0	21	1	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Speed Greater than or Equal to: 25.00 mph																
	Direction															
Hours	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	2	1	79	11	14	32	36	30	9	16	9	7	3	10	2	12
2	0	0	55	3	5	22	24	17	5	8	4	3	1	6	0	6
4	0	0	34	0	1	14	13	4	3	1	0	0	0	4	0	0
8	0	0	15	0	0	6	5	0	0	0	0	0	0	0	0	0
12	0	0	4	0	0	2	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speed Greater than or Equal to: 30.00 mph																
	Direction															
Hours	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	0	0	1	0	1	9	21	16	7	6	4	3	0	4	0	2
2	0	0	0	0	0	5	15	8	5	3	1	1	0	2	0	0
4	0	0	0	0	0	1	7	2	3	0	0	0	0	0	0	0
8	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table 2.3.2-203 (Sheet 3 of 3) Wind Direction Persistence/Wind Speed Distributions for the Units 6 & 7 Site 60-Meter Level

Speed Greater than or Equal to: 35.00 mph																
Direction																
Hours	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**
1	0	0	0	0	0	2	14	10	5	2	1	1	0	0	0	0
2	0	0	0	0	0	0	9	6	4	1	0	0	0	0	0	0
4	0	0	0	0	0	0	3	2	2	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Speed Greater than or Equal to: 40.00 mph																
Direction																
Hours	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**
1	0	0	0	0	0	1	8	8	5	1	0	0	0	0	0	0
2	0	0	0	0	0	0	4	6	4	0	0	0	0	0	0	0
4	0	0	0	0	0	0	1	2	2	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PTN COL 2.3-2

Table 2.3.2-204
Seasonal and Annual Vertical Stability Class and 10-Meter Level Wind Speed Distributions for Units 6 & 7 Site (2002, 2005, and 2006)

	Vertical Stability Categories[a]						
Period	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Winter							
Frequency (%)	5.17	6.08	9.14	26.64	31.01	11.67	10.29
Wind Speed (m/sec)	5.61	5.19	4.93	4.53	3.56	2.04	1.97
Spring							
Frequency (%)	12.52	7.62	7.52	23.72	30.37	9.35	8.90
Wind Speed (m/sec)	5.79	5.18	4.83	4.60	3.66	2.12	1.93
Summer							
Frequency (%)	2.78	4.37	6.52	30.78	42.21	11.61	1.73
Wind Speed (m/sec)	4.77	4.70	4.46	4.16	3.13	1.81	1.71
Autumn							
Frequency (%)	3.33	4.38	6.39	32.61	41.67	8.45	3.17
Wind Speed (m/sec)	4.70	4.64	4.68	4.30	3.32	1.96	2.15
Annual							
Frequency (%)	5.90	5.59	7.36	28.51	36.47	10.26	5.92
Wind Speed (m/sec)	5.47	4.98	4.74	4.37	3.38	1.97	1.96

(a) Vertical stability based on temperature difference (ΔT) between 60-meter and 10-meter temperature measurement levels.

PTN COL 2.3-2

Table 2.3.2-205 (Sheet 1 of 8) Joint Frequency Distribution of Wind Speed and Wind Direction (10-Meter Level) by Atmospheric Stability Class for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 10M **Speed:** WS10M

Direction: WD10M **Lapse:** DT10M–60M

Stability Class: A Extremely Unstable

	Wind Speed (m/s)												
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	0	0	0	0	0	5	40	26	3	0	0	0	74
NNE	0	0	0	0	0	0	20	23	0	0	0	0	43
NE	0	0	0	0	0	1	35	73	12	0	0	0	121
ENE	0	0	0	0	0	0	9	69	10	0	0	0	88
E	0	0	0	0	0	0	15	72	16	0	0	0	103
ESE	0	0	0	0	0	0	39	110	35	0	0	0	184
SE	0	0	0	0	0	0	46	78	23	1	0	0	148
SSE	0	0	0	0	1	14	110	77	13	0	0	0	215
S	0	0	0	0	0	4	58	92	22	0	0	0	176
SSW	0	0	0	0	0	2	11	37	15	0	0	0	65
SW	0	0	0	0	0	0	6	16	6	0	0	0	28
WSW	0	0	0	0	0	0	5	6	2	0	0	0	13
W	0	0	0	0	1	0	8	6	2	0	0	0	17
WNW	0	0	0	1	0	3	8	4	3	0	0	0	19
NW	0	0	1	0	2	1	20	14	0	0	0	0	38
NNW	0	0	0	0	0	4	67	76	21	0	0	0	168
Totals	**0**	**0**	**1**	**1**	**4**	**34**	**497**	**779**	**183**	**1**	**0**	**0**	**1500**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**873**
Number of Valid Hours for:	**Total Period**	**1500**
Total Hours for:	**Total Period**	**26,280**

Note: Stability class based on the vertical temperature difference (ΔT or lapse rate) between the 60-meter and 10-meter measurement levels.

PTN COL 2.3-2

Table 2.3.2-205 (Sheet 2 of 8)
Joint Frequency Distribution of Wind Speed and Wind Direction (10-Meter Level) by Atmospheric Stability Class for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 10M **Speed:** WS10M

Direction: WD10M **Lapse:** DT10M–60M

Stability Class: B Moderately Unstable

	Wind Speed (m/s)												
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	0	0	0	0	2	8	46	17	2	0	0	0	75
NNE	0	0	0	0	1	4	21	11	0	0	0	0	37
NE	0	0	0	0	0	0	65	45	5	0	0	0	115
ENE	0	0	0	0	0	2	55	60	4	0	0	0	121
E	0	1	0	0	1	1	47	69	19	0	0	0	138
ESE	0	0	0	0	0	1	94	109	16	0	0	0	220
SE	0	0	0	0	0	11	46	65	22	0	0	0	144
SSE	0	0	0	0	0	22	81	50	5	0	0	0	158
S	0	0	0	0	0	8	72	47	7	0	0	0	134
SSW	0	0	0	0	2	6	22	38	5	0	0	0	73
SW	0	0	0	0	2	3	5	16	14	0	0	0	40
WSW	0	0	0	0	1	2	3	9	0	0	0	0	15
W	0	0	0	0	0	0	8	3	1	0	0	0	12
WNW	0	0	0	0	0	1	8	6	1	0	0	0	16
NW	0	0	1	0	3	2	22	4	0	0	0	0	32
NNW	0	0	0	0	2	8	56	18	5	0	0	0	89
Totals	**0**	**1**	**1**	**0**	**14**	**79**	**651**	**567**	**106**	**0**	**0**	**0**	**1419**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**873**
Number of Valid Hours for:	**Total Period**	**1419**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-205 (Sheet 3 of 8) Joint Frequency Distribution of Wind Speed and Wind Direction (10-Meter Level) by Atmospheric Stability Class for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 10M **Speed:** WS10M

Direction: WD10M **Lapse:** DT10M–60M

Stability Class: C Slightly Unstable

Wind Speed (m/s)													
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	0	0	0	0	2	16	43	15	3	0	0	0	79
NNE	0	0	0	0	2	5	33	4	1	0	0	0	45
NE	0	0	0	0	1	8	78	60	6	0	0	0	153
ENE	0	0	0	1	0	7	75	90	20	0	0	0	193
E	0	0	0	0	0	7	152	143	14	0	0	0	316
ESE	1	0	0	0	0	15	175	128	19	0	0	0	338
SE	0	0	0	1	2	16	76	72	10	1	0	0	178
SSE	0	0	0	1	4	30	81	34	5	0	0	0	155
S	0	0	0	1	2	14	43	27	5	0	0	0	92
SSW	0	0	0	0	5	9	16	42	6	0	0	0	78
SW	0	0	0	0	0	4	11	13	5	0	0	0	33
WSW	0	0	0	0	0	11	13	7	0	0	0	0	31
W	0	0	1	2	2	3	7	8	0	0	0	0	23
WNW	0	0	0	0	1	3	16	8	2	0	0	0	30
NW	0	0	0	1	2	15	19	7	0	0	0	0	44
NNW	0	0	0	3	2	18	35	18	6	0	0	0	82
Totals	**1**	**0**	**1**	**10**	**25**	**181**	**873**	**676**	**102**	**1**	**0**	**0**	**1870**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**873**
Number of Valid Hours for:	**Total Period**	**1870**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-205 (Sheet 4 of 8) Joint Frequency Distribution of Wind Speed and Wind Direction (10-Meter Level) by Atmospheric Stability Class for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 10M **Speed:** WS10M

Direction: WD10M **Lapse:** DT10M–60M

Stability Class: D Neutral

	Wind Speed (m/s)												
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	0	0	5	13	18	75	121	42	4	0	0	0	278
NNE	0	0	1	4	11	35	54	25	4	0	0	0	134
NE	2	0	3	7	14	72	179	239	76	0	0	0	592
ENE	1	1	1	6	14	112	480	336	29	0	0	0	980
E	2	2	0	7	20	105	799	520	61	0	0	0	1516
ESE	1	0	1	7	21	114	644	271	50	0	0	0	1109
SE	0	0	1	10	11	72	270	160	47	6	2	0	579
SSE	0	1	1	12	16	78	191	111	7	1	2	2	422
S	1	0	1	3	11	45	178	59	7	0	1	1	307
SSW	0	1	2	5	16	36	95	62	15	4	0	0	236
SW	0	0	2	4	11	19	73	54	17	1	0	0	181
WSW	1	1	1	5	7	20	56	39	11	0	0	0	141
W	0	0	0	1	16	39	64	21	1	0	0	0	142
WNW	0	0	3	9	15	37	57	14	3	0	0	0	138
NW	0	1	1	14	20	47	55	11	6	0	0	0	155
NNW	1	1	0	18	25	62	155	62	9	0	0	0	333
Totals	**9**	**8**	**23**	**125**	**246**	**968**	**3471**	**2026**	**347**	**12**	**5**	**3**	**7243**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**873**
Number of Valid Hours for:	**Total Period**	**7243**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-205 (Sheet 5 of 8) Joint Frequency Distribution of Wind Speed and Wind Direction (10-Meter Level) by Atmospheric Stability Class for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 10M **Speed:** WS10M

Direction: WD10M **Lapse:** DT10M–60M

Stability Class: E Slightly Stable

Wind Speed (m/s)													
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	0	2	11	19	46	151	131	13	0	0	0	0	373
NNE	3	7	9	17	22	44	75	20	6	0	0	0	203
NE	0	2	5	23	22	89	252	140	22	1	0	0	556
ENE	3	3	9	36	75	289	586	132	3	3	0	0	1139
E	4	5	5	69	181	594	1062	232	20	7	2	0	2181
ESE	2	6	12	66	118	349	571	170	31	14	1	0	1340
SE	4	4	10	60	57	227	385	125	24	7	6	0	909
SSE	2	4	8	24	35	119	194	68	12	1	1	3	471
S	1	2	5	23	48	107	127	25	1	1	3	0	343
SSW	0	5	11	31	38	64	66	20	1	1	0	0	237
SW	2	5	7	22	27	44	32	24	5	1	0	0	169
WSW	0	3	4	41	27	32	38	6	0	0	0	0	151
W	1	1	9	36	36	70	34	3	0	0	0	0	190
WNW	2	4	11	40	44	60	27	3	0	0	0	0	191
NW	1	5	7	28	41	96	64	8	1	0	0	0	251
NNW	2	3	19	34	57	164	256	26	1	0	0	0	562
Totals	**27**	**61**	**142**	**569**	**874**	**2499**	**3900**	**1015**	**127**	**36**	**13**	**3**	**9266**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**873**
Number of Valid Hours for:	**Total Period**	**9266**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-205 (Sheet 6 of 8) Joint Frequency Distribution of Wind Speed and Wind Direction (10-Meter Level) by Atmospheric Stability Class for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 10M **Speed:** WS10M

Direction: WD10M **Lapse:** DT10M–60M

Stability Class: F Moderately Stable

	Wind Speed (m/s)												
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	1	7	13	49	67	117	27	1	0	0	0	0	282
NNE	1	1	4	21	16	14	6	3	0	0	0	0	66
NE	3	3	5	17	11	13	10	0	0	0	0	0	62
ENE	1	1	2	16	21	30	5	1	0	0	0	0	77
E	3	1	8	25	42	116	15	0	0	0	0	0	210
ESE	4	3	7	23	44	80	20	0	0	0	0	0	181
SE	3	6	7	21	34	63	10	1	0	0	0	0	145
SSE	2	3	6	19	19	25	5	0	0	0	0	0	79
S	1	1	2	17	10	23	7	0	0	0	0	0	61
SSW	1	4	8	21	17	22	5	0	0	1	0	0	79
SW	3	4	4	33	24	26	4	1	0	1	0	0	100
WSW	4	4	8	23	32	48	11	2	0	1	0	0	133
W	8	5	9	40	53	49	1	0	0	0	0	0	165
WNW	11	7	7	49	46	46	7	0	0	0	0	0	173
NW	5	6	17	66	82	85	28	0	0	0	0	0	289
NNW	5	8	21	83	145	180	60	2	0	0	0	0	504
Totals	**56**	**64**	**128**	**523**	**663**	**937**	**221**	**11**	**0**	**3**	**0**	**0**	**2606**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**873**
Number of Valid Hours for:	**Total Period**	**2606**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-205 (Sheet 7 of 8)
Joint Frequency Distribution of Wind Speed and Wind Direction (10-Meter Level) by Atmospheric Stability Class for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 10M **Speed:** WS10M

Direction: WD10M **Lapse:** DT10M–60M

Stability Class: G Extremely Stable

	Wind Speed (m/s)												
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	3	1	7	29	60	167	11	0	0	0	0	0	278
NNE	0	2	1	10	8	6	0	0	0	0	0	0	27
NE	2	0	1	4	0	2	0	0	0	0	0	0	9
ENE	0	0	0	2	0	0	0	0	0	0	0	0	2
E	1	1	0	1	5	2	0	0	0	0	0	0	10
ESE	0	0	1	0	2	0	0	0	0	0	0	0	3
SE	1	0	3	1	2	5	0	0	0	0	0	0	12
SSE	1	2	3	4	2	2	0	0	0	0	0	0	14
S	1	1	2	3	2	5	0	0	0	0	0	0	14
SSW	2	2	3	6	5	12	1	0	0	0	0	0	31
SW	3	0	3	14	15	21	2	0	0	0	0	0	58
WSW	1	1	2	11	22	20	2	0	0	0	0	0	59
W	1	3	6	21	33	24	0	0	0	0	0	0	88
WNW	3	5	9	39	52	35	0	0	0	0	0	0	143
NW	5	3	5	35	53	102	7	0	0	0	0	0	210
NNW	7	2	11	34	135	327	29	0	0	0	0	0	545
Totals	**31**	**23**	**57**	**214**	**396**	**730**	**52**	**0**	**0**	**0**	**0**	**0**	**1503**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**873**
Number of Valid Hours for:	**Total Period**	**1503**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-205 (Sheet 8 of 8) Joint Frequency Distribution of Wind Speed and Wind Direction (10-Meter Level) by Atmospheric Stability Class for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Summary of All Stability Classes

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 10M **Speed:** WS10M

Direction: WD10M **Lapse:** DT10M–60M

	Wind Speed (m/s)												
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	4	10	36	110	195	539	419	114	12	0	0	0	1,439
NNE	4	10	15	52	60	108	209	86	11	0	0	0	555
NE	7	5	14	51	48	185	619	557	121	1	0	0	1,608
ENE	5	5	12	61	110	440	1,210	688	66	3	0	0	2,600
E	10	10	13	102	249	825	2,090	1,036	130	7	2	0	4,474
ESE	8	9	21	96	185	559	1,543	788	151	14	1	0	3,375
SE	8	10	21	93	106	394	833	501	126	15	8	0	2,115
SSE	5	10	18	60	77	290	662	340	42	2	3	5	1,514
S	4	4	10	47	73	206	485	250	42	1	4	1	1,127
SSW	3	12	24	63	83	151	216	199	42	6	0	0	799
SW	8	9	16	73	79	117	133	124	47	3	0	0	609
WSW	6	9	15	80	89	133	128	69	13	1	0	0	543
W	10	9	25	100	141	185	122	41	4	0	0	0	637
WNW	16	16	30	138	158	185	123	35	9	0	0	0	710
NW	11	15	32	144	203	348	215	44	7	0	0	0	1,019
NNW	15	14	51	172	366	763	658	202	42	0	0	0	2,283
Totals	**124**	**157**	**353**	**1,442**	**2,222**	**5,428**	**9,665**	**5,074**	**865**	**53**	**18**	**6**	**25,407**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**873**
Number of Valid Hours for:	**Total Period**	**25,407**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-206 (Sheet 1 of 8)
Joint Frequency Distribution of Wind Speed and Wind Direction (60-Meter Level) by Atmospheric Stability for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 60M **Speed:** WS60M

Direction: WD60M **Lapse:** DT10M–60M

Stability Class: A Extremely Unstable

	Wind Speed (m/s)												
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	0	0	0	0	0	0	14	36	22	2	0	0	74
NNE	0	0	0	0	0	0	5	21	18	1	0	0	45
NE	0	0	0	0	0	0	1	43	72	7	0	0	123
ENE	0	0	0	0	0	0	0	31	40	5	0	0	76
E	0	0	0	0	0	0	4	45	54	5	0	0	108
ESE	0	0	0	0	0	0	16	89	66	3	0	0	174
SE	0	0	0	0	0	0	34	55	42	8	0	0	139
SSE	0	0	0	0	0	6	71	95	30	1	0	0	203
S	0	0	0	0	0	0	34	89	50	6	0	0	179
SSW	0	0	0	0	0	2	6	23	29	9	0	0	69
SW	0	0	0	0	0	0	1	6	13	4	0	0	24
WSW	0	0	0	0	0	0	5	4	4	0	0	0	13
W	0	0	0	0	1	0	1	6	6	2	0	0	16
WNW	0	0	0	0	0	1	3	9	4	0	3	0	20
NW	0	0	0	0	0	3	5	14	21	0	0	0	43
NNW	0	0	0	0	0	1	14	61	67	10	0	0	153
Totals	**0**	**0**	**0**	**0**	**1**	**13**	**214**	**627**	**538**	**63**	**3**	**0**	**1,459**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**2,337**
Number of Valid Hours for:	**Total Period**	**1,459**
Total Hours for:	**Total Period**	**26,280**

Note: Stability class based on the vertical temperature difference (ΔT or lapse rate) between the 60-meter and 10-meter measurement levels.

PTN COL 2.3-2

Table 2.3.2-206 (Sheet 2 of 8)
Joint Frequency Distribution of Wind Speed and Wind Direction (60-Meter Level) by Atmospheric Stability for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 60M **Speed:** WS60M

Direction: WD60M **Lapse:** DT10M–60M

Stability Class: B Moderately Unstable

	Wind Speed (m/s)												
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	0	0	0	0	0	4	22	32	11	1	0	0	70
NNE	0	0	0	0	0	1	13	22	7	0	0	0	43
NE	0	0	0	0	0	1	22	68	42	5	0	0	138
ENE	0	0	1	0	1	1	12	56	42	3	0	0	116
E	0	0	0	0	0	1	16	62	43	1	0	0	123
ESE	0	0	0	0	0	1	51	101	42	3	0	0	198
SE	0	0	0	0	1	6	42	44	43	6	0	0	142
SSE	0	0	0	0	0	11	57	48	26	1	0	0	143
S	0	0	0	0	0	3	39	70	21	1	0	0	134
SSW	0	0	0	0	1	3	15	34	16	3	0	0	72
SW	0	0	0	0	2	1	5	3	21	4	0	0	36
WSW	0	0	0	0	0	0	3	6	6	0	0	0	15
W	0	0	0	0	1	0	3	4	3	1	0	0	12
WNW	0	0	0	0	0	1	2	4	10	0	1	0	18
NW	0	0	0	0	2	2	12	11	3	0	0	0	30
NNW	0	0	0	0	0	4	24	35	18	3	0	0	84
Totals	**0**	**0**	**1**	**0**	**8**	**40**	**338**	**600**	**354**	**32**	**1**	**0**	**1374**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**2337**
Number of Valid Hours for:	**Total Period**	**1374**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-206 (Sheet 3 of 8) Joint Frequency Distribution of Wind Speed and Wind Direction (60-Meter Level) by Atmospheric Stability for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 60M **Speed:** WS60M

Direction: WD60M **Lapse:** DT10M–60M

Stability Class: C Slightly Unstable

	Wind Speed (m/s)												
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	0	0	0	0	0	7	24	30	17	0	0	0	78
NNE	0	0	0	0	0	3	19	19	4	2	0	0	47
NE	0	0	0	1	0	6	35	62	56	7	0	0	167
ENE	0	0	0	0	1	5	27	77	69	11	0	0	190
E	0	0	0	0	0	2	86	147	64	1	0	0	300
ESE	0	0	0	0	0	2	111	123	60	1	0	0	297
SE	0	0	0	0	1	11	54	68	47	2	1	0	184
SSE	0	0	0	1	4	16	58	49	13	1	0	0	142
S	0	0	0	2	1	13	25	31	11	1	0	0	84
SSW	0	0	0	0	2	5	14	24	24	4	0	0	73
SW	0	0	0	0	1	1	7	16	11	2	1	0	39
WSW	0	0	0	0	0	6	7	6	5	0	0	0	24
W	0	0	0	1	0	8	1	8	5	0	0	0	23
WNW	0	0	0	1	0	2	6	7	10	1	1	0	28
NW	0	0	0	0	3	5	16	10	8	2	0	0	44
NNW	0	0	0	0	0	5	18	26	16	5	0	0	70
Totals	**0**	**0**	**0**	**6**	**13**	**97**	**508**	**703**	**420**	**40**	**3**	**0**	**1790**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**2337**
Number of Valid Hours for:	**Total Period**	**1790**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-206 (Sheet 4 of 8) Joint Frequency Distribution of Wind Speed and Wind Direction (60-Meter Level) by Atmospheric Stability for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 60M **Speed:** WS60M

Direction: WD60M **Lapse:** DT10M–60M

Stability Class: D Neutral

Wind Speed (m/s)													
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	0	0	2	4	13	30	90	83	42	2	0	0	266
NNE	0	0	0	1	8	20	42	24	30	4	0	0	129
NE	0	0	1	2	7	40	117	113	238	102	5	0	625
ENE	0	0	0	1	13	44	226	337	339	28	0	0	988
E	0	3	0	3	7	42	389	514	290	24	0	0	1272
ESE	0	0	1	4	7	64	444	373	146	17	0	0	1056
SE	0	0	1	6	6	40	171	164	150	21	2	2	563
SSE	0	0	1	5	6	37	137	115	91	7	5	4	408
S	0	0	1	5	4	23	98	103	44	3	1	2	284
SSW	0	0	0	2	6	19	55	70	48	8	4	0	212
SW	0	0	0	3	7	12	31	64	52	6	2	0	177
WSW	0	0	0	2	2	16	24	20	31	8	1	0	104
W	0	0	0	4	7	19	26	37	30	3	0	0	126
WNW	0	0	0	4	7	25	36	26	18	6	1	0	123
NW	0	0	0	2	14	16	39	26	17	9	0	0	123
NNW	0	0	1	4	10	25	49	102	91	8	1	0	291
Totals	**0**	**3**	**8**	**52**	**124**	**472**	**1974**	**2171**	**1657**	**256**	**22**	**8**	**6747**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**2337**
Number of Valid Hours for:	**Total Period**	**6747**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-206 (Sheet 5 of 8)
Joint Frequency Distribution of Wind Speed and Wind Direction (60-Meter Level) by Atmospheric Stability for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 60M **Speed:** WS60M

Direction: WD60M **Lapse:** DT10M–60M

Stability Class: E Slightly Stable

	Wind Speed (m/s)												
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	0	0	0	2	1	20	109	167	56	0	0	0	355
NNE	0	0	0	1	3	13	52	66	36	0	0	0	171
NE	0	0	3	5	11	17	96	169	225	55	0	0	581
ENE	0	0	0	2	8	49	283	476	237	11	0	0	1066
E	0	3	1	5	12	101	553	799	340	18	3	0	1835
ESE	1	0	1	5	14	92	474	505	225	17	10	1	1345
SE	0	0	0	8	20	97	311	339	157	14	11	5	962
SSE	0	2	2	4	13	63	168	143	113	16	4	4	532
S	0	0	5	7	8	55	129	98	40	4	2	2	350
SSW	0	0	1	6	12	29	90	64	32	2	1	0	237
SW	0	0	2	3	6	27	50	42	28	3	1	0	162
WSW	0	0	1	4	4	22	28	34	12	0	0	0	105
W	0	0	0	10	8	30	49	41	5	1	0	0	144
WNW	0	1	3	5	6	22	57	46	17	1	0	0	158
NW	0	0	3	9	9	29	46	45	41	3	0	0	185
NNW	0	0	1	6	7	24	78	173	129	1	0	0	419
Totals	**1**	**6**	**23**	**82**	**142**	**690**	**2573**	**3207**	**1693**	**146**	**32**	**12**	**8607**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**2337**
Number of Valid Hours for:	**Total Period**	**8607**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-206 (Sheet 6 of 8)
Joint Frequency Distribution of Wind Speed and Wind Direction (60-Meter Level) by Atmospheric Stability for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 60M **Speed:** WS60M

Direction: WD60M **Lapse:** DT10M–60M

Stability Class: F Moderately Stable

	Wind Speed (m/s)												
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	0	0	2	7	14	28	83	124	51	0	0	0	309
NNE	0	0	0	7	6	19	41	18	4	0	0	0	95
NE	0	0	1	9	6	30	45	8	7	0	0	0	106
ENE	0	0	1	6	9	21	30	13	4	0	0	0	84
E	1	3	1	7	11	29	82	49	4	0	0	0	187
ESE	1	1	2	6	11	29	112	73	7	0	0	0	242
SE	0	2	5	6	11	25	69	55	1	0	0	0	174
SSE	0	0	5	12	8	29	54	27	0	0	0	0	135
S	0	0	1	1	5	17	35	20	0	0	0	0	79
SSW	1	1	3	1	7	14	53	11	3	0	1	0	95
SW	0	1	3	3	7	15	37	19	2	0	1	0	88
WSW	0	0	2	2	9	16	28	23	13	0	1	0	94
W	0	1	7	8	9	23	54	53	7	0	0	0	162
WNW	0	0	1	3	11	31	53	49	10	0	0	0	158
NW	0	1	3	4	9	20	45	45	37	0	0	0	164
NNW	0	0	4	8	10	33	68	102	76	0	0	0	301
Totals	**3**	**10**	**41**	**90**	**143**	**379**	**889**	**689**	**226**	**0**	**3**	**0**	**2473**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**2337**
Number of Valid Hours for:	**Total Period**	**2473**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-206 (Sheet 7 of 8) Joint Frequency Distribution of Wind Speed and Wind Direction (60-Meter Level) by Atmospheric Stability for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 60M **Speed:** WS60M

Direction: WD60M **Lapse:** DT10M–60M

Stability Class: G Extremely Stable

	Wind Speed (m/s)												
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	0	1	1	5	7	29	65	128	117	3	0	0	356
NNE	0	2	1	4	5	19	45	14	7	0	0	0	97
NE	0	2	0	1	9	23	38	1	0	0	0	0	74
ENE	0	1	2	2	6	23	19	1	0	0	0	0	54
E	0	1	1	7	4	13	23	4	0	0	0	0	53
ESE	0	0	2	8	4	13	11	1	0	0	0	0	39
SE	0	1	3	2	4	6	7	5	0	0	0	0	28
SSE	0	1	0	5	3	7	13	7	0	0	0	0	36
S	0	1	0	0	5	7	6	15	1	0	0	0	35
SSW	0	0	0	4	2	4	14	11	6	0	0	0	41
SW	0	1	0	4	1	9	16	21	10	0	0	0	62
WSW	1	0	1	3	4	7	26	10	11	0	0	0	63
W	0	0	1	2	4	12	34	26	3	0	0	0	82
WNW	0	0	0	2	4	22	47	44	4	0	0	0	123
NW	2	1	1	4	6	23	49	39	20	0	0	0	145
NNW	0	2	0	4	2	21	40	77	59	0	0	0	205
Totals	**3**	**14**	**13**	**57**	**70**	**238**	**453**	**404**	**238**	**3**	**0**	**0**	**1493**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**2337**
Number of Valid Hours for:	**Total Period**	**1493**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-206 (Sheet 8 of 8) Joint Frequency Distribution of Wind Speed and Wind Direction (60-Meter Level) by Atmospheric Stability for Units 6 & 7 Site (2002, 2005, and 2006)

Hours at Each Wind Speed and Direction

Summary of All Stability Classes

Total Period

Period of Record: 3-Year Composite (2002, 2005, 2006)

Elevation: 60M **Speed:** WS60M

Direction: WD60M **Lapse:** DT10M–60M

	Wind Speed (m/s)												
Wind Direction (from)	**0.22–0.50**	**0.51–0.75**	**0.76–1.0**	**1.1–1.5**	**1.6–2.0**	**2.1–3.0**	**3.1–5.0**	**5.1–7.0**	**7.1–10.0**	**10.1–13.0**	**13.1–18.0**	**>18.0**	**Total**
N	0	1	5	18	35	118	407	600	316	8	0	0	1,508
NNE	0	2	1	13	22	75	217	184	106	7	0	0	627
NE	0	2	5	18	33	117	354	464	640	176	5	0	1,814
ENE	0	1	4	11	38	143	597	991	731	58	0	0	2,574
E	1	10	3	22	34	188	1,153	1,620	795	49	3	0	3,878
ESE	2	1	6	23	36	201	1,219	1,265	546	41	10	1	3,351
SE	0	3	9	22	43	185	688	730	440	51	14	7	2,192
SSE	0	3	8	27	34	169	558	484	273	26	9	8	1,599
S	0	1	7	15	23	118	366	426	167	15	3	4	1,145
SSW	1	1	4	13	30	76	247	237	158	26	6	0	799
SW	0	2	5	13	24	65	147	171	137	19	5	0	588
WSW	1	0	4	11	19	67	121	103	82	8	2	0	418
W	0	1	8	25	30	92	168	175	59	7	0	0	565
WNW	0	1	4	15	28	104	204	185	73	8	6	0	628
NW	2	2	7	19	43	98	212	190	147	14	0	0	734
NNW	0	2	6	22	29	113	291	576	456	27	1	0	1,523
Totals	**7**	**33**	**86**	**287**	**501**	**1,929**	**6,949**	**8,401**	**5,126**	**540**	**64**	**20**	**23,943**

Number of Calm Hours not included above for:	**Total Period**	**0**
Number of Variable Direction Hours for:	**Total Period**	**0**
Number of Invalid Hours for:	**Total Period**	**2,337**
Number of Valid Hours for:	**Total Period**	**23,943**
Total Hours for:	**Total Period**	**26,280**

PTN COL 2.3-2

Table 2.3.2-207
Climatological Normals at Selected NWS and Cooperative Observing Stations in the Area of the Units 6 & 7 Site

Station	Normal Annual Temperatures (°F)				Normal Annual Precipitation	
	Mean Monthly Maximum	Mean Monthly Minimum	Mean Monthly Range	Mean Monthly Mean	Rainfall (inches)	Snowfall (inches)
Dania 4 WNW	N/A	N/A	N/A	N/A	54.7[a]	0.0[a]
Flamingo Ranger Station	84.3[b]	66.1[b]	18.2	75.2[b]	47.5[b]	0.0[a]
Fort Lauderdale	83.4[b]	68.3[b]	15.1	75.9[b]	64.2[b]	0.0[a]
Fort Lauderdale Experiment Station	83.5[a]	64.1[a]	19.4	73.8[a]	60.9[a]	0.0[a]
Hialeah	85.3[b]	71.4[b]	13.9	78.4[b]	66.0[b]	0.0[a]
Homestead Experiment Station	84.1[c]	65.5[c]	18.6	74.8[c]	58.2[c]	0.0[a]
Kendall 2 E	N/A	N/A	N/A	N/A	61.6[a]	0.0[a]
Miami Beach	80.3[b]	71.3[b]	9.0	75.9[b]	46.6[b]	0.0[a]
Miami 12 SSW (POR 1931-1958)	83.4[a]	66.3[a]	17.1	74.9[d]	55.8[a]	0.0[a]
Miami 12 SSW (POR 1958-1988)	82.9[a]	66.3[a]	16.6	74.6[d]	57.2[a]	0.0[a]
Miami International Airport	84.2[b]	69.1[b]	15.1	76.7[b]	58.5[b]	0.0[a]
Oasis Ranger Station	85.7[a]	65.9[a]	19.8	75.8[d]	58.8[c]	0.0[a]
Perrine 4 W	83.2[a]	64.9[a]	18.5	74.1[d]	61.6[c]	0.0[a]
Pompano Beach	84.5[b]	67.5[b]	17.0	76.0[b]	57.3[b]	0.0[a]
Royal Palm Ranger Station	84.9[b]	65.3[b]	19.6	75.1[b]	55.6[b]	0.0[a]
Tamiami Trail 40-Mile Bend	85.6[b]	66.0[b]	19.6	75.8[b]	51.6[b]	0.0[a]
Tavernier	82.4[b]	71.0[b]	11.4	76.7[b]	44.8[b]	0.0[a]

(a) Reference 205
(b) Reference 202
(c) Reference 203
(d) Value calculated as the mean of Mean Annual Maximum and Mean Annual Minimum.
N/A — Not Available

PTN COL 2.3-2

Table 2.3.2-208
Climatological Extremes at Selected NWS and Cooperative Observing Stations in the Area of the Units 6 & 7 Site

Station	Maximum Temperature (°F)	Minimum Temperature (°F)	Maximum 24-Hr Rainfall (inches)	Maximum Monthly Rainfall (inches)	Maximum 24-Hr Snowfall (inches)	Maximum Monthly Snowfall (inches)
Dania 4 WNW	96[(a)(b)] (10/03/65)	42[(a)(b)] (11/19/51)	9.5[(a)(b)] (10/30/69)	22.0[(a)(b)] (09/60)	0.0[(a)(b)]	0.0[(a)(b)]
Flamingo Ranger Station	104[(c)] (06/24/98)	25[(c)] (12/25/89)	8.2[(c)] (08/18/81)	24.7[(a)] (05/75)	0.0[(c)]	0.0[(c)]
Fort Lauderdale	99[(c)] [07/13/80]	28[(c)] (01/20/77)	14.6[(c)] (04/25/79)	24.4[(c)] (06/92)	0.0[(c)]	0.0[(c)]
Fort Lauderdale Experiment Station	100[(a)(b)] (06/24/77)	26[(a)(b)] (01/20/77)	11.5[(a)(b)] (04/25/79)	21.3[(a)(b)] (06/66)	0.0[(a)(b)]	0.0[(a)(b)]
Hialeah	100[(c)] (07/10/98)	28[(c)] (01/13/81)	10.0[(c)] (05/05/77)	31.9[(c)] (06/99)	0.0[(c)]	0.0[(c)]
Homestead Experiment Station	100[(a)(b)(d)] (06/24/44)	26[(a)(b)(e)] (02/16/43)	11.5[(a)(b)] (10/05/33)	27.3[(a)(b)] (08/81)	T[(a)(b)] (01/19/77)	T[(a)(b)] (01/77)
Kendall 2 E	N/A	N/A	9.8[(a)(b)] (05/25/58)	23.2[(a)(b)] (08/73)	0.0[(a)(b)]	0.0[(a)(b)]
Miami Beach	98[(c)] (08/29/99)	32[(c)] (12/24/89)	8.4[(c)] (09/23/60)	17.5[(c)] (05/84)	0.0[(c)]	0.0[(c)]
Miami 12 SSW (POR 1931-1958)	98[(a)(b)(f)] (06/18/34)	28[(a)(b)(g)] (02/06/47)	7.6[(a)(b)] (09/22/48)	23.8[(a)(b)] (09/48)	0.0[(a)(b)]	0.0[(a)(b)]
Miami 12 SSW (POR 1958-1988)	97[(a)(b)(h)] (08/10/87)	25[(a)(b)(i)] (01/20/77)	10.1[(a)(b)] (09/10/60)	27.5[(a)(b)] (09/60)	0.0[(a)(b)]	0.0[(a)(b)]
Miami International Airport	98[(j)(k)(l)] (07/03/98)	30[(k)(m)] (12/25/89)	14.9[(k)] (04/25/79)	24.4[(k)] (09/60)	0.0[(c)]	0.0[(c)]
Oasis Ranger Station	103[(a)(b)] (06/18/81)	26[(a)(b)(n)] (02/16/91)	8.1[(a)(b)] (08/24/95)	24.2[(a)(b)] (06/99)	0.0[(a)(b)]	0.0[(a)(b)]
Perrine 4 W	98[(a)(b)] (07/04/98)	29[(a)(b)] (12/24/89)	15.1[(a)(b)] (08/26/05)	29.5[(a)(b)] (09/60)	0.0[(a)(b)]	0.0[(a)(b)]
Pompano Beach	101[(a)] (07/16/81)	21[(a)] (02/09/95)	12.7[(a)] (10/15/65)	34.4[(a)(b)] (10/65)	0.0[(a)]	0.0[(a)]
Royal Palm Ranger Station	102[(a)(o)] (04/28/07)	24[(a)] (01/20/77)	9.6[(a)] (06/09/97)	25.5[(a)(b)] (06/69)	0.0[(a)]	0.0[(a)]
Tamiami Trail 40-Mile Bend	102[(a)] (06/17/81)	28[(a)(p)] (12/25/89)	7.5[(a)(q)] (10/16/99)	23.5[(a)(b)] (06/69)	0.0[(a)]	0.0[(a)]
Tavernier	98[(a)(r)] (09/03/03)	35[(a)(s)] (12/24/89)	13.8[(a)] (06/02/82)	21.8[(a)(b)] (06/67)	0.0[(a)]	0.0[(a)]

PTN COL 2.3-2

Table 2.3.2-208
Climatological Extremes at Selected NWS and Cooperative Observing Stations in the Area of the Units 6 & 7 Site

(a) Reference 206
(b) Reference 204
(c) Reference 202
(d) Occurs on multiple dates: 07/21/42; 06/24/44 (most recent date shown in table)
(e) Occurs on multiple dates: 12/13/34; 03/02/41; 02/16/43 (most recent date shown in table)
(f) Occurs on multiple dates: 07/09/32; 06/18/34 (most recent date shown in table)
(g) Occurs on multiple dates: 01/28/40; 02/06/47 (most recent date shown in table)
(h) Occurs on multiple dates: 05/01/71; 06/25/87 (most recent date shown in table)
(i) Occurs on multiple dates: 08/06/54; 07/19/81; 06/04/85 (most recent date shown in table)
(j) Occurs on multiple dates: 01/22/85; 12/25/89 (most recent date shown in table)
(k) Reference 201
(l) Occurs on multiple dates: 06/04/85; 07/03/98; 08/01/90 (most recent date shown in table)
(m) Occurs on multiple dates: 01/22/85; 12/25/89 (most recent date shown in table)
(n) Occurs on multiple dates: 01/12/89; 12/25/89; 02/16/91 (most recent date shown in table)
(o) Occurs on multiple dates: 07/22/96; 04/28/07 (most recent date shown in table)
(p) Occurs on multiple dates: 01/22/85; 12/25/89 (most recent date shown in table)
(q) Occurs on multiple dates: 09/23/48; 10/16/99 (most recent date shown in table)
(r) Occurs on multiple dates: 08/14/57; 09/03/63 (most recent date shown in table)
(s) Occurs on multiple dates: 01/13/81;12/24/89 (most recent date shown in table)
N/A — Not Available. This parameter is not measured at this station.
T — Trace

PTN COL 2.3-2

Table 2.3.2-209
CALPUFF Predicted Visible Cooling Tower Vapor Plume Height and Length — All Hours

Conditions		Winter hours/ year	Winter %	Spring hours/ year	Spring %	Summer hours/ year	Summer %	Autumn hours/ year	Autumn %	Annual[(a)] hours/ year	Annual[(a)] %
Ambient Fog/ Calm Hours Removed		**718**	**41.7**	**387**	**22.5**	**230**	**13.3**	**388**	**22.5**	**1723**	**100.0**
Plume Height (m)											
>0	200	365	50.78	222	57.45	115	50.00	206	53.17	908	52.71
>200	400	328	45.63	153	39.61	106	46.25	168	43.32	755	43.84
>400	600	15	2.14	8	1.96	6	2.53	9	2.37	38	2.21
>600	1000	10	1.34	4	0.98	3	1.13	4	1.13	20	1.18
>1000		1	0.11	0	0.00	0	0.09	0	0.00	1	0.06
Plume Length (m)											
>0	100	166	23.1	111.2	28.75	65.8	28.66	104.4	26.92	447	25.96
>100	300	220	30.6	119.6	30.92	67.4	29.36	104.8	27.02	511	29.69
>300	500	35	4.8	16.2	4.19	9.4	4.09	14.8	3.82	75	4.35
>500	1000	46	6.5	25	6.46	17.4	7.58	38.6	9.95	127	7.40
>1000	3000	84	11.6	43.6	11.27	28.4	12.37	47.6	12.27	203	11.80
>3000	5000	52.4	7.29	22.4	5.79	16.6	7.23	26.2	6.76	118	6.83
>5000		116	16.15	49	12.62	25	10.71	51	13.25	241	13.98

(a) Annual average of the 5-year period from 2001 to 2005.

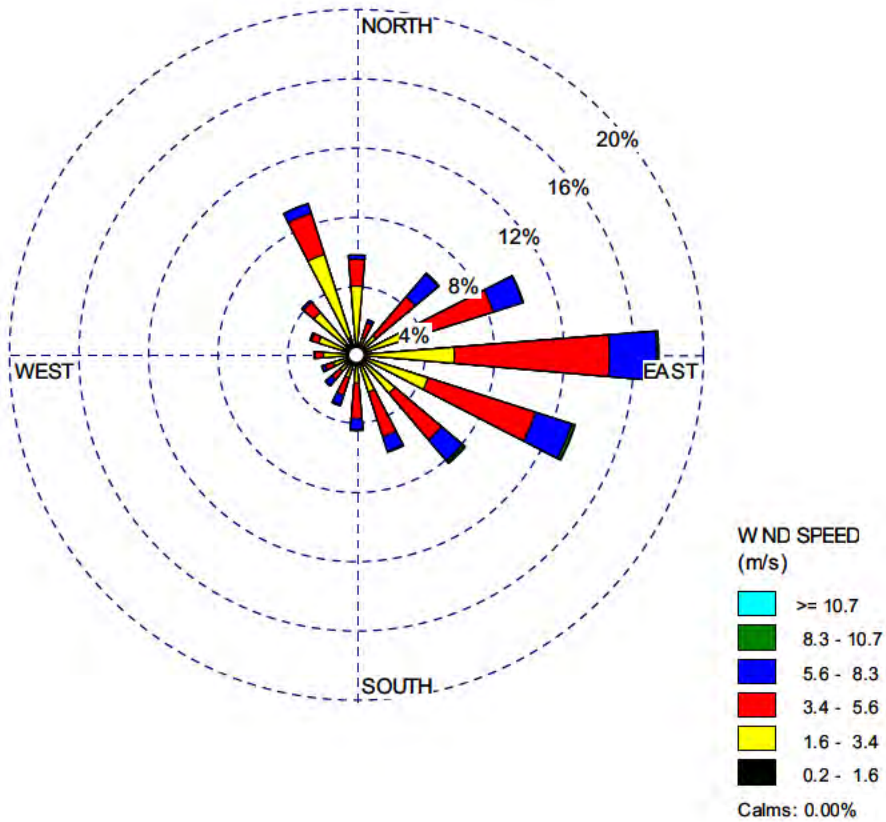
PTN COL 2.3-2

Table 2.3.2-210
CALPUFF Predicted Visible Cooling Tower Vapor Plume Height and Length — Daylight Hours

Conditions		Winter hours/ year	Winter %	Spring hours/ year	Spring %	Summer hours/ year	Summer %	Autumn hours/ year	Autumn %	Annual[a] hours/ year	Annual[a] %
Ambient Fog/ Calm Hours Removed		**213**	**36.5%**	**137**	**23.4**	**99**	**17.0**	**134**	**23.0**	**584**	**100.0**
Plume Height (m)											
>0	200	119	55.87	84	61.40	57	57.75	77	56.99	337	57.75
>200	400	79	36.90	46	33.48	34	34.61	47	35.12	206	35.30
>400	600	9	41.13	5	3.36	6	5.63	7	5.06	26	4.42
>600	1000	6	2.91	2	1.75	2	1.81	4	2.83	14	2.43
>1000		0	0.19	0	0.00	0	0.20	0	0.00	1	0.10
Plume Length (m)											
>0	100	61	28.8	41.4	30.26	30.8	30.99	37.6	27.98	171	29.34
>100	300	77	36.3	55	40.20	42	42.25	46.4	34.52	221	37.83
>300	500	13	5.9	7.8	5.70	5.6	5.63	7.4	5.51	33	5.75
>500	1000	15	7.2	11.6	8.48	9.6	9.66	16	11.90	53	9.01
>1000	3000	19	8.8	9.8	7.16	7.6	7.65	13	9.67	49	8.43
>3000	5000	7.4	3.47	3.6	2.63	1.8	1.81	4	2.98	17	2.88
>5000		20	9.39	8	5.56	2	2.01	10	7.44	40	6.79

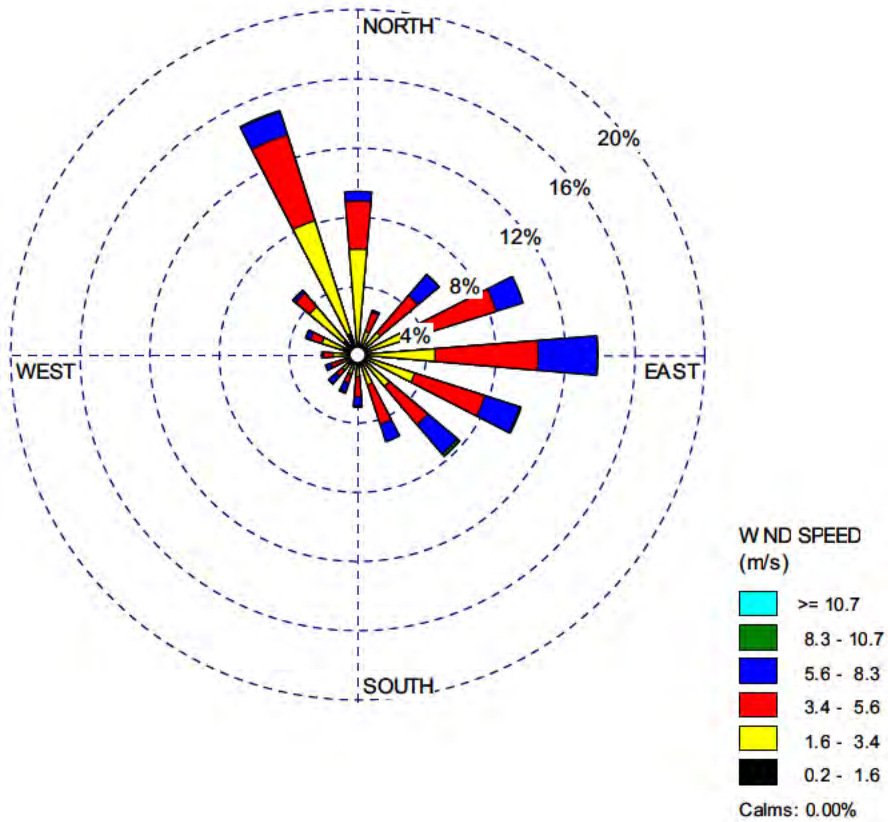
(a) Annual average of the 5-year period from 2001 to 2005.

PTN COL 2.3-2 **Figure 2.3.2-201 10-Meter Level 3-Year Composite Wind Rose — Annual (2002, 2005, and 2006)**



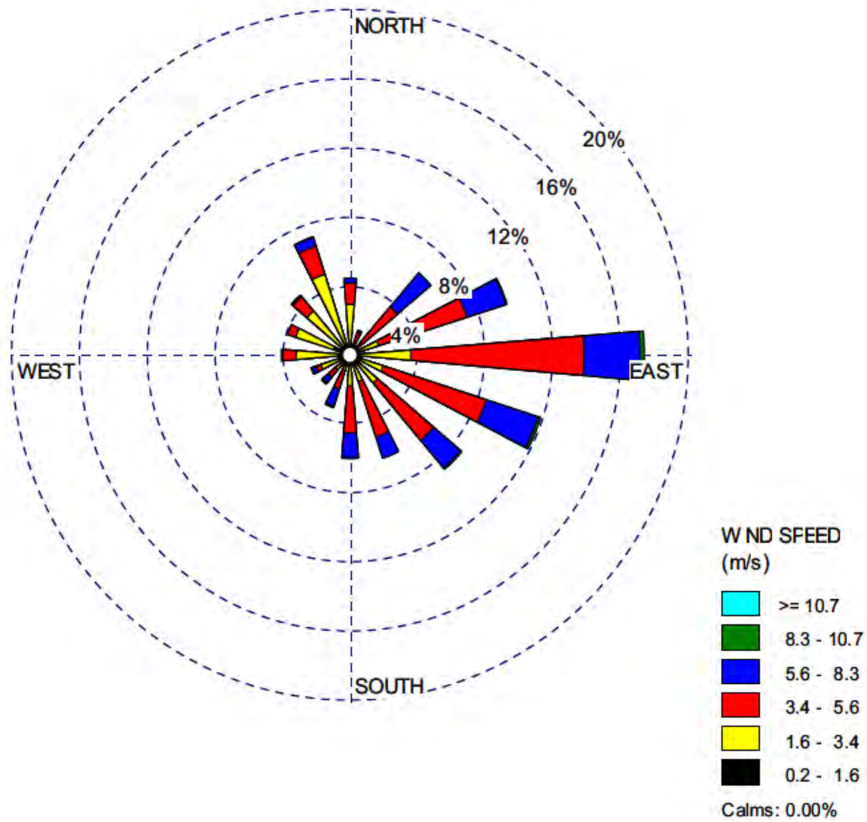
PTN COL 2.3-2

Figure 2.3.2-202 10-Meter Level 3-Year Composite Wind Rose — Winter (2002, 2005, and 2006)

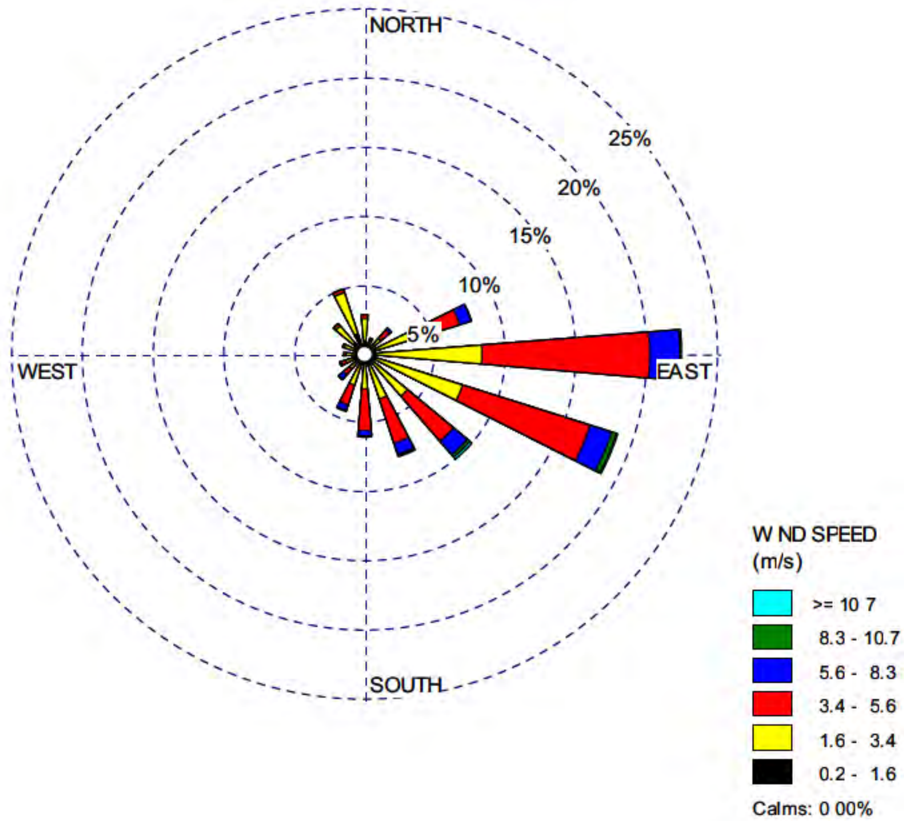


PTN COL 2.3-2

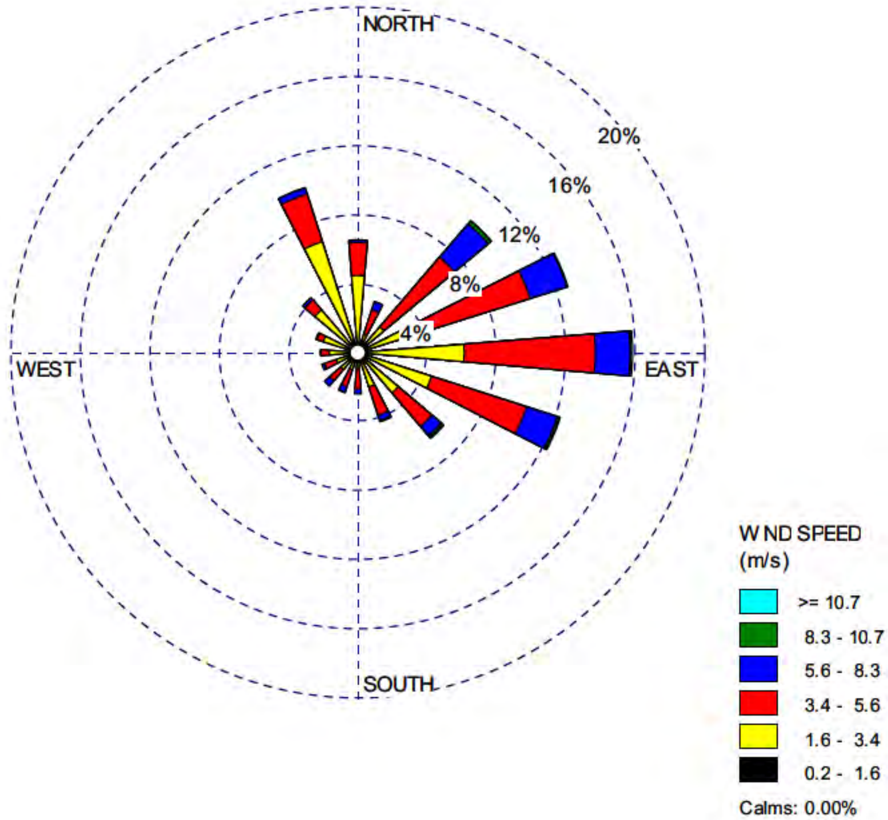
Figure 2.3.2-203 10-Meter Level 3-Year Composite Wind Rose — Spring (2002, 2005, and 2006)



PTN COL 2.3-2 **Figure 2.3.2-204 10-Meter Level 3-Year Composite Wind Rose — Summer (2002, 2005, and 2006)**

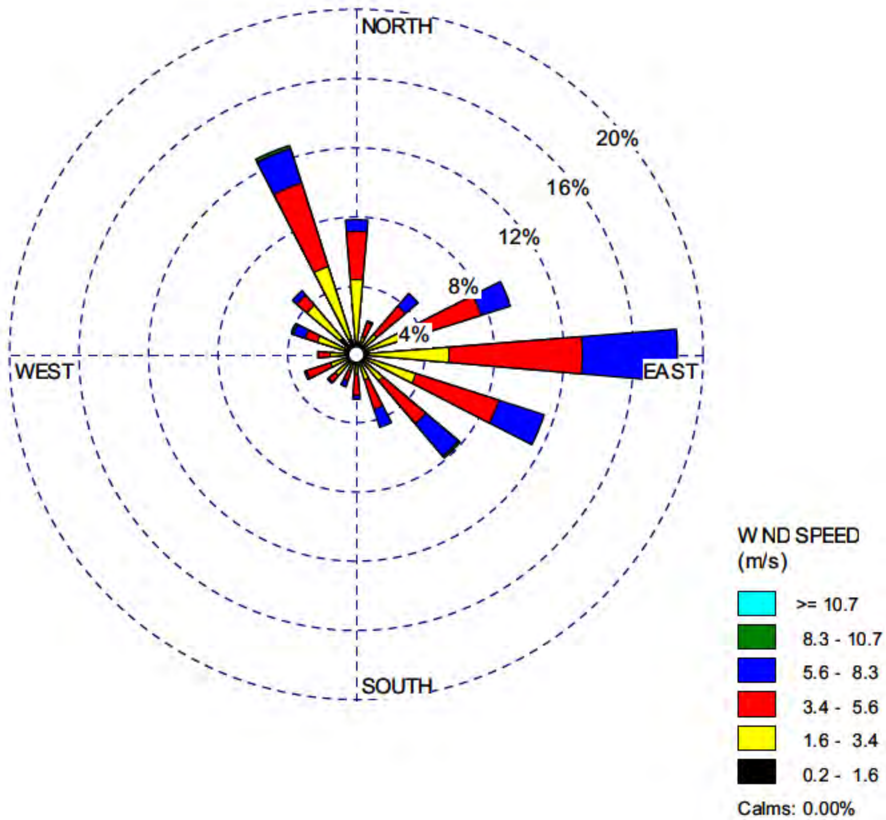


PTN COL 2.3-2 **Figure 2.3.2-205 10-Meter Level 3-Year Composite Wind Rose — Autumn (2002, 2005, and 2006)**



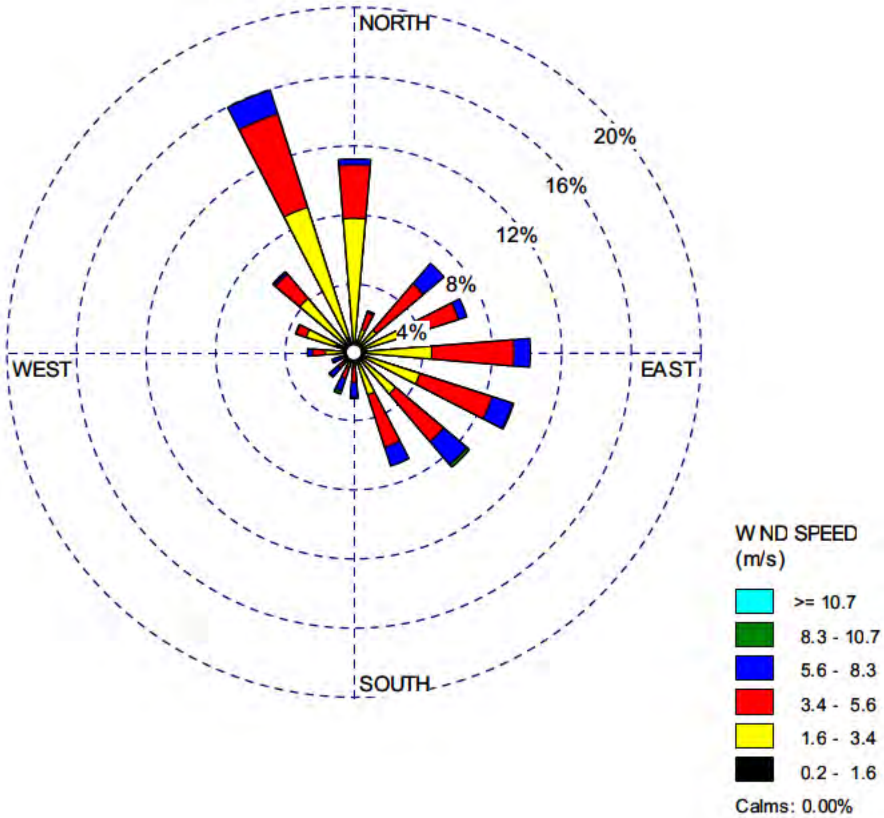
PTN COL 2.3-2

Figure 2.3.2-206 10-Meter Level 3-Year Composite Wind Rose — January (2002, 2005, and 2006) (Sheet 1 of 12)



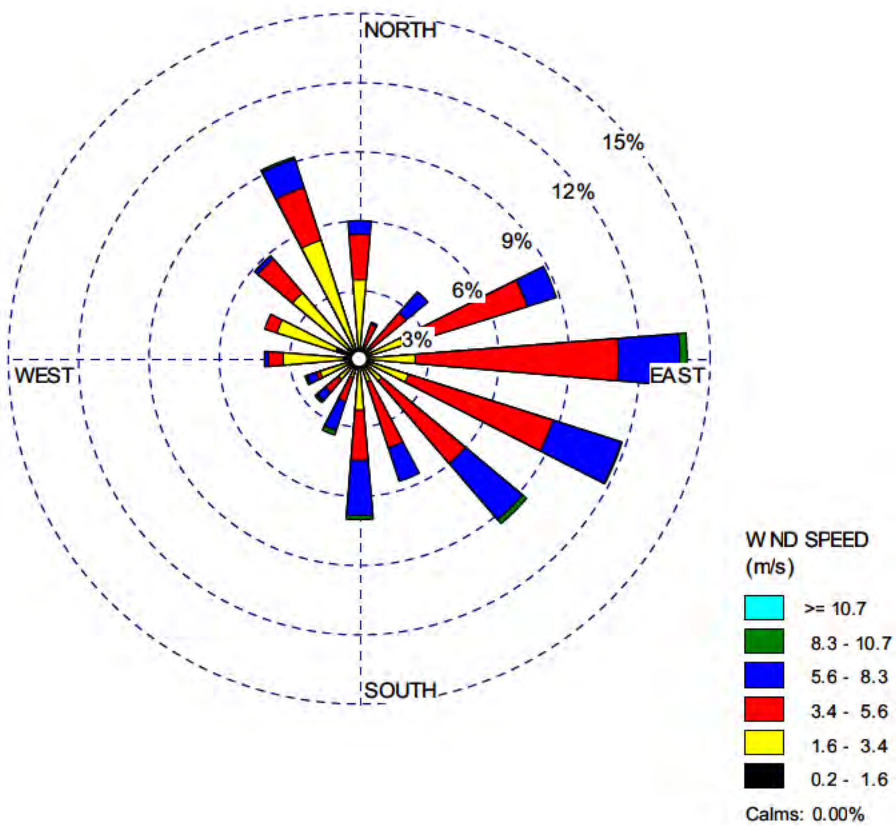
PTN COL 2.3-2

Figure 2.3.2-206 10-Meter Level 3-Year Composite Wind Rose — February (2002, 2005, and 2006) (Sheet 2 of 12)



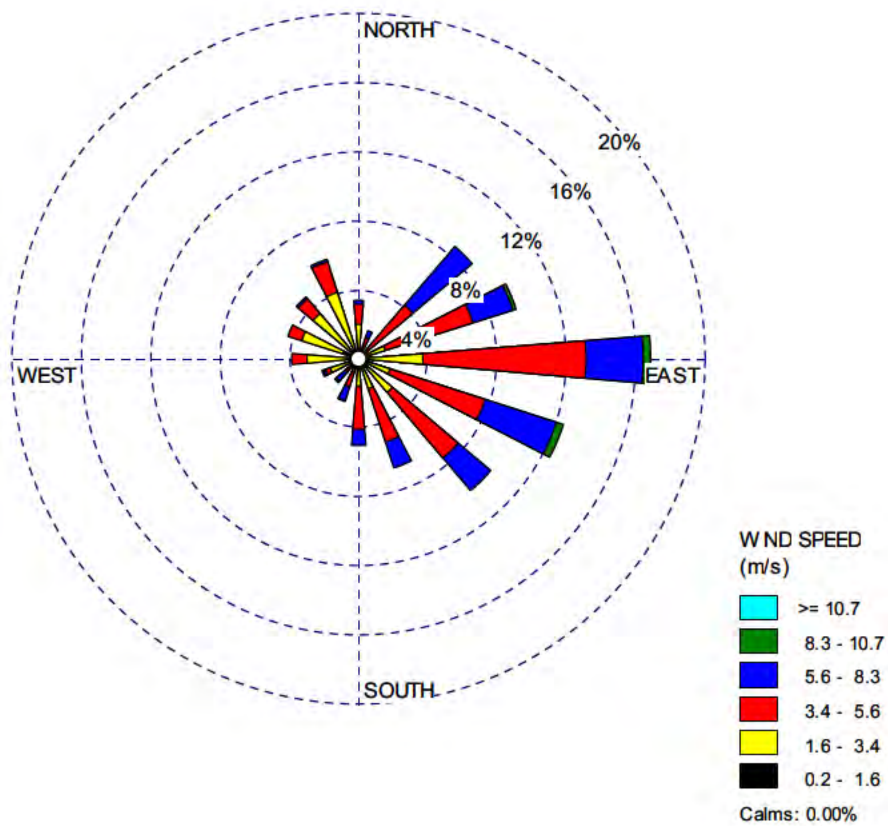
PTN COL 2.3-2

Figure 2.3.2-206 10-Meter Level 3-Year Composite Wind Rose — March (2002, 2005, and 2006) (Sheet 3 of 12)



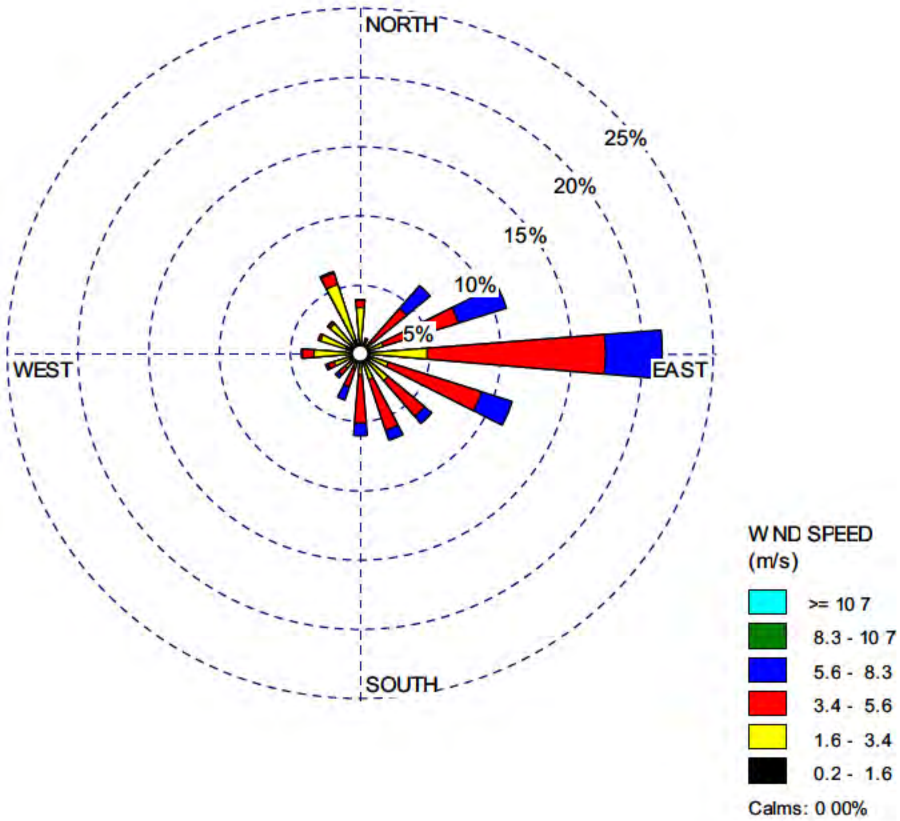
PTN COL 2.3-2

Figure 2.3.2-206 10-Meter Level 3-Year Composite Wind Rose — April (2002, 2005, and 2006) (Sheet 4 of 12)



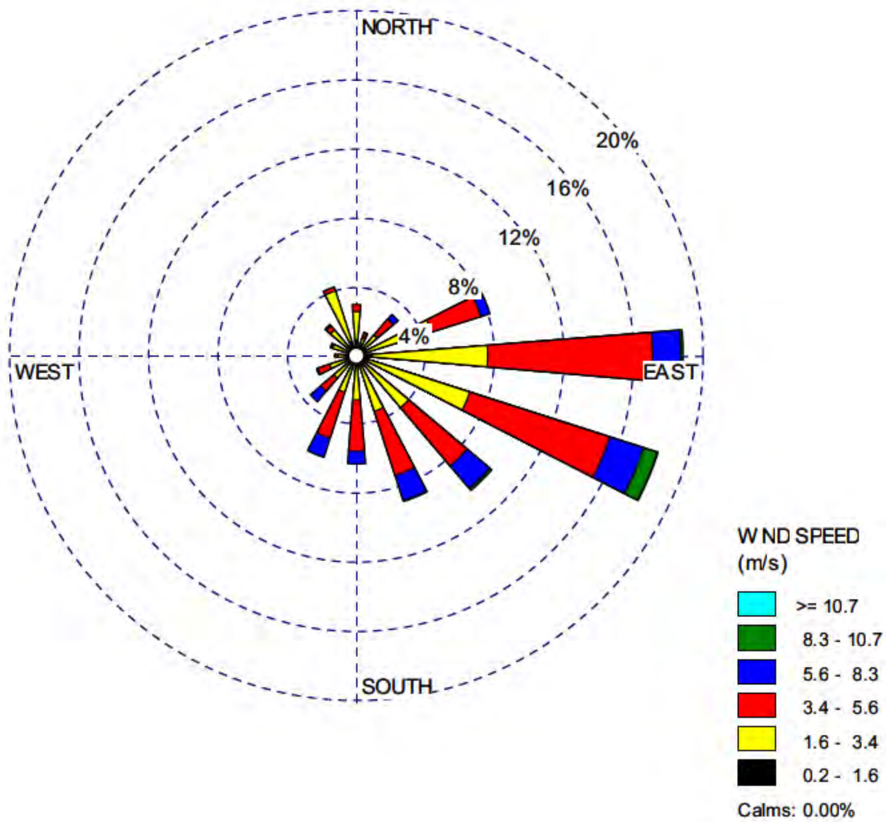
PTN COL 2.3-2

Figure 2.3.2-206 10-Meter Level 3-Year Composite Wind Rose — May (2002, 2005, and 2006) (Sheet 5 of 12)



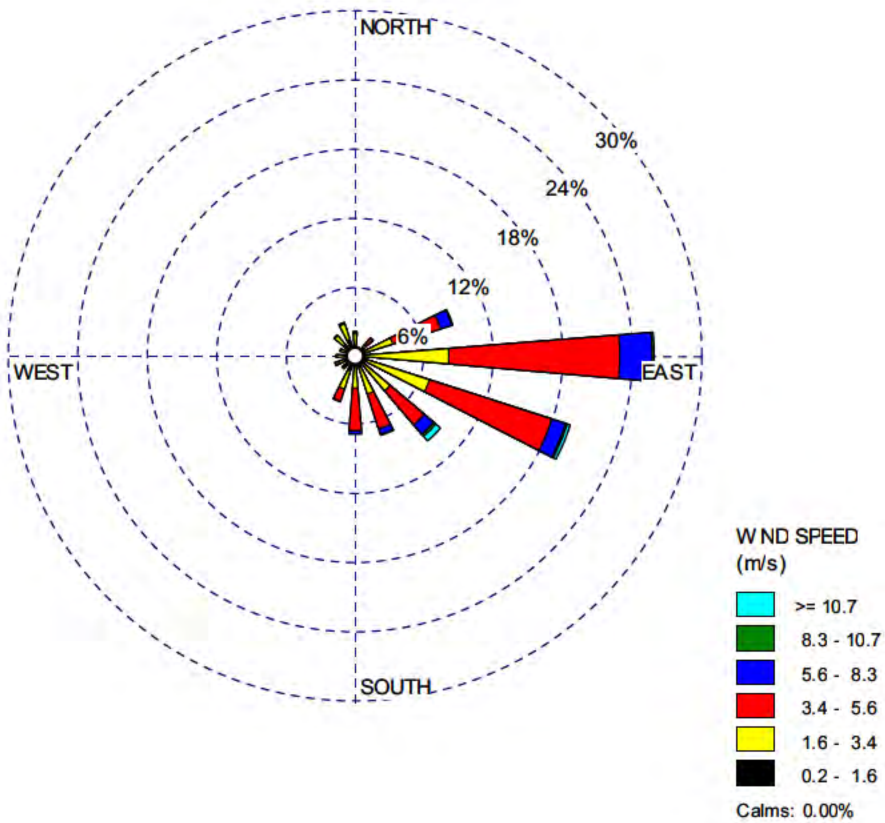
PTN COL 2.3-2

Figure 2.3.2-206 10-Meter Level 3-Year Composite Wind Rose — June (2002, 2005, and 2006) (Sheet 6 of 12)



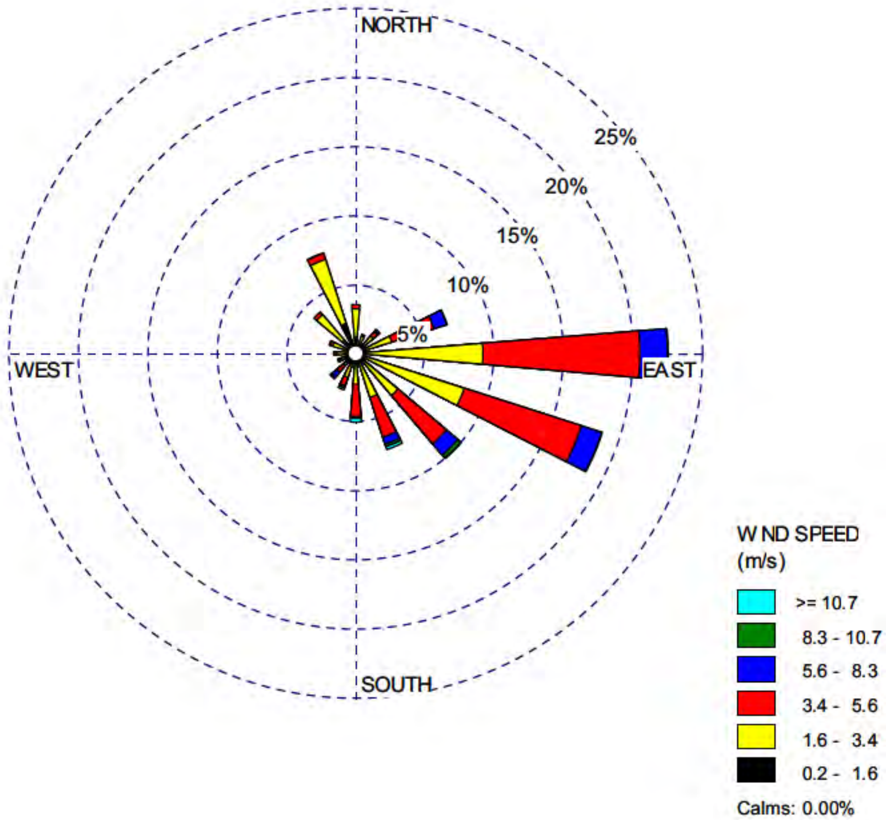
PTN COL 2.3-2

Figure 2.3.2-206 10-Meter Level 3-Year Composite Wind Rose — July (2002, 2005, and 2006) (Sheet 7 of 12)



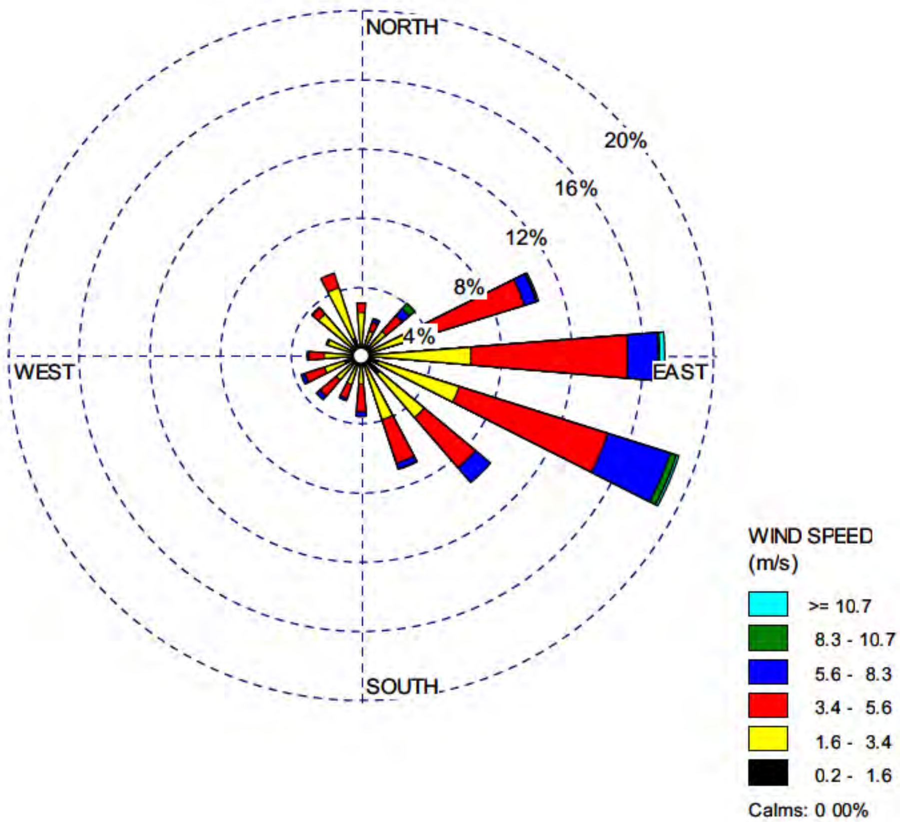
PTN COL 2.3-2

Figure 2.3.2-206 10-Meter Level 3-Year Composite Wind Rose — August (2002, 2005, and 2006) (Sheet 8 of 12)



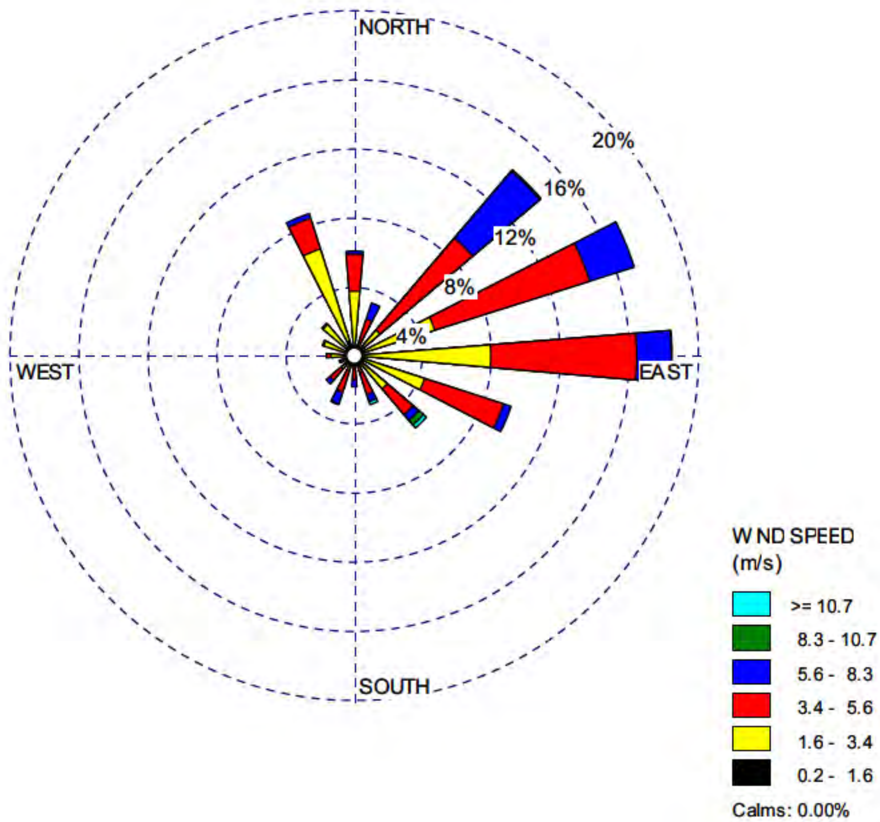
PTN COL 2.3-2

Figure 2.3.2-206 10-Meter Level 3-Year Composite Wind Rose — September (2002, 2005, and 2006) (Sheet 9 of 12)



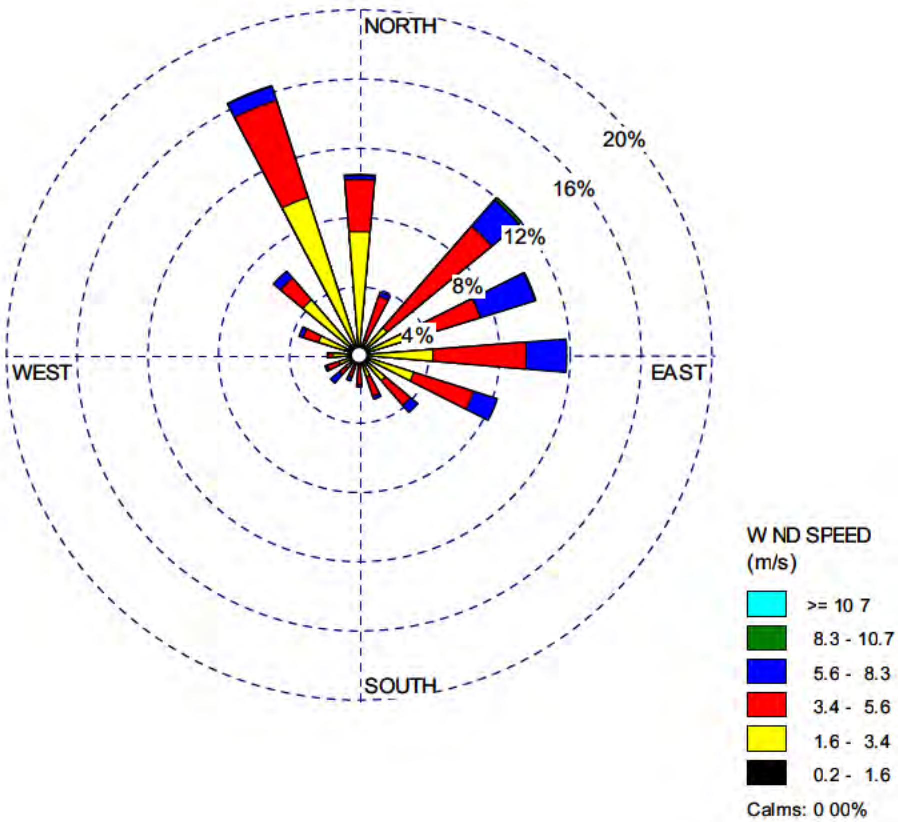
PTN COL 2.3-2

Figure 2.3.2-206 10-Meter Level 3-Year Composite Wind Rose — October (2002, 2005, and 2006) (Sheet 10 of 12)



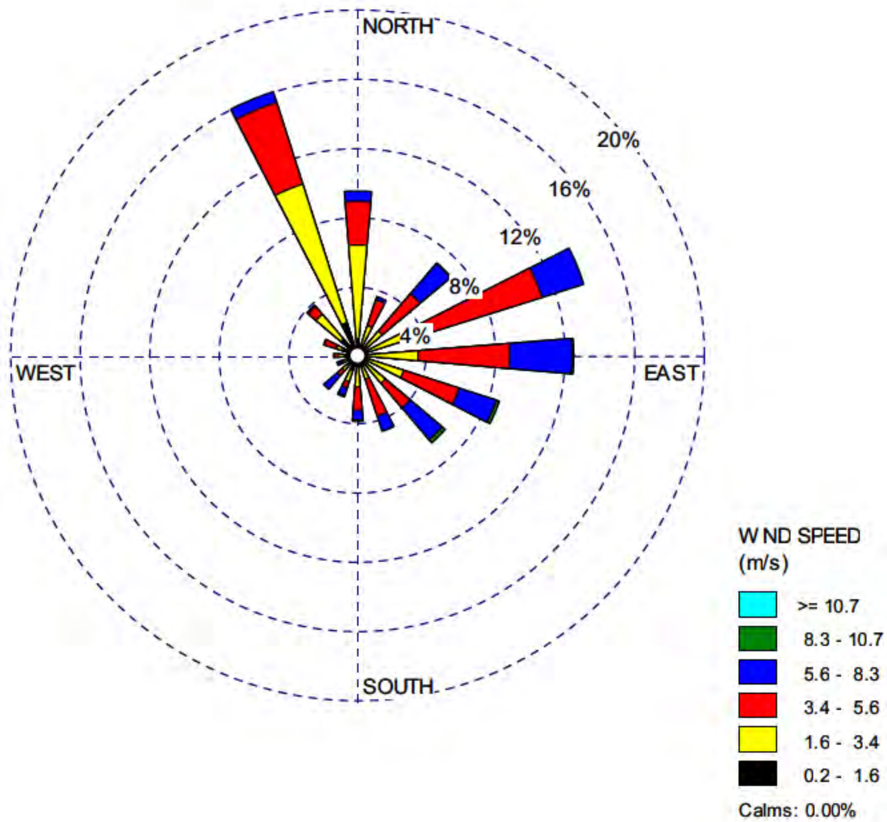
PTN COL 2.3-2

Figure 2.3.2-206 10-Meter Level 3-Year Composite Wind Rose — November (2002, 2005, and 2006) (Sheet 11 of 12)

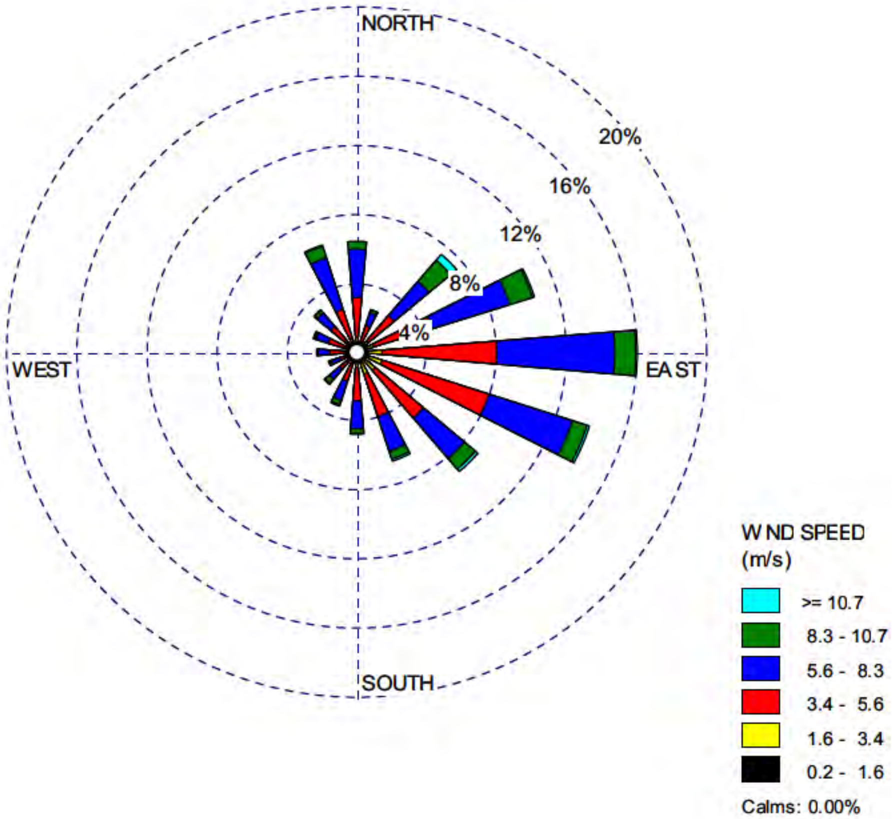


PTN COL 2.3-2

Figure 2.3.2-206 10-Meter Level 3-Year Composite Wind Rose — December (2002, 2005, and 2006) (Sheet 12 of 12)

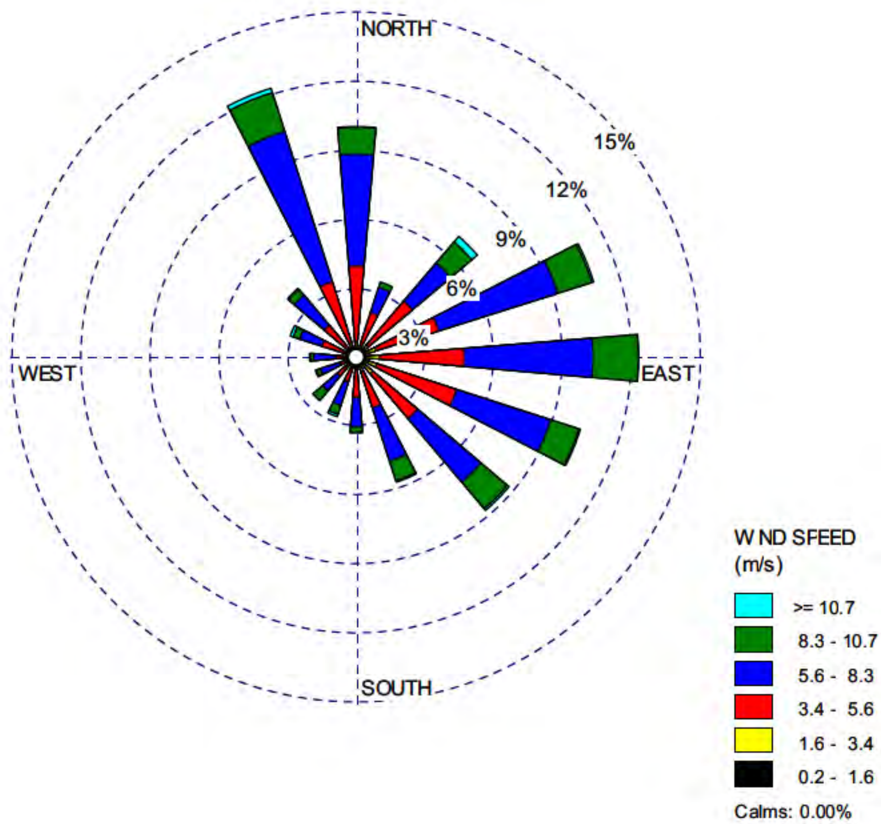


PTN COL 2.3-2 **Figure 2.3.2-207 60-Meter Level 3-Year Composite Wind Rose — Annual (2002, 2005, and 2006)**



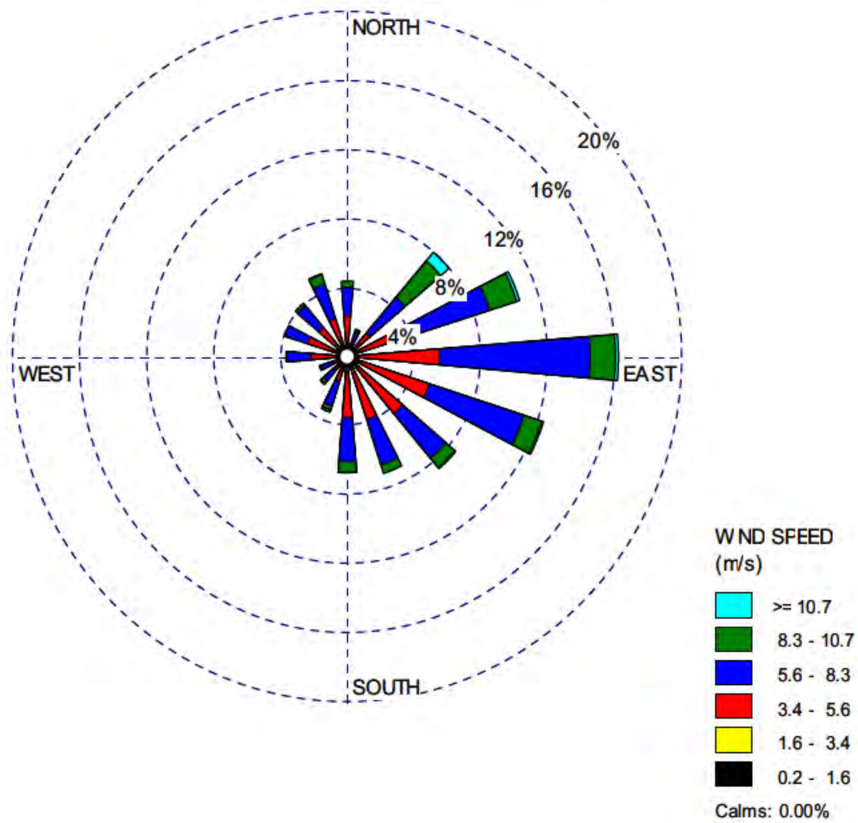
PTN COL 2.3-2

Figure 2.3.2-208 60-Meter Level 3-Year Composite Wind Rose — Winter (2002, 2005, and 2006)

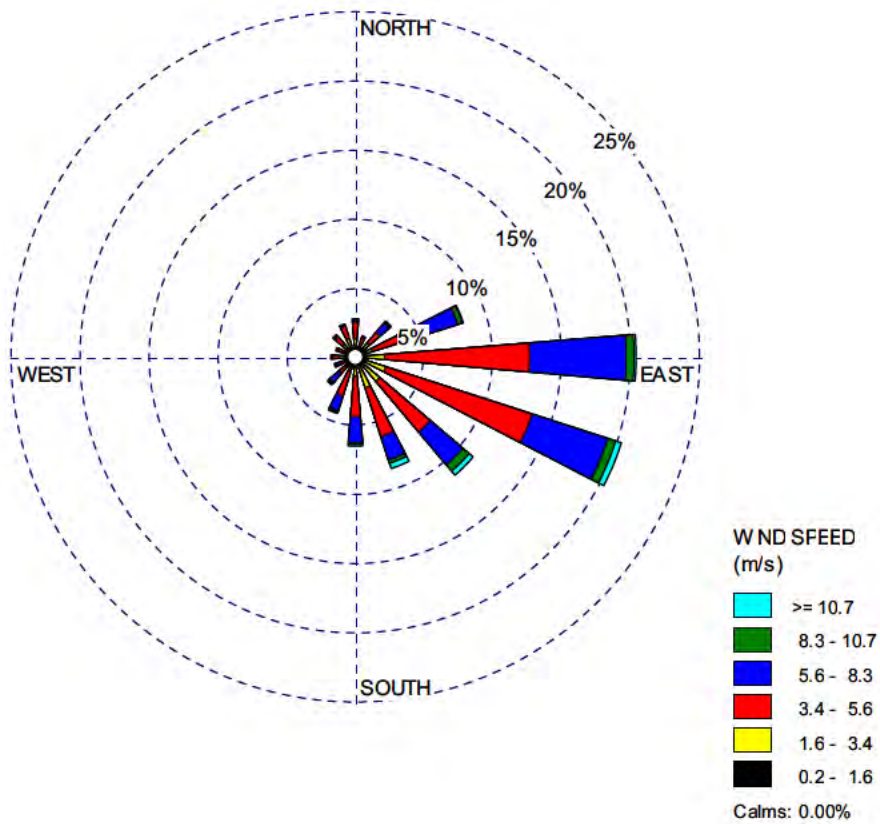


PTN COL 2.3-2

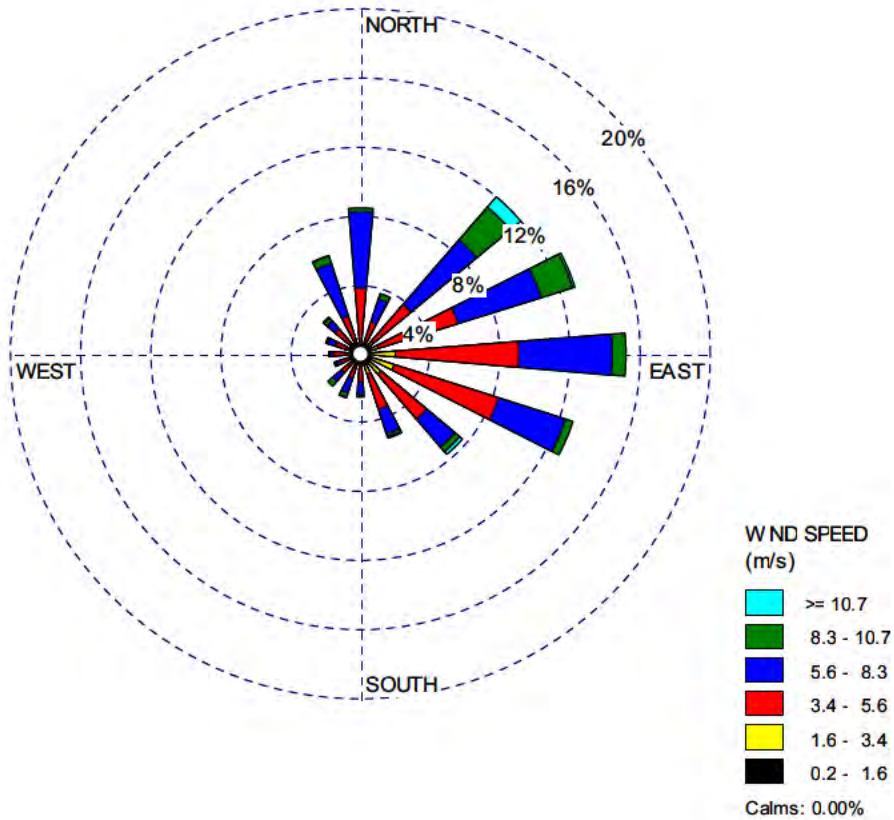
Figure 2.3.2-209 60-Meter Level 3-Year Composite Wind Rose — Spring (2002, 2005, and 2006)



PTN COL 2.3-2 **Figure 2.3.2-210 60-Meter Level 3-Year Composite Wind Rose — Summer (2002, 2005, and 2006)**

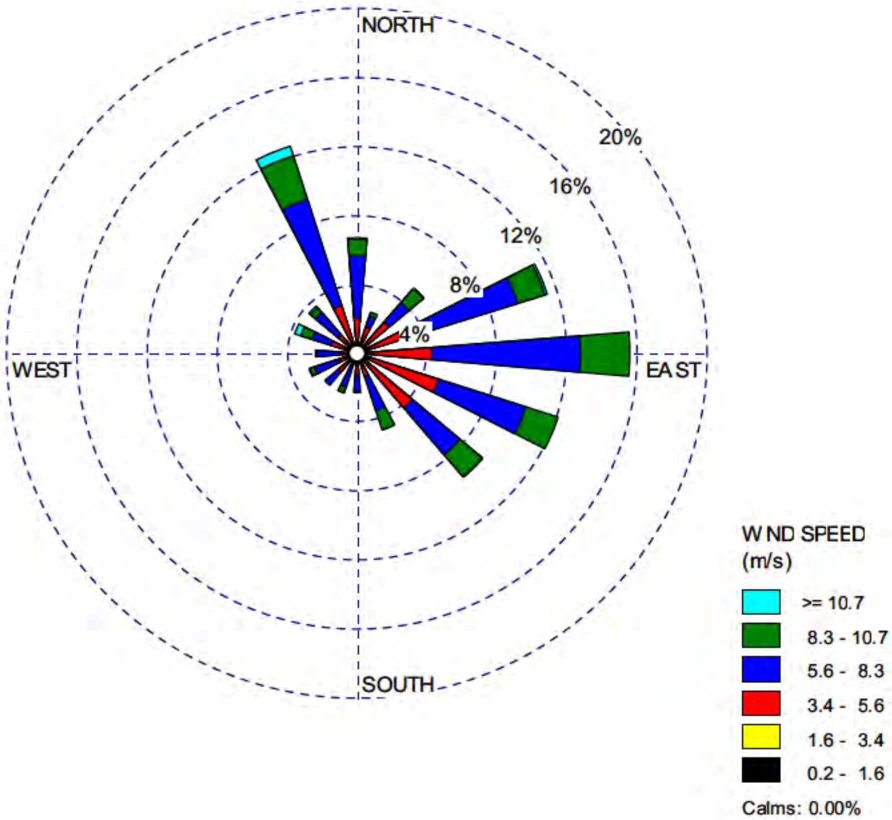


PTN COL 2.3-2 **Figure 2.3.2-211 60-Meter Level 3-Year Composite Wind Rose — Autumn (2002, 2005, and 2006)**



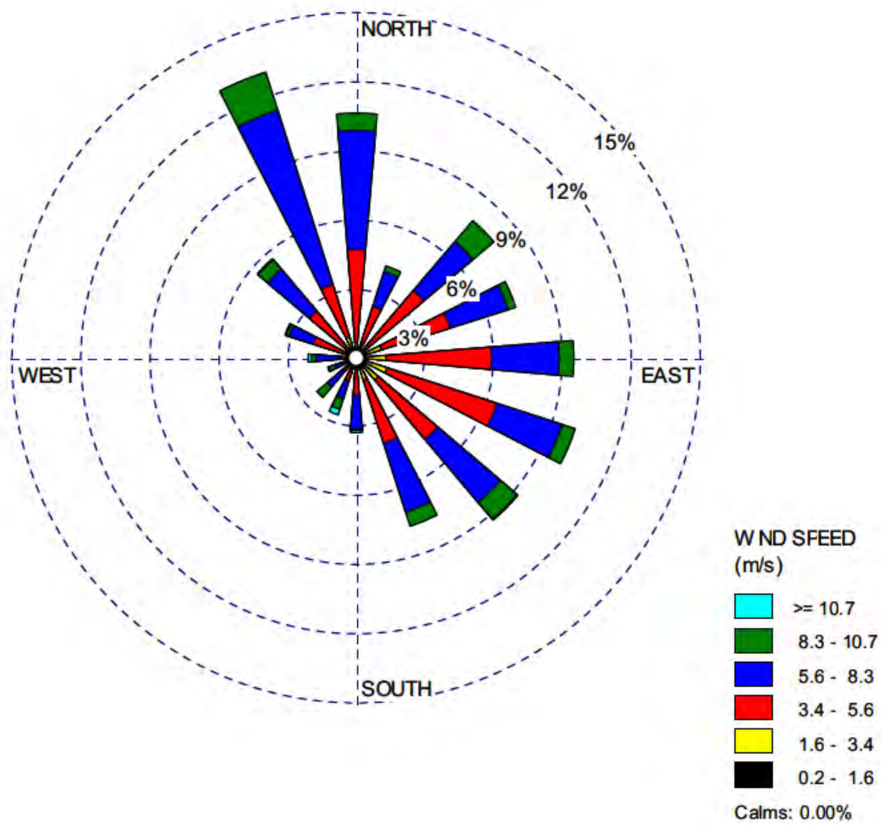
PTN COL 2.3-2

Figure 2.3.2-212 60-Meter Level 3-Year Composite Wind Rose — January (2002, 2005, and 2006) (Sheet 1 of 12)



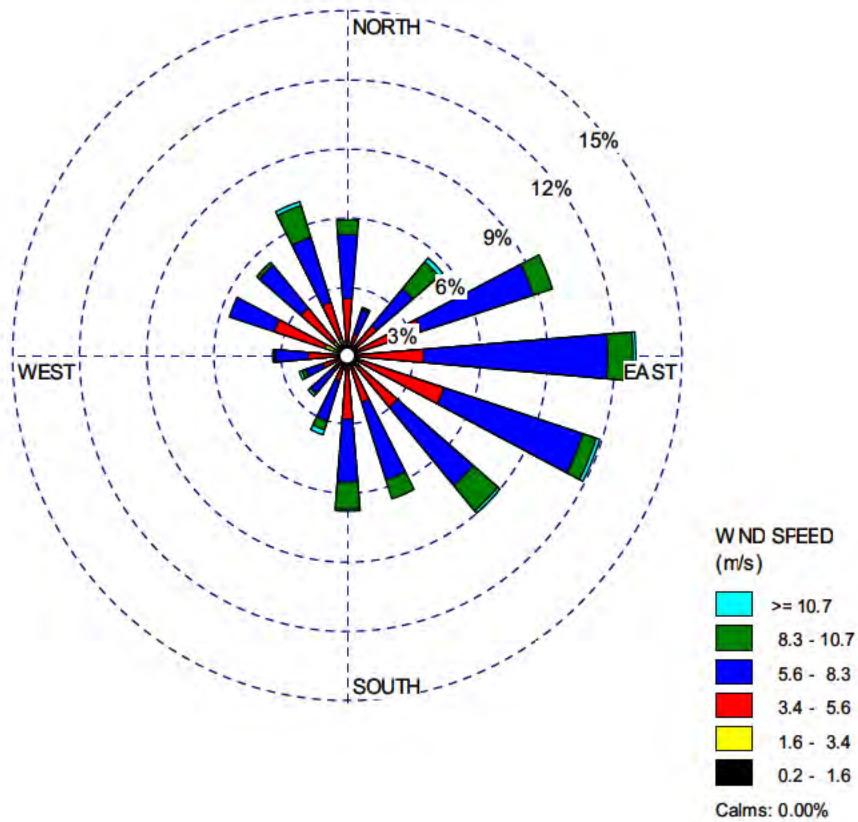
PTN COL 2.3-2

Figure 2.3.2-212 60-Meter Level 3-Year Composite Wind Rose — February (2002, 2005, and 2006) (Sheet 2 of 12)



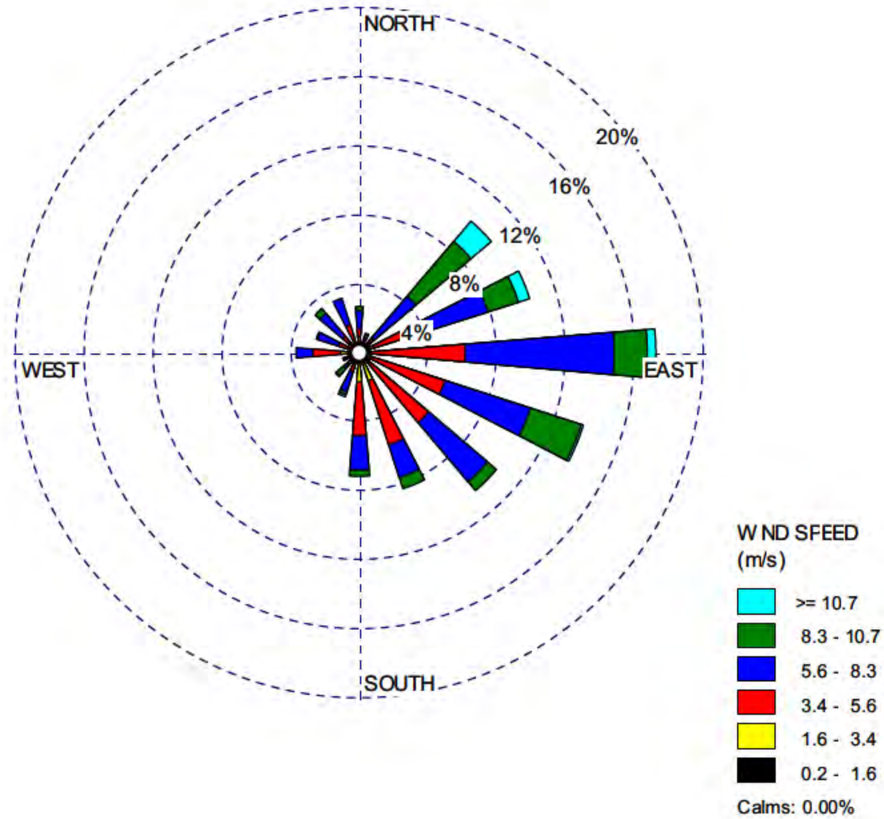
PTN COL 2.3-2

Figure 2.3.2-212 60-Meter Level 3-Year Composite Wind Rose — March (2002, 2005, and 2006) (Sheet 3 of 12)



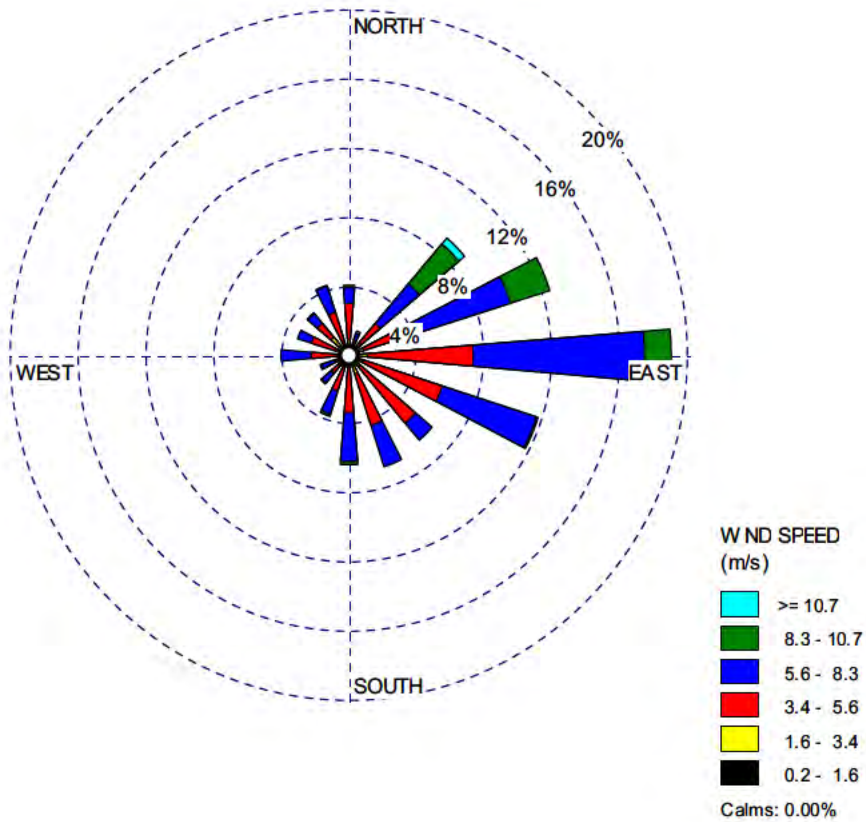
PTN COL 2.3-2

Figure 2.3.2-212 60-Meter Level 3-Year Composite Wind Rose — April (2002, 2005, and 2006) (Sheet 4 of 12)



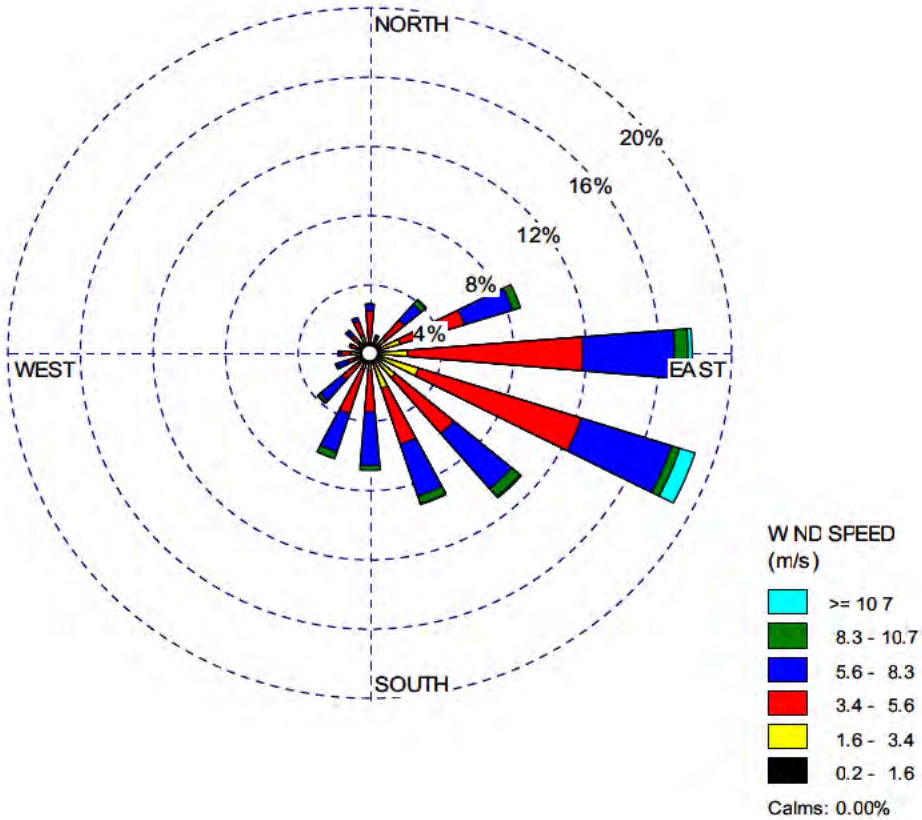
PTN COL 2.3-2

Figure 2.3.2-212 60-Meter Level 3-Year Composite Wind Rose — May (2002, 2005, and 2006) (Sheet 5 of 12)



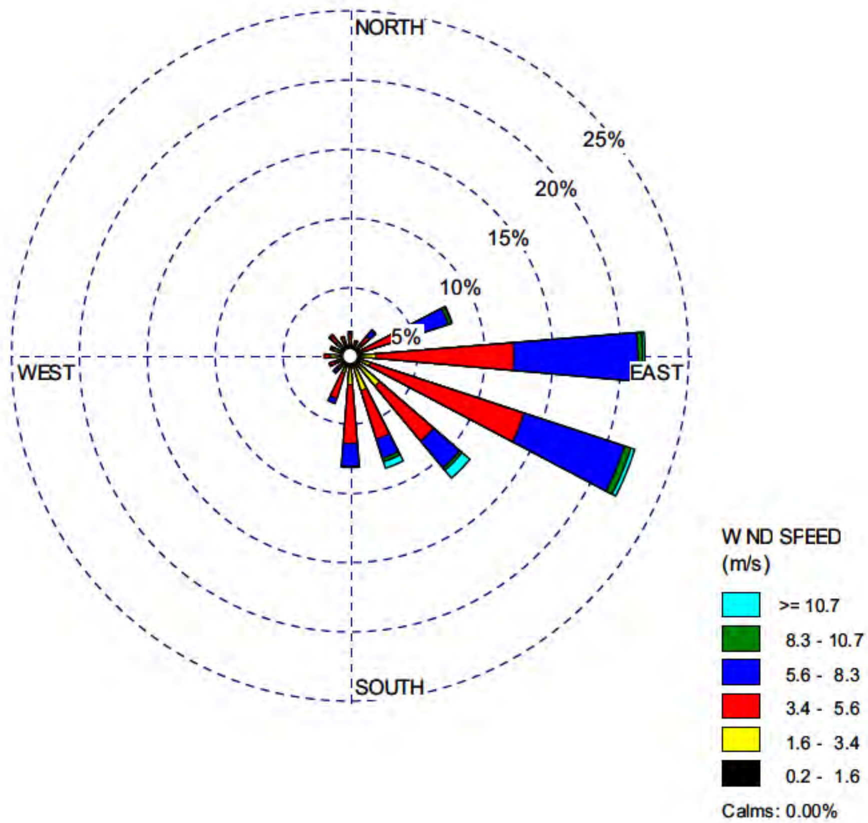
PTN COL 2.3-2

Figure 2.3.2-212 60-Meter Level 3-Year Composite Wind Rose — June (2002, 2005, and 2006) (Sheet 6 of 12)



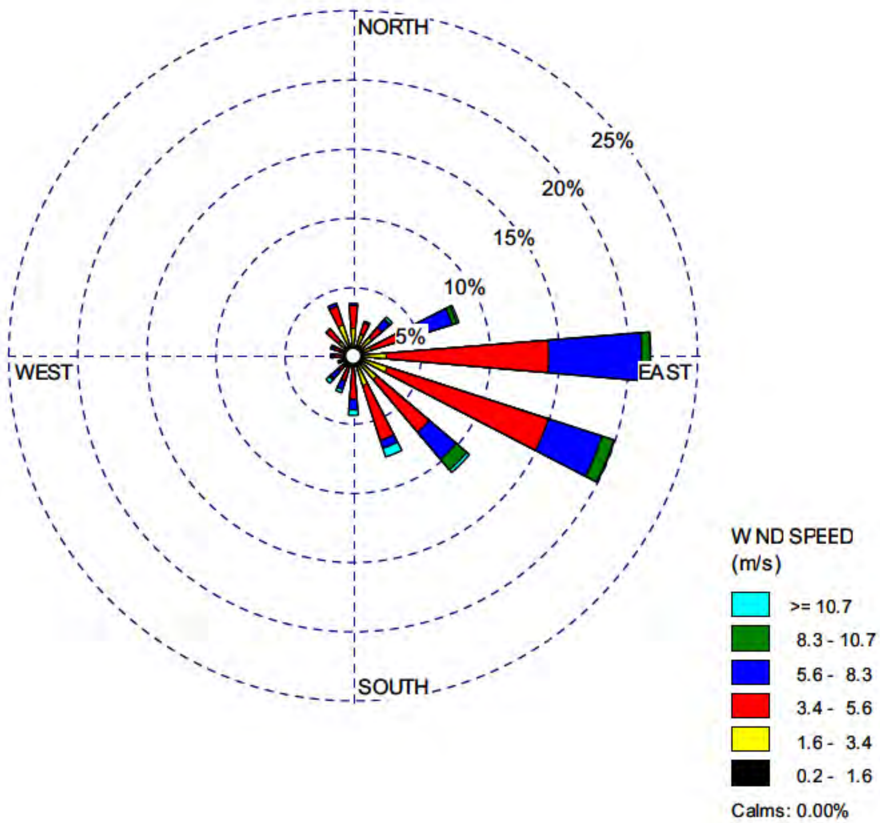
PTN COL 2.3-2

Figure 2.3.2-212 60-Meter Level 3-Year Composite Wind Rose — July (2002, 2005, and 2006) (Sheet 7 of 12)



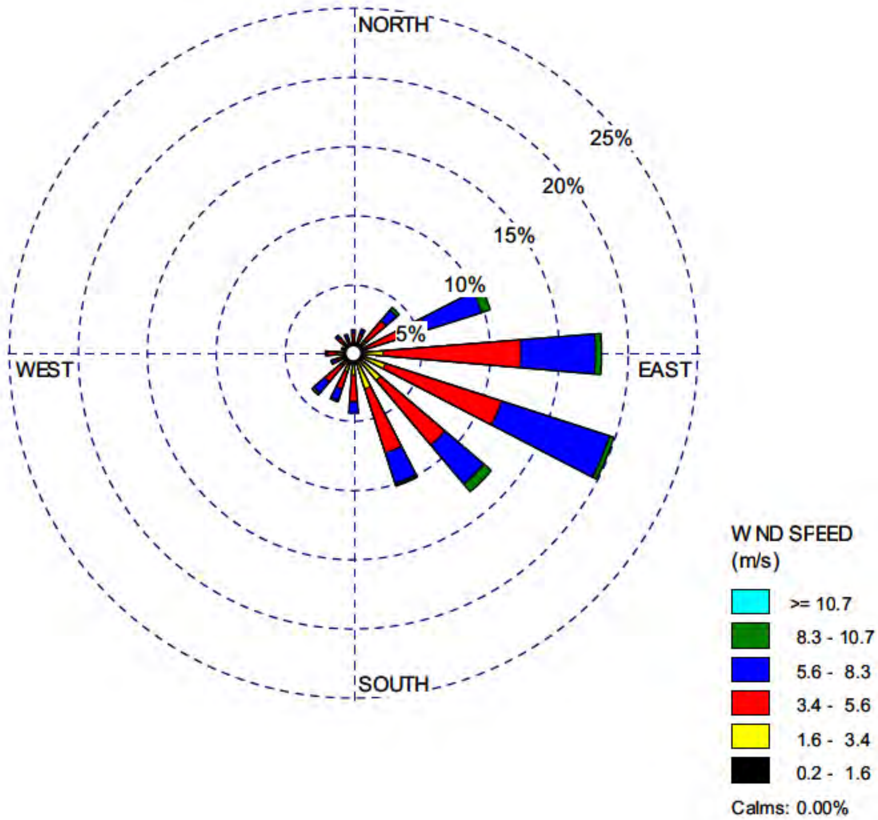
PTN COL 2.3-2

Figure 2.3.2-212 60-Meter Level 3-Year Composite Wind Rose — August (2002, 2005, and 2006) (Sheet 8 of 12)



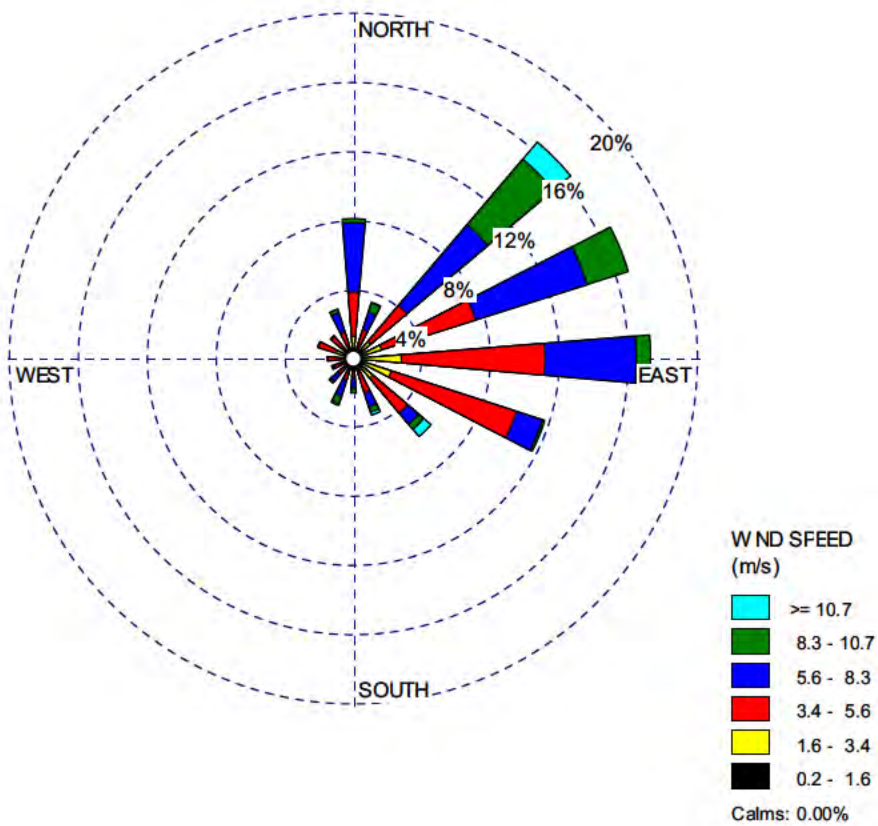
PTN COL 2.3-2

Figure 2.3.2-212 60-Meter Level 3-Year Composite Wind Rose — September (2002, 2005, and 2006) (Sheet 9 of 12)



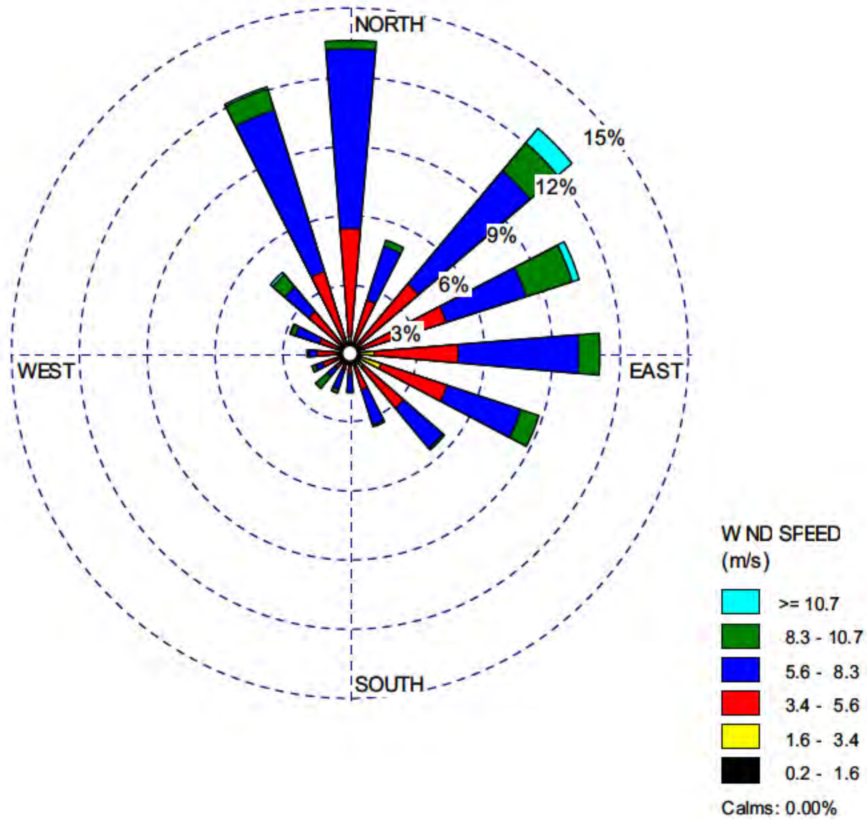
PTN COL 2.3-2

Figure 2.3.2-212 60-Meter Level 3-Year Composite Wind Rose — October (2002, 2005, and 2006) (Sheet 10 of 12)



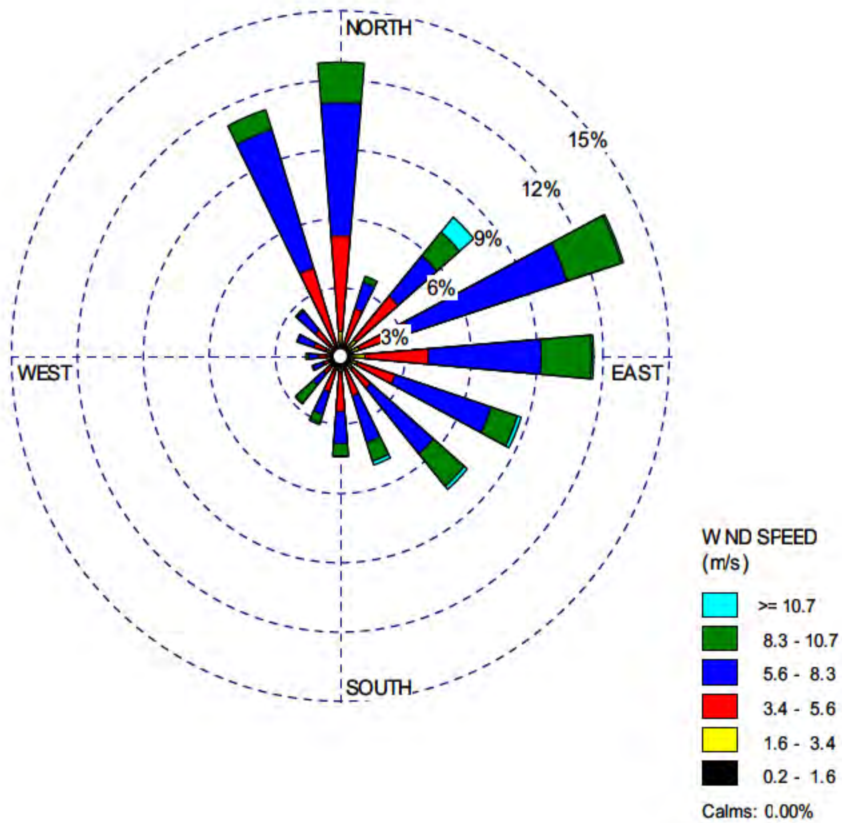
PTN COL 2.3-2

Figure 2.3.2-212 60-Meter Level 3-Year Composite Wind Rose — November (2002, 2005, and 2006) (Sheet 11 of 12)



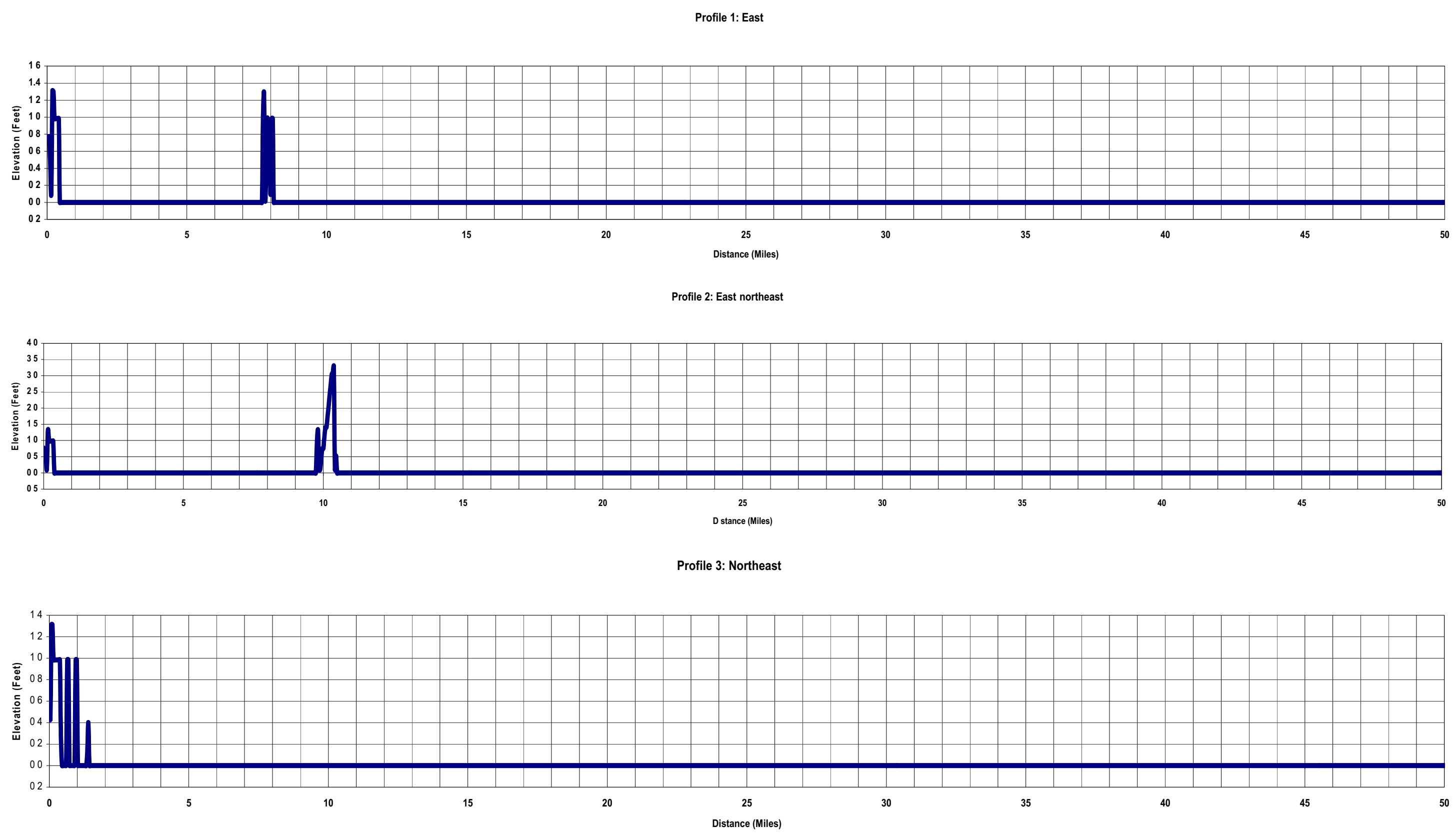
PTN COL 2.3-2

Figure 2.3.2-212 60-Meter Level 3-Year Composite Wind Rose — December (2002, 2005, and 2006) (Sheet 12 of 12)



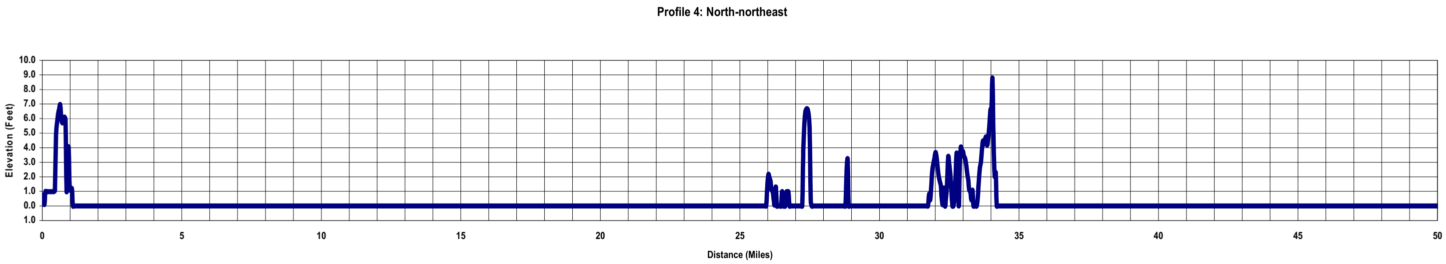
PTN COL 2.3-2

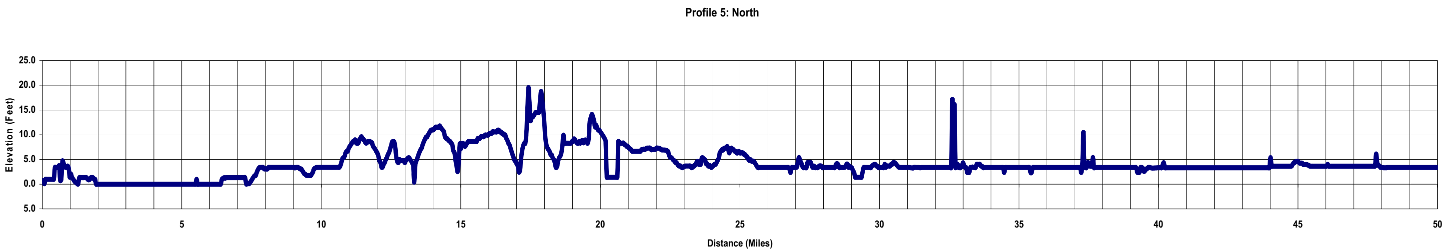
Figure 2.3.2-213 Terrain Elevation Profiles Within 50 Miles of the Units 6 & 7 Site (Sheet 1 of 6)

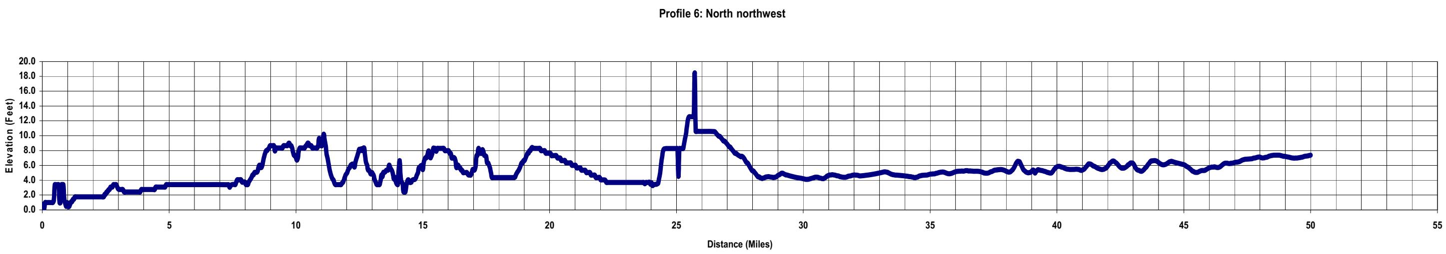


PTN COL 2.3-2

Figure 2.3.2-213 Terrain Elevation Profiles Within 50 Miles of the Units 6 & 7 Site (Sheet 2 of 6)

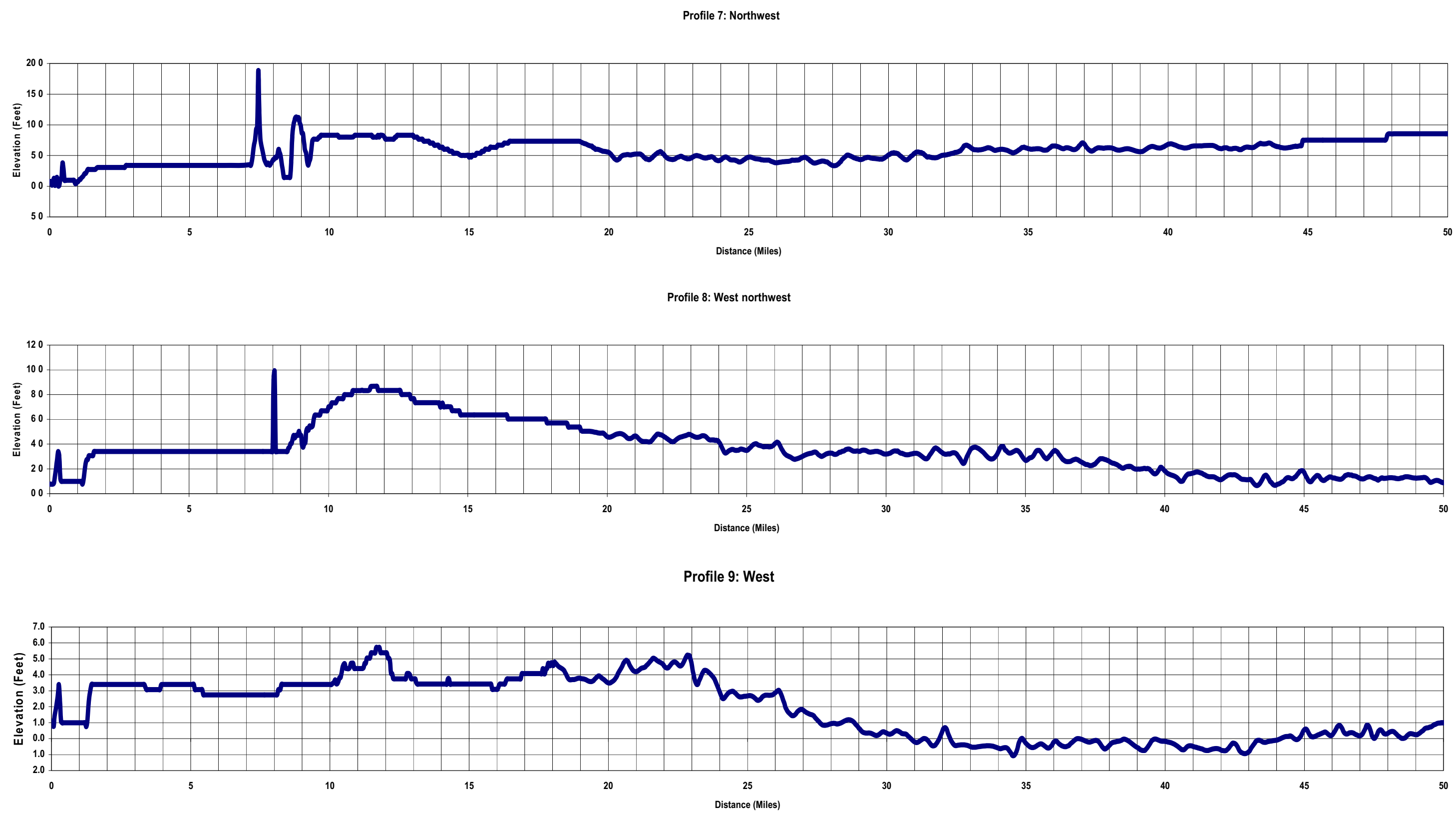






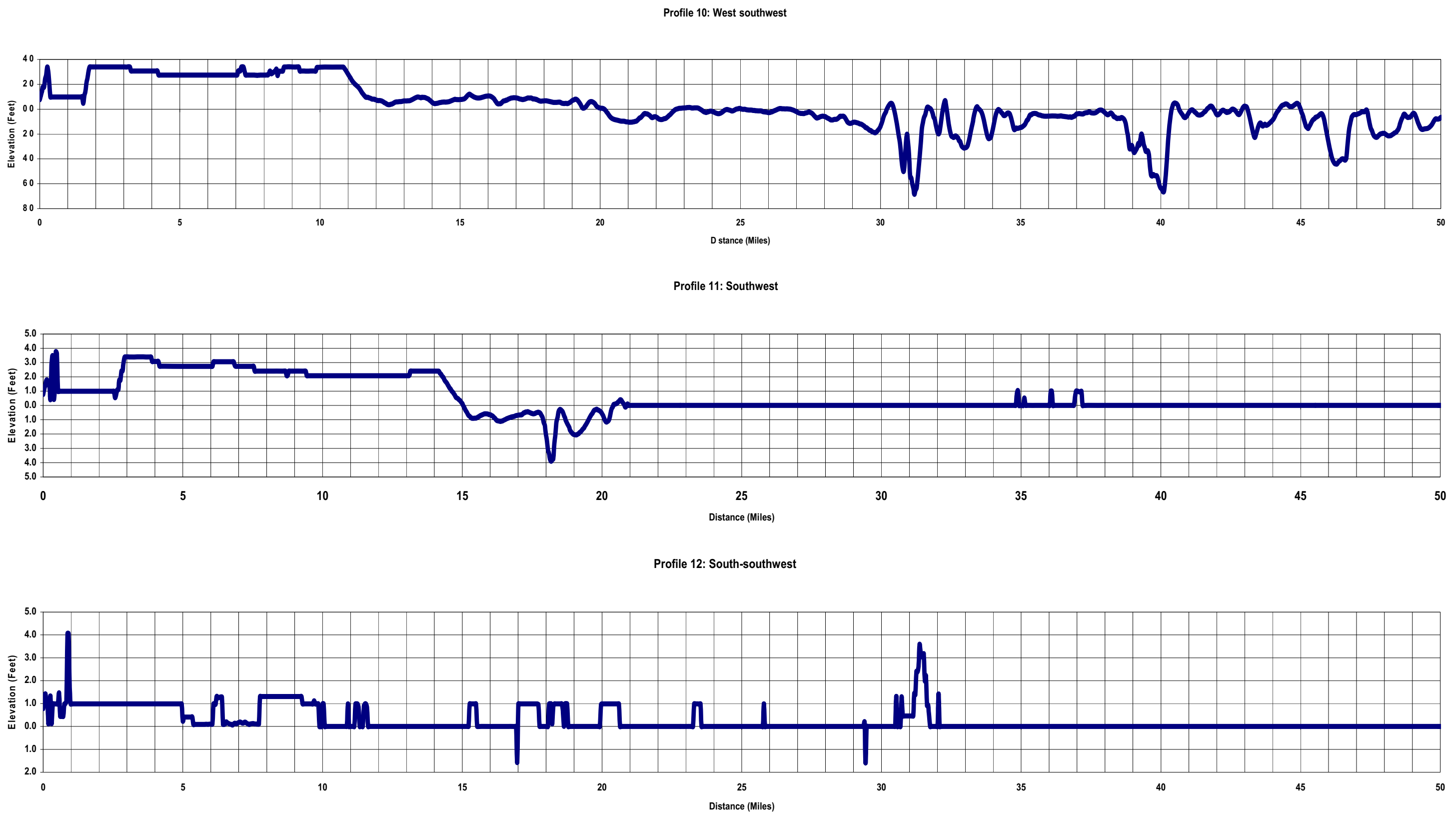
PTN COL 2.3-2

Figure 2.3.2-213 Terrain Elevation Profiles Within 50 Miles of the Units 6 & 7 Site (Sheet 3 of 6)



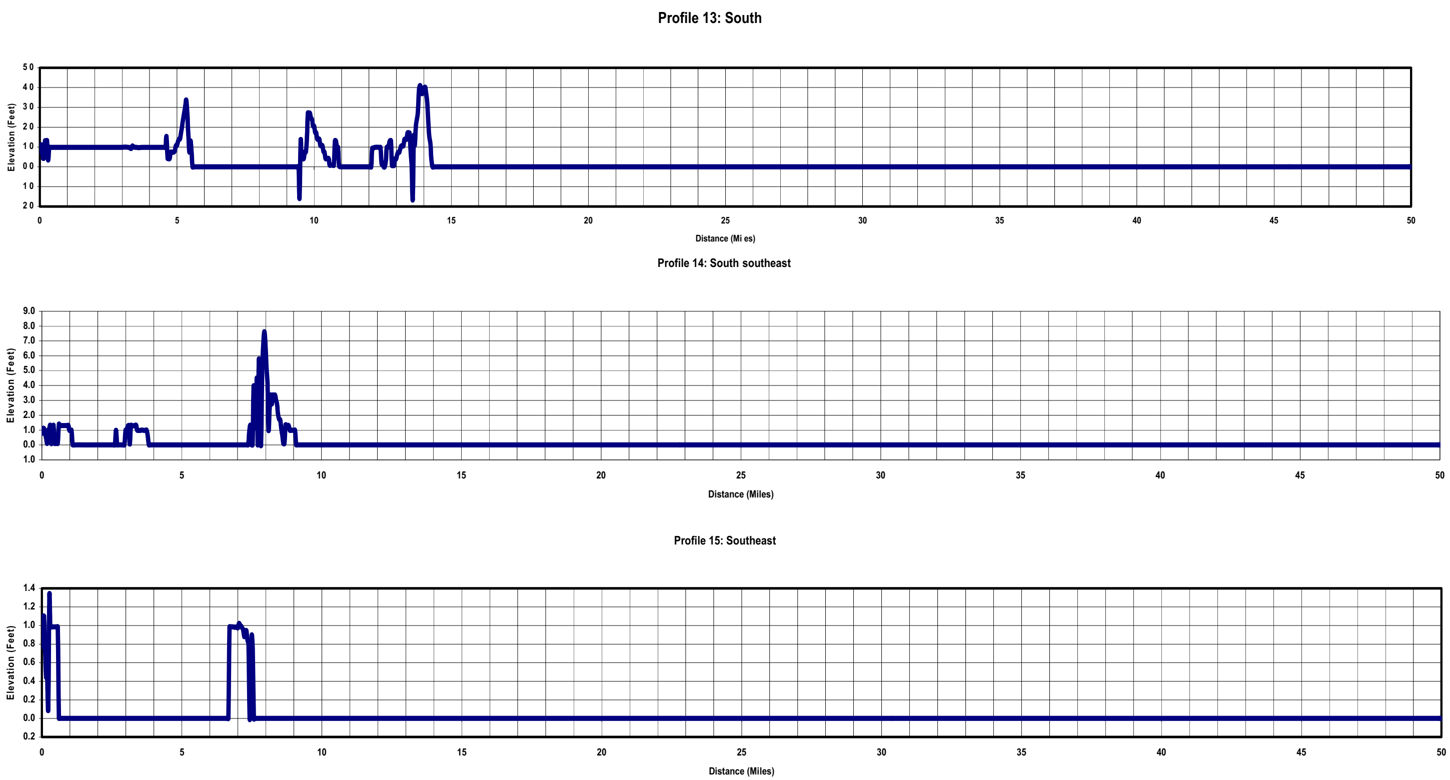
PTN COL 2.3-2

Figure 2.3.2-213 Terrain Elevation Profiles Within 50 Miles of the Units 6 & 7 Site (Sheet 4 of 6)



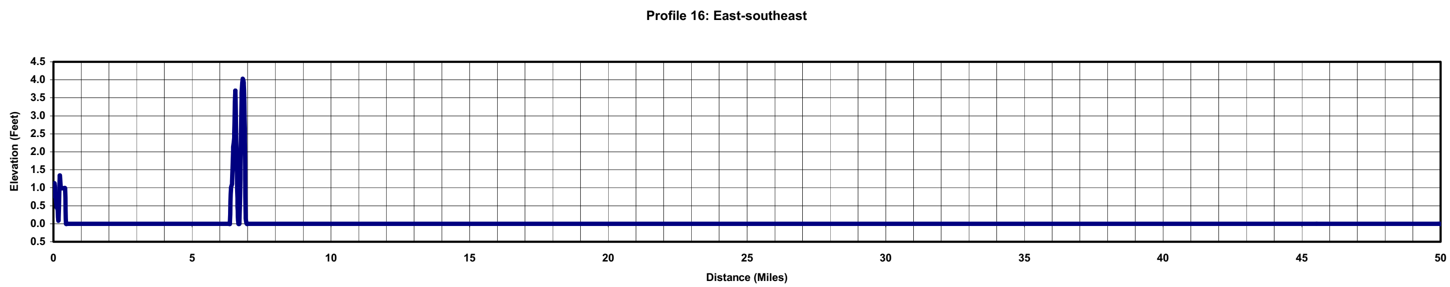
PTN COL 2.3-2

Figure 2.3.2-213 Terrain Elevation Profiles Within 50 Miles of the Units 6 & 7 Site (Sheet 5 of 6)



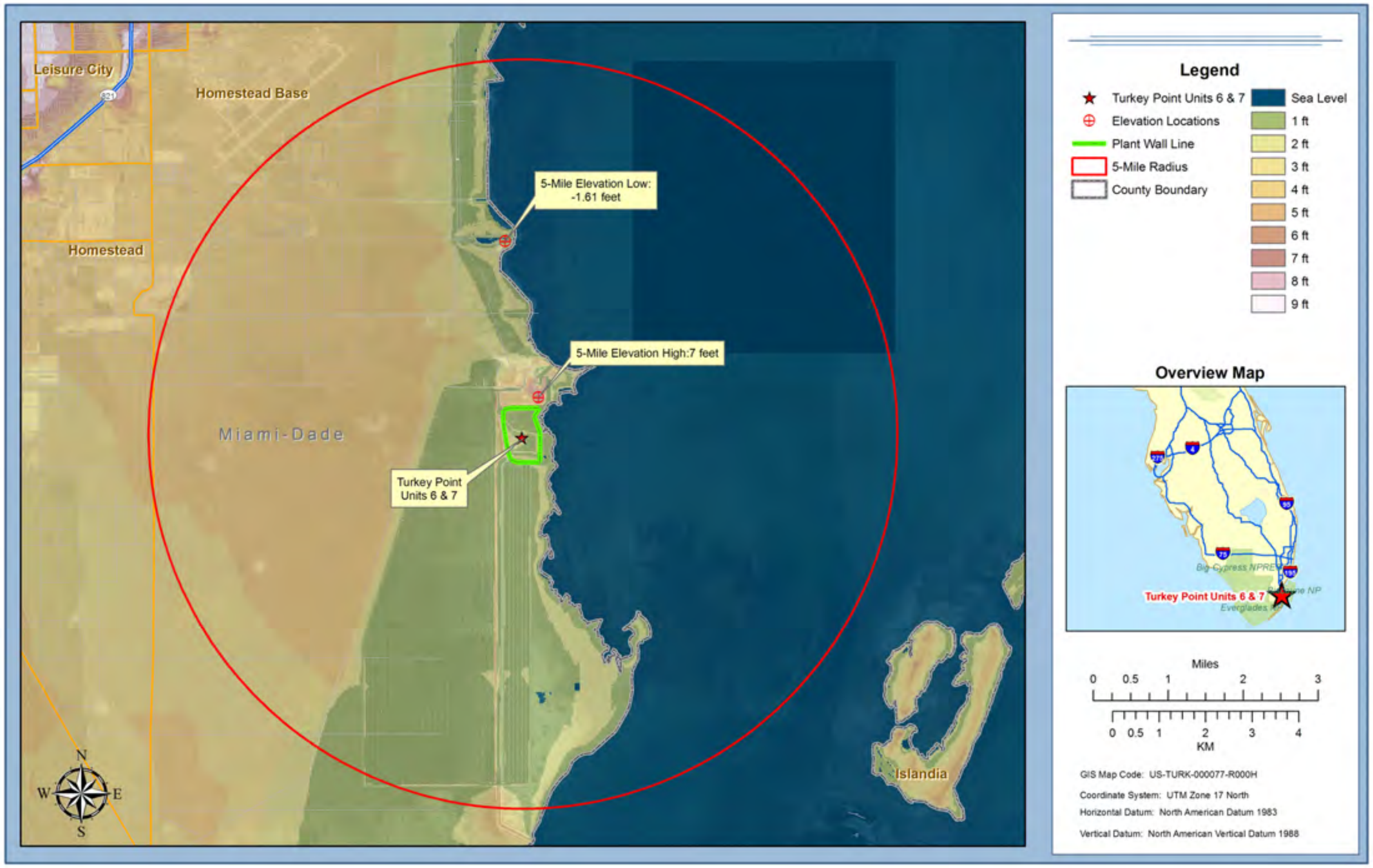
PTN COL 2.3-2

Figure 2.3.2-213 Terrain Elevation Profiles Within 50 Miles of the Units 6 & 7 Site (Sheet 6 of 6)



PTN COL 2.3-2

Figure 2.3.2-214 Topographic Features Within 5 Miles of the Units 6 & 7 Site



2.3.3 ONSITE METEOROLOGICAL MEASUREMENT PROGRAMS

PTN COL 2.3-3 This subsection provides a description of the onsite preoperational and operational meteorological monitoring programs for Units 6 & 7, including a description and site map showing tower locations with respect to man-made structures, topographic features, and other site features that can influence site meteorological measurements. In addition, a description of measurements made including elevations and exposure of instruments; instruments used including instrument performance specifications, calibration and maintenance procedures; data output and recording systems and locations; and data processing, archiving, and analysis procedures is provided by this subsection.

The Units 6 & 7 meteorological monitoring program is comprised of a set of towers and their associated shelters, electronic racks, power systems, and power backup systems. The onsite meteorological monitoring programs for Units 6 & 7 consist of two phases:

- Preoperational Monitoring — As a result of nearby existing Units 3 & 4, data from the Units 3 & 4 meteorological stations during 2002, 2005, and 2006 establish a baseline for identifying and assessing environmental impacts resulting from operation of Units 6 & 7. The preoperational meteorological monitoring program for Units 6 & 7 is conducted in conformance with RG 1.23, Revision 1 for the existing configuration, except as noted in the following description.

- Operational Monitoring — the same preoperational set of existing meteorological stations is used for the operational phase for Units 6 & 7. Because the current meteorological monitoring program for Units 3 & 4 is conducted in accordance with the regulatory guidance criteria (except as noted), the existing system may continue to be used for Units 6 & 7 during plant operation. Although the current system, including meteorological sensors, may be upgraded periodically or replaced before new plant operation, the functional requirements of the operational program for Units 6 & 7 are described based on the current system.

Data from the meteorological monitoring stations is used to:

- Describe local and regional atmospheric transport and diffusion characteristics

- Calculate the dispersion estimates for both postulated accidental and expected routine airborne releases of effluents
- Compare with offsite sources to determine the appropriateness of climatological data used for design considerations
- Evaluate environmental risk from the radiological consequences of a spectrum of postulated accidents
- Provide a meteorological database for evaluation of the effects from plant construction and operation, including radiological and nonradiological impacts and real-time predictions of atmospheric effluent transport and diffusion
- Develop emergency response plans, including provision for real-time meteorological data and plume trajectory dispersion modeling capabilities for dose and exposure predictions

2.3.3.1 Preoperational and Operational Monitoring Programs

This subsection describes the current meteorological monitoring program operated in support of existing Units 3 & 4, focusing primarily on the period of record used to provide meteorological data for the COL Application for Units 6 & 7 (i.e., the years 2002, 2005, and 2006). The same meteorological monitoring program is in use for operational monitoring for proposed Units 6 & 7.

The 2002, 2005 and 2006 period of data taken for Units 3 & 4 is determined to be the best available (using validated data with least data substitution), representative (tower and sensor siting in accordance with RG 1.23, Revision 1), and complete (with annualized composite data recovery of 90 percent), without being older than 10 years. Because RG 1.23, Revision 1 specifies that 3 or more years of data is preferable, 3 years (i.e., 2002, 2005 and 2006) of Units 3 & 4 data is used in support of the preoperational monitoring program for Units 6 & 7. The findings presented below indicate that these 3 years of data are suitable for use in characterizing the atmospheric dispersion conditions for Units 6 & 7.

Two meteorological towers are located onsite; the 60-meter South Dade tower (Figure 2.3.3-201) and the 10-meter land utilization (LU) tower (Figure 2.3.3-202) near the land utilization office. The operational meteorological monitoring program consists of the existing South Dade 60-meter tower and the existing 10-meter LU tower.

The 60-meter South Dade meteorological tower serves as the data collection system and source of onsite meteorological data for the COL Application (10-meter and 60-meter levels) and the 10-meter LU tower serves as a backup to this system. The 10-meter wind speed and wind direction data from the LU tower is primarily used in emergency situations at the site. The data from the South Dade 60-meter tower is used as backup during a plant emergency, if needed. The rationale for designating the LU tower for emergency situations for wind speed and wind direction is that it is physically closer to the plant and can provide a representative reading and allow more reliable dose assessment.

The meteorological instrumentation is located at multiple levels on the 60-meter South Dade guyed tower, and at a single level on the 10-meter LU tower. The meteorological instrumentation on these towers is summarized in Table 2.3.3-201.

The South Dade and LU wind sensors are designed to operate across the range from 0 to 125 mph (56 meters per second). The 60-meter South Dade meteorological tower is located approximately 5.5 miles (8.9 kilometers) southwest of Units 3 & 4. The height of the concrete pad on which the tower rests is approximately 18 inches (45.7 centimeters).

The height of the sensors for wind direction and speed at the 10-meter elevation of the South Dade meteorological tower is 38 feet (11.58 meters) above local grade surface. The height of temperature sensors A and B at the 10-meter elevation of the South Dade meteorological tower is 34 feet [10.36 meters] above local grade surface. The South Dade meteorological tower was rebuilt in 1994, consistent with the relevant regulatory guidance.

The 10-meter LU tower measures wind speed, wind direction, standard deviation of wind direction (used to indicate atmospheric stability), and rainfall.

Subsection 2.3.3.1.1 describes meteorological tower location and siting, while Subsection 2.3.3.1.2 describes meteorological instrumentation and siting.

2.3.3.1.1 Meteorological Tower Location and Siting

The following topics are addressed regarding meteorological tower location and siting:

- Subsection 2.3.3.1.1.1 describes general location
- Subsection 2.3.3.1.1.2 addresses tower location relative to potential obstructions to airflow

- Subsection 2.3.3.1.1.3 describes tower location relative to potential sources of heat and moisture
- Subsection 2.3.3.1.1.4 addresses tower location relative to Biscayne Bay

2.3.3.1.1.1 General Location

Refer to Subsection 2.3.2.2.1 (Topographic Description) for a general description of topographic features up to 50-miles (80-kilometers) from Units 6 & 7. Digital map elevations in this radial area and more detailed topographic features 5 miles (8 kilometers) from the site are shown, including elevation characteristics in the immediate vicinity of Turkey Point.

Figures 2.3.3-201 and 2.3.3-202 show the location of 60-meter South Dade tower and 10-meter LU tower in relation to existing Units 3 & 4, Units 6 & 7, cooling towers, the existing cooling canals, and Biscayne Bay, respectively. The 60-meter South Dade tower is located at 25° 21' 05.74120" north latitude and 80° 22' 45.54962" west longitude, approximately 11.3 kilometers (7 miles) south of the LU building. The 10-meter LU tower is located at 25 25' 35.072" north latitude and 80° 20' 15.536" west longitude, near the LU building.

Section 1.2 describes the final grade elevation of Units 6 & 7, which is approximately 25 feet (7.6 meters) North American Vertical Datum 1988 (NAVD 88). The Units 6 & 7 control room/receptor elevation relative to grade at 0.0 meters for the plant vent release elevation is 183 feet (55.7 meters) and the passive containment cooling system air diffuser elevation relative to grade at 0.0 meters is 229 feet (69.8 meters) (DCD Table 15A-7).

Although the base of the South Dade tower is approximately 25 feet below the elevation of the finished grade of Units 6 & 7, there are minimal terrain variations between the tower and Units 6 & 7. Therefore, it is concluded that the location of the South Dade tower site and Units 6 & 7 have similar meteorological exposures. The tower and instrument siting conformance status in relation to RG 1.23, Revision 1 are summarized in Tables 2.3.3-202 and 2.3.3-203, respectively. The base of the LU tower is approximately 22 feet below the finished grade of Units 6 & 7. Based on the relatively close distance (0.30 miles) of the LU tower to Units 6 & 7, the LU tower requires relocation because of different meteorological exposures.

2.3.3.1.1.2 Tower Location Relative to Potential Obstructions to Airflow

The wind sensors should be located over level, open terrain at a distance of at least 10 times the height of any nearby natural and man-made obstructions (e.g., terrain, trees and buildings), if the height of the obstruction exceeds one-half the height of the wind measurements (in accordance with RG 1.23, Revision 1). Therefore, an assessment is made regarding whether the wind measurements at locations and heights on the towers avoid airflow modifications by obstructions and the findings follow below:

Figure 2.3.3-201 presents the 60-meter South Dade tower in relation to potential obstructions to airflow. The emergency generator shelter mound is located approximately 21.5 feet (6.6 meters) north of the tower and the emergency generator shelter building is located approximately 36.75 feet (11.2 meters) north of the tower. The emergency generator shelter mound is approximately 9.6 feet (2.9 meters) above ground level and the shelter roof is approximately 10.75 feet (3.3 meters) above the base, for a total height of approximately 20.4 feet (6.2 meters).

The emergency generator shelter houses the data acquisition system for tower measurements and is located on a raised mound to protect it from tidal surges during hurricanes. The azimuth angles of each side of the shelter were sighted and measured from the tower base. These form the basis of defining a sector of possible influence. This sector extends from approximately 353 degrees to 28 degrees in the 360 degree tower wind measurement field. A frequency of occurrence analysis of wind direction for 1 year (January–December 2003) of wind data from the 10-meter level at the 60-meter meteorological station show winds from the sector of possible influence occurred 6.8 percent of the time during 2003.

The LU meteorological tower equipment shelter is currently approximately 35 feet (10.7 meters) west of the 10-meter LU tower. With an obstruction height of approximately 20 feet, according to the 10-times-the-height-of-the-obstruction convention, the tower should be 200 feet away. Because tower separation from the obstruction is approximately 35 feet, the site does not meet conventional specifications for the measurement of an obstruction. A utility pole exists northwest of the LU tower. It should be noted, however, that similar to the South Dade tower, the obstructions are not in the path of prevailing east wind direction flow.

Because of the increased traffic during Units 6 & 7 construction and the raised elevation of the finished plant grade and associated structures, the LU tower requires relocation to an appropriate location on the plant property to ensure tower/instrument operation is in conformance with relevant regulations.

At least 3 months prior to the start of Units 6 & 7, construction activities that could potentially impact the location and/or monitoring capabilities of the current 10-meter meteorological LU tower, a replacement 10-meter meteorological tower will be installed and made operational at an appropriate location on the Turkey Point plant property.

There have been no changes to obstructions in relation to the 60-meter South Dade tower for the period 2002, 2005, and 2006. Potential wake effects are not considered to have influenced wind measurements from the 60-meter South Dade tower during the period of record used to support this COL Application.

2.3.3.1.1.3 Tower Location Relative to Potential Sources of Heat and Moisture

The predominant potential source of heat and moisture in the vicinity of the 60-meter South Dade tower site is the 5900-acre (2388 hectare) industrial wastewater facility/cooling canals, of which 4370 acres (1768 hectare) is water surface (Reference 202).

The 60-meter South Dade tower is located approximately 4500 feet (1372 meters) southwest of the cooling canals. Because of the relatively large size of the cooling canals, it is expected that the cooling canals could have certain influence to the meteorological data monitoring especially when the meteorological tower is located downwind from the cooling canals. Wind directions from the NNE to ENE have a straight-line, over-canal, upwind fetch in relation to the 60-meter tower.

Warmer temperatures from the cooling canals could increase the lower level temperature and create thermal instability. Subsequently, more unstable atmospheric stability is expected. However, this effect enhances the dispersion capability for releases occurring near the plant site.

The water temperature from the Units 3 & 4 plant discharge into the cooling canals averages approximately 105°F (41°C), based on 18 years of measurements between 1980 and 1998. The water temperature in the plant intake from the cooling canals averages approximately 91°F (33°C) during the same period. Temperatures in the southern portions of the cooling leg average approximately 93°F (34°C) (Reference 202).

Ocean water temperatures at Miami Beach average 80.1°F (26.7°C) on an annual basis, ranging from a low of 71.9°F (22.2°C) in January to a high of 88.5°F (31.4°C) in August (Reference 202). Water temperatures in the southern portion of the cooling canals are expected to track ocean water temperatures over the course of the year. Air temperatures are not expected to be modified significantly during onshore airflow conditions between the shoreline and the tower site. When the southeasterly winds prevail, the air traveling through the south Atlantic could have some counter effect to the warming of the cooling canals.

The measured data represents the conditions of the parcel of air if a release occurs from Units 6 & 7 and travels over the cooling canals.

The ground surface surrounding the 60-meter South Dade tower is a grainy, light-colored material with patches of low-cut grass or weeds around the base of the tower which is typical of ground cover in the area. Light-colored ground surface is a potential source of reflective heat that might influence lower-level temperature measurements.

The cooling system for Units 6 & 7 includes six mechanical draft cooling towers. The cooling canals in the industrial wastewater facility are approximately 4500 feet northeast of the South Dade tower at their closest point, while the Units 6 & 7 cooling towers are approximately 5.5 miles northeast of the South Dade tower. The location of the South Dade tower is not directly downwind of the cooling canals or the Units 6 & 7 cooling towers under the prevailing downwind wind direction (i.e., easterly). Therefore, there is no influence on the South Dade heat sensors. In addition, the tower temperature sensors are mounted in fan-aspirated radiation shields, which are horizontal to minimize the impact of thermal radiation and precipitation.

The LU tower is located immediately adjacent to the main return canal in the industrial wastewater facility. Temperature is not measured at this location. The LU tower is used for emergency situations only (short-term) and not for normal data collection/reporting. No parameters related to atmospheric moisture are currently measured on the Turkey Point plant property.

Tropical Storm Gordon in November 13–16, 1994 flooded near the base of the 60-meter South Dade tower. There was some less severe flooding in 2005. The 10-meter temperature measurements may have been influenced (e.g., lower than what might otherwise have been observed had the ground surface not been covered with water).

No paved or other improved surfaces were located in the vicinity of the 60-meter tower during 2002, 2005, or 2006.

2.3.3.1.1.4 Tower Location Relative to Biscayne Bay

The 60-meter South Dade tower is located approximately 3 miles (4.8 kilometers) west from Biscayne Bay. Refer to Subsection 2.3.1.1 for a general description of the effects of Biscayne Bay and adjacent waters on the climate of the Turkey Plant site.

Coastal locations are frequently subject to the daytime formation of a temperature discontinuity referred to as the thermal internal boundary layer (TIBL). The TIBL develops at or very near the land-water interface based on the rate of differential heating between the land and water surfaces, wind conditions and other factors. In general, the TIBL increases in height with increasing distance from the coastline (NUREG/CR-0936).

It is important in siting a meteorological tower in a coastal location, which provides data to be used in atmospheric dispersion calculations, to ensure that the different measurement levels on the tower are in the same boundary layer of air. Consequently, such towers are not located directly on the coastline, but rather some distance inland where the TIBL height is usually greater than the instrument levels on the tower (NUREG/CR-0936).

The 60-meter South Dade tower is located approximately three miles (4.8 kilometers) inland. The TIBL horizontal extent penetrates inland from the shoreline, however it is likely to do so at an elevation greater than the instrument levels on the tower.

2.3.3.1.2 Meteorological Instrumentation and Siting

This subsection describes parameters measured, instrument siting, and system accuracies for the 60-meter South Dade tower during 2002, 2005 and 2006.

2.3.3.1.2.1 Parameters Measured

The meteorological parameters measured at the 60-meter South Dade tower during 2002, 2005 and 2006 are wind speed, wind direction, air temperature A and air temperature B at both the 60-meter height and the 10-meter height. Also measured were solar radiation, barometric pressure, and precipitation.

Ambient temperature is monitored both at the 10- and the 60-meter levels. The ΔT is calculated as the difference between the temperatures measured at 10 meters and at 60 meters. Precipitation is measured at 24.5 feet (7.5 meters) southeast from base of the 60-meter South Dade tower at a height of 4.5 feet (1.37 meters) above ground, while the solar radiation is measured at 4 feet (1.2 meters) above ground.

The meteorological monitoring system block diagrams reflecting the operational station monitoring system configuration during 2002, 2005, and 2006 are provided as Figures 2.3.3-203 and 2.3.3-204 for the South Dade and LU towers, respectively.

Instrumentation (ambient temperature, ΔT, wind speed, wind direction, precipitation [rainfall], solar radiation, and time) conforms to Revision 1 of RG 1.23, Revision 1 during the 2002, 2005 and 2006 period of record.

Table 2.3.3-204 lists, by parameter: measurement height; sensor type; manufacturer and model number; operating range; measurement resolution; starting thresholds (wind speed and direction sensors only); for the Units 6 & 7 meteorological data collection system.

Wind speed, wind direction, and wind direction standard deviation (i.e., sigma theta for atmospheric stability class determination) are obtained at the 10-meter level on the LU 10-meter tower. The LU 10-meter tower provides wind speed, wind direction, and standard deviation of wind direction data to the plant. The standard deviation of wind direction is used to indicate atmospheric stability. Either the LU tower or the South Dade tower is required to be operational. The LU tower measures wind using a Climatronics Wind sensor. It also measures rainfall using a Climatronics tipping bucket rain gauge.

No parameters related to atmospheric moisture are measured at the Turkey Point plant property.

Subsection 2.3.3.1.2.3 contains a more detailed description of system accuracies.

2.3.3.1.2.2 Instrument Siting

The 60-meter South Dade tower, rebuilt in 1994, is 197 feet tall, constructed out of steel, with open-lattice shape, and guyed. The meteorological instrumentation is located at multiple levels on the 60-meter guyed tower, with platforms at 10 meters, 60 meters, and an intermediate (non-instrumented) level. The meteorological instrumentation heights are summarized in Table 2.3.3-201.

The wind sensors are mounted on booms into the prevailing southeast wind direction approximately 6 feet (1.8 meters) away from the open-lattice tower. This position on the boom is equal to two tower widths (one tower width is 3 feet [0.9 meters]) away from the tower. The wind speed and wind direction boom is pointed southeast into the prevailing wind direction.

The temperature sensors discharge points north. Temperature sensors are mounted on booms at a distance of approximately 4 feet (1.2 meters) (< 1.5 tower horizontal widths) from the tower so that the sensors are unaffected by thermal radiation from the tower. To further ensure that air temperature measurements avoid air modification by heat and moisture, their sensors are mounted in fan aspirated solar radiation shields.

The barometric pressure sensor is located outside the tower control building on the south wall. Barometric pressure is not reported to the NRC.

The solar radiation sensor is approximately 23 feet (7 meters) southeast from the base of the 60-meter South Dade tower. The sensor (Eppley Black and White Pyranometer Model 8-48) is mounted 4 feet (1.2 meters) above ground.

The rain gauge is located approximately 24.5 feet (7.5 meters) southeast from base of 60-meter South Dade tower. The top edge of the rain gauge is 4.5 feet (1.4 meters) above ground. The ground surface surrounding the base of the rain gauge and the 60-meter South Dade tower is a grainy, light-colored material with patches of low-cut grass or weeds that is typical of ground cover in the area. A wind shield is not installed on the rain gauge. The wind speed and wind direction sensors and rain gauge are not heated.

2.3.3.1.2.3 System Accuracies

The overall station system accuracies include the errors introduced by sensors, cables, signal conditioners, temperature environments for signal conditioning and recording equipment, recorders, processors, data displays, and the data reduction process. The system accuracies of the Units 6 & 7 meteorological station data collection system are compared against the regulatory requirements and the findings are summarized in Table 2.3.3-204. As shown in the table, the system accuracies of the proposed system meet the regulatory guidance in accordance with RG 1.23, Revision 1 and ANSI/ANS 3.11 (Reference 204).

The time clock is not calibrated, but is checked as part of weekly tower inspection visits. Time is recorded as Eastern Standard Time during 2002, 2005, and 2006.

The calibration procedures perform system accuracies from sensor to data logger (sensor to end point). Calibration forms are used for the plant computer and indication in the control room.

2.3.3.1.3 System Operation, Maintenance, and Calibration

This subsection describes system operation and maintenance, and system calibration.

2.3.3.1.3.1 System Operation and Maintenance

Meteorological sensors used on both meteorological towers are designed to operate in the environmental conditions found at the Turkey Point site. Specifically, this instrumentation is capable of withstanding the following environmental conditions:

- Ambient temperature range of –22°F (–30°C) to 122°F (50°C)
- Wind load up to 100 miles per hour (45 meters per second) (the wind sensors blew away during Hurricane Andrew)

The instruments on the towers are off-the-shelf components and are used universally throughout the nuclear industry and others for the purpose of meteorological measurement. Based on operating experience, the only adverse operational effects that have been noted is the susceptibility of the rotating-cup and weather vane instruments to bearing wear and degradation due to the site environmental conditions that required the instruments to be rebuilt or replaced approximately every 6 months. The meteorological tower guy wires are inspected on an annual basis and the tower anchors are inspected once every three years, in accordance with NRC Regulatory Guide 1.23, Revision 1, Section C.5.

2.3.3.1.3.2 System Calibration

Calibration and maintenance of the onsite meteorological monitoring station system are performed in accordance with RG 1.23, Revision 1, Section C.5., Regulatory Position, Instrument Maintenance and Servicing Schedules and ANSI/ANS 3.11, Section 7, System Performance (Reference 204). The existing meteorological monitoring system is calibrated semi-annually at both towers, and channel checks are performed daily in order to achieve maximum data recovery.

Detailed instrument calibration procedures and acceptance criteria are strictly followed during station system calibration. Calibrations verify and, if necessary, re-establish accuracies of sensors, associated signal processing equipment and displays. Routine calibrations include obtaining both “as-found” (prior to maintenance) and “as-left” (final configuration for operation) results. The end-to-end results are compared with expected values. Any observed anomalies which may affect equipment performance or reliability are reported for corrective action. If any acceptance criteria is not met during performance of calibration procedures, timely corrective measures (e.g., adjusting response to conform to desired results by qualified personnel onsite or return the sensor to vendor for calibration) are initiated. Inspection, service, and maintenance, including preventive and/or corrective maintenance on system components for transmitting, manipulating, and/or processing meteorological data for computer display or storage, are performed according to the instrument manuals and plant surveillance program procedures to maintain at least 90 percent data recovery.

The following semiannual calibrations occur in June and December:

- Emergency Response Data Acquisition and Display System calibration data points
- Loop checks from tower (5 points)
- Outage notification and system calibration to maintain the system accuracy of the meteorological system)
- Final Overlap Test:

Repair Calibrations: As needed from any combination of the above.

- Routine site checks are conducted weekly
- Troubleshooting of individual channels on the meteorological parameters system loop.

2.3.3.1.4 Data Acquisition and Recording

Data loggers and communication equipment at the LU and South Dade meteorology tower station shelters include a new CR1000 data logger and new radio communication equipment. The radios are Campbell Scientific model RF310. They are manufactured by Midland (Midlandradio.com) as model SD125V2 VHF. The configuration changes occurred in 2007, as follows:

An older Climatronics analog system was replaced with a new supervisory control and data acquisition/ModBus digital radio system. Data is currently independently polled on frequencies A and B using ModBus commands from the meteorological towers to the Foxboro computers for Units 3 & 4. Somewhat aged data loggers have been replaced with new ones. The data acquisition system for the LU office has been upgraded.

Independent microprocessors are used as the primary data collection system for the meteorological towers, with digital data recorders used as a backup data collection system. The microprocessors sample the meteorological processor modules once per second for each parameter measured except for precipitation. Water collected by the rain gauge is automatically drained and counted each time an internal bucket fills with 0.01 inch of rainfall. The temperature difference (ΔT) is calculated from the difference between 60-meter and 10-meter level ambient temperature measurements.

The station processing equipment is housed in environmentally controlled (air-conditioned) shelters. A direct readout capability from these microprocessors is included. The equipment is located in the station instrument shelter near the base of the South Dade Tower, across the road from the LU tower, in the LU office, and in the Units 3 & 4 control room.

The LU and control room have Omni meteorological antennae and a meteorological data loggers. The South Dade tower uses Yagi antennas. Meteorological communications equipment provides radio-transmitted serial data communications back to the computer room.

Personnel in the LU office monitor the data being reported by the meteorological towers and they are required to submit meteorological reports to the NRC. LoggerNet™ software (computer software for Campbell Scientific dataloggers supporting programming, communications, and data retrieval between Campbell Scientific dataloggers and a PC) has been installed on a personal computer (PC) in the LU office so it can receive data from the meteorological towers using Frequency C. LoggerNet is also able to send data logger programs, check and set the data logger clocks and other normal LoggerNet functions.

Real time monitoring of the met tower data is accomplished by programming the meteorological tower data loggers to send their one minute data shortly after the end of the minute using the “SendData” command. RTMC software is used to build graphs and charts that display the data in the minute of its receipt.

NRC reportable data is required to be in discrete 1-hour intervals. LoggerNet has been set up to “poll” or request the hourly data from the met towers every 2 hours.

2.3.3.1.5 Data Processing and Validation

This subsection describes data reduction and review, data validation, and data reporting and archival.

2.3.3.1.5.1 Data Reduction and Review

Hourly average data is downloaded and formatted monthly for review and editing. Acceptable data editing methods have been established and implemented. Missing or invalid 60-meter tower 10-meter wind speed, wind direction, and ΔT data are deleted or manually replaced with backup tower data.

2.3.3.1.5.2 Data Validation

Processing of monthly, quarterly and annual data files have defined procedures. Validation checks for monthly data may include importing the file into Microsoft Office Excel® and plotting the temperatures—TA10 against TB10 and TA60 against TB60. The point of this exercise is to try to see which one is at fault if one temperature goes too low, which happens when the terminals are corroded and wet. For this reason, plotting the precipitation as well can frequently provide additional information. FPLDiagnose (uncompiled Microsoft Visual Basic®) is used on the file, which flags the problems. The user can then set a status of “valid” or “missing” for each issue, then apply the NRC checks. The FPLDiagnose program writes the following files:

- TPyy.mmm files, with the validations applied
- TPyymmm.err files, which contain the record of the flags and invalidations
- MTPyymmm.csv files, which have the record of sigma thetas set to missing because of wind speeds below 3.5 miles per hour
- DTPyy.mmm files, which are used for input to subsequent programs

The acceptance criteria for the meteorological data are as follows:

1. Wind direction out of range (0–360°)

2. Wind direction absolute difference between the 10- and 60-meter levels too large (wind speed >12 miles per hour for both levels, wind direction difference >= 30°)

3. Wind speed out of range (0–99 miles per hour)

4. Wind speed absolute difference between the 60- and 10-meter levels too large (wind speed difference >=15 miles per hour)

5. Temperatures A and B for each level do not match within 0.5° F

6. The ΔT A and B do not match within 0.5°C per 100 meters

7. The ΔT less than -3.4°C per 100 meters

8. Sigma-Theta unreasonable (WS10 < 3.5 miles per hour)

2.3.3.1.5.3 Data Reporting and Archival

An additional feature of the data acquisition system is the storage of the 15- and 60-minute averaged meteorological data. At a minimum, the latest 12 months of averaged data resides on the system hard-drive. The historical data can be retrieved, archived, displayed, or printed. Running 15-minute-averaged data is stored on local plant computers for trending and reporting purposes in accordance with RG 1.21.

2.3.3.1.6 Data Recovery and Representativeness

The 3 years of data used in the atmospheric dispersion estimates was determined to be (1) the best available, because the data has been validated and required the least data substitution, (2) representative, because the meteorological tower and sensor siting were performed in accordance with RG 1.23, Revision 1, and (3) complete with annualized data recovery of 90 percent as shown in Table 2.3.3-205.

Three years of representative data (i.e., 2002, 2005, and 2006) collected at the existing towers are used in preparing the Units 6 & 7 COL Application. The data set satisfies the guidance provided in RG 1.23, Revision 1. The required joint frequency distributions are presented in Subsection 2.3.2, Tables 2.3.2-205 and 2.3.2-206 in the format described in RG 1.23, Revision 1 for the following: wind speed and wind direction by stability class and by stability classes combined for the 10- and 60-meter levels measurements.

The annualized data recovery rates for 2002, 2005, and 2006 are presented in Table 2.3.3-205 for the individual parameters (e.g., wind speed and wind direction) and the composite parameters. As shown in the table, data recovery rates (with the exception of 60-meter wind direction in 2005 of 89.59 percent) exceed 90 percent as specified in RG 1.23, Revision 1. Although measured, barometric pressure and solar radiation data were not validated and so are not included in this table (or in the NRC-formatted data file).

The recovery rate is greater than 90 percent for each of the 3 years when considering the 10-meter speed and direction combined with the vertical temperature difference. Data recovery for the 60-meter speed and direction combined with the vertical temperature difference also is greater than 90 percent for the 3-year composite, but not for each individual year (2005 being slightly less than 80 percent for this joint recovery) For the AP1000 design only the 10-meter joint frequency distributions are applicable to modeling potential accidental and routine releases, and composite 3-year data recoveries for 60-meter wind speed and wind direction are greater than 90 percent if used in the ARCON96 modeling of control room dispersion estimates.

Refer to Subsections 2.3.2.2.1 through 2.3.2.2.3 for descriptions of the long-term representativeness of atmospheric dispersion-related parameters based on the 2002, 2005 and 2006 period of record (i.e., winds and atmospheric stability).

Refer to Subsections 2.3.1.3.4, 2.3.2.2.4, and 2.3.2.2.6 for descriptions of the long-term representativeness of normal, mean and extreme precipitation (rainfall) and temperature conditions that might be expected to occur at the Turkey Point site.

2.3.3.1.7 Emergency Preparedness Support

The Units 6 & 7 onsite data collection system is used to provide representative meteorological data for use in real-time atmospheric dispersion modeling for dose assessments during and following any accidental atmospheric radiological releases. The data is also used to represent meteorological conditions in the 10-mile Emergency Planning Zone radius in NUREG 0696, NUREG 0737, and NUREG 0654.

Microprocessors sample the meteorological processor modules once per second for each of the following parameters in order to provide near real-time meteorological data for use in atmospheric dispersion modeling: wind speed, wind direction, and ambient temperature for calculations of vertical temperature

difference. Dose assessment calculations are performed using the most recent 15-minute average of data in RG 1.97.

In order to identify rapidly changing meteorological conditions for use in performing emergency response dose consequence assessments, 15-minute average values are compiled for real-time display in the Units 6 & 7 control room, technical support center, and emergency operations facility. The meteorological channels required for input to the dose consequence assessment models are available and presented in a format compatible for input to these dose assessment models in RG 1.97.

Currently, provisions are in place to obtain representative regional meteorological data during an emergency if the site meteorological system is unavailable.

2.3.3.1.8 Need of Additional Data Sources for Airflow Trajectories

Topographic features and the dispersion characteristics of the area of the site were examined in Subsections 2.3.2 and 2.3.3.1. The area of the site is generally flat and is considered an open terrain site. The airflow is dominated mostly by large-scale weather patterns and infrequent recirculation of airflow during periods of prolonged atmospheric stagnation.

The NRC-sponsored computational model (XOQDOQ), based on RG 1.111, is a constant mean wind direction model, using meteorological data from a single station to calculate dispersion estimates out to 50 miles of a site of interest. In the model, application of terrain induced airflow-recirculation factor options are provided to account for the effects of airflow recirculation phenomenon occurring in the area of interest, when meteorological data from a single station is used to represent the entire modeling domain. However, application of airflow-recirculation factor for sites located in open terrain is not required. This methodology implies that the meteorological data from an onsite station is reasonably representative of the entire modeling domain and adjustment to the dispersion estimates calculated by the model out to 50 miles of a site located in open terrain is not required.

For coastal sites located in open terrain such as the Turkey Point site, an airflow-recirculation factor provided in the XOQDOQ model is used to account for potential airflow recirculation due to sea breeze and land breeze effects and during the infrequent stagnation conditions that could lead to more restrictive dispersion estimates. With application of the appropriate airflow recirculation factor, this methodology further implies that using data collected from an onsite

meteorological monitoring station located in open terrain for making dispersion estimates out to 50 miles of a coastal site is considered to be adequate and acceptable.

Therefore, data collected by the onsite meteorological system is used for the description of atmospheric transport and diffusion characteristics 80 kilometers (50 miles) from Units 6 & 7 and for making dispersion estimates out to 50 miles of the site. No other offsite data collection systems have been considered while determining the dispersion characteristics of the area of the Turkey Point site.

2.3.3.2 References

201. Not Used.

202. Lyerly, R., T*hermal Performance of the Turkey Point Cooling Canal System in 1998*, October 1998.

203. Not Used.

204. American Nuclear Society/American National Standards Institute, American National Standard for Determining Meteorological Information at Nuclear Facilities, ANS/ANSI 3.11-2005, December 2005.

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Table 2.3.3-201
Units 6 & 7 System Meteorological Instrumentation

Parameter	South Dade Tower Level (meters)	LU Tower Level (meters)
Wind Speed	10, 60	10
Wind Direction	10, 60	10
Temperature	10, 60	None
Vertical Temperature Difference (ΔT)	(60–10)	None
Sigma Theta	None	10
Precipitation	1.37[a]	—
Solar Radiometer	1.2[b]	None
Barometric Pressure	[c]	None
Humidity	None	None

(a) Located approximately 24.5 feet (7.5 meters) southeast from base of 60-meter tower
(b) Located approximately 23 feet (7 meters) southeast from the base of the 60-meter tower
(c) Located outside the equipment shelter on the south wall

Table 2.3.3-202
Meteorological Tower Siting Conformance Status

RG 1.23, Revision 1 Criteria	Conformance Status	Remarks
Tower Siting		
The meteorological tower sites and the Units 6 & 7 location have similar meteorological exposure.	Yes	The Turkey Point plant property is generally flat land.
The base of the tower is at approximately the same elevation as the finished grade of Units 6 & 7.	No No	The South Dade tower is below the approximately 25.5 feet finished grade. However, due to the similarity of the landscape, there would be minimal effects. The finished grade of Units 6 & 7 and associated buildings would produce different meteorological exposures than at the current LU tower location. The LU tower would need to be relocated.
Location of the tower is not directly downwind of the plant cooling systems (i.e., cooling canals in the industrial wastewater facility and mechanical draft cooling towers) under the prevailing downwind wind direction.	Yes No	The South Dade tower is not located near preexisting or planned cooling systems. The LU tower is located near existing cooling canals on both the east and west sides; however, the majority of the cooling canals are located west of the LU tower, while the path of the prevailing downwind wind direction is from the east. The LU tower would need to be relocated because of construction impacts and operational concerns (i.e., height of the Units 6 & 7 finished grade and structures).
Tower is not located on or near permanent man-made surface.	Yes No	There are no large concrete or asphalt parking lot or temporary land disturbance, such as plowed fields or storage areas nearby the South Dade tower. The closest large concrete or asphalt parking lots are at Units 3 & 4, which is approximately 6.5 miles from the South Dade tower. The LU tower is located near an asphalt roadway and temperature is not measured. Temperature concerns would not be an issue in the siting of the LU tower at a new location.

Table 2.3.3-203 (Sheet 1 of 2)
Meteorological Sensor Siting Conformance Status

RG 1.23, Revision 1 Criteria	Conformance Status	Remarks
Sensor Siting		
Wind sensors should be located away from nearby obstructions to airflow (e.g., plant buildings, other structures, trees, nearby terrain) by a distance of at least 10 times the height of any such obstruction that exceeds one-half the height of the wind measurement level to avoid any modifications to airflow (i.e., turbulent wake effects).	Yes No	The South Dade tower is located near a raised mound/equipment shelter. However, the effects were found to be minimal on the South Dade tower. The LU tower would need to be relocated because of construction impacts and operational concerns (i.e., height of the finished grade and buildings).
Wind sensors are located at heights that avoid airflow modifications by nearby obstructions with heights exceeding one-half of the wind measurement.	Yes	See remark above.
Wind sensors are located extended outward on a boom to reduce airflow modification and turbulence induced by the supporting structure itself. Wind sensors on the side of a tower should be mounted at a distance equal to at least twice the longest horizontal dimension of the tower (e.g., the side of a triangular tower).	Yes	Tower booms (6 feet long) are oriented into the prevailing winds to reduce tower effects on the measurements. The wind sensors are boom-mounted more than approximately 6.5 feet from the tower (more than twice the tower's width of 3 feet).
The sensors should be on the upwind side of the mounting object in areas with a dominant prevailing wind direction.	Yes	The wind speed/direction boom is pointed southeast into the dominant wind direction.
Air temperature and dew point sensors are located in such a way to avoid modification by the existing and proposed heat and moisture sources, such as ventilation systems, water bodies, or the influence of large parking lots or other paved surfaces.	Yes (see remark) No	The South Dade tower is not located near any heat or moisture sources. The LU tower is located near the cooling canals. Dew point is not measured at either the South Dade or LU towers.
Temperature sensors should be mounted in fan-aspirated radiation shields to minimize adverse influences of thermal radiation and precipitation. Aspirated temperature shields should either be pointed downward or laterally towards the north. The shield inlet should be at least 1.5 times the tower horizontal width away from the nearest point on the tower.	Yes	Temperature is measured only on the South Dade Tower. Temperature sensors are mounted in fan-aspirated radiation shields. Aspirated temperature shields are horizontal. The shield inlet is situated approximately 4 feet from the tower (slightly less than 1.5 times the tower's width of 3 feet).

Table 2.3.3-203 (Sheet 2 of 2)
Meteorological Sensor Siting Conformance Status

RG 1.23, Revision 1 Criteria	Conformance Status	Remarks
Precipitation measured at ground level near the base of the tower. Precipitation gauges should be equipped with wind shields to minimize wind-caused loss of precipitation and, where appropriate, equipped with heaters to melt frozen precipitation.	Yes (see remark)	Precipitation is measured at ground level near the base of each of the towers, but the gauge is located away from the tower shelter to prevent any interference in precipitation capture. Neither precipitation gauge is equipped with wind shields to minimize the wind-caused loss of precipitation, but each gauge has a funnel screen.

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Table 2.3.3-204 (Sheet 1 of 2)
Units 6 & 7 Meteorological System — Operational Configuration

Sensed Parameter	Sensor Type	Manufacturer/ Model	Range	System Accuracy	System Accuracy (per RG 1.23, Revision 1)	System Accuracy (per ANSI/ANS-3.11-2005, Reference 204)	Starting Thresholds	Starting Threshold (RG 1.23, Revision 1)	Measurement Resolution	Measurement Resolution (RG 1.23, Revision 1)	Measurement Resolution (per ANSI/ANS-3.11-2005, Reference 204)	Elevation (Relative to Tower)
South Dade Tower Instruments												
Wind Speed	3 Cup Anemometer	Climatronics/ Model Wind Speed F460	0 to 145 mph (0 to 65 m/s)	0.15 mph (±0.07 m/s) or ±1.0% of true air speed (whichever is greater)	±0.45 mph (±0.2 m/s) or 5% of observed wind speed	±0.45 mph (0.2 m/s) or 5% of observed wind speed	0.5 mph (0.22 m/s)	1 mph (<0.45 m/s)	—	0.1 mph (0.1 m/s)	0.1 mph (0.1 m/s)	10 m, 60 m
Wind Direction	Wind Vane	Climatronics/ Model Wind Direction F460	0 to 360 degrees — mechanical	±2 degrees	±5°	5°azimuth	0.5 mph (0.22 m/s)	1 mph (<0.45 m/s)	<1 degree	1.0 degree	1.0° azimuth	10 m, 60 m
Ambient Temperature	Epoxy Coated Thermistor	Climatronics/ P/N 100093	–22.0° to 122.0°F (–30.0° to 50°C)	±0.27°F (±.15 °C)	±0.9°F (±0.5°C)	±0.9°F (0.5°C)	—	—	—	0.1°F (0.1°C)	0.1°F (0.1°C)	10 m
Differential Temperature(a)	N/A	N/A	—	—	±0.18°F (±0.1°C)	±0.18°F (0.1°C)	—	—	—	0.1°F (0.1°C)	0.1°F (0.1°C)	60 m–10 m
Precipitation(b)	Tipping Bucket	Climatronics/ P/N 100097	—	+/–3% (Rates of 1 to 6 inches per hour)	±10% for a volume equivalent to 0.1 in (2.54 mm) of precipitation at a rate <2 in/h (<50 mm/h)	±10% for a volume equivalent to 0.1 in (2.54 mm) of precipitation at a rate <2 in/h (<50 mm/h)	—	—	—	0.01 in (0.25 mm)	0.01 in (0.25)	Tower base
Solar Radiation	Pyranometer	Eppley Black and White Model 8-48	0.3-3um	±0.008 Langley/min(c)	—	—	—	—	—	—	—	Tower base
Barometric Pressure	—	Climatronics barometer	—	—	—	3 hPa	—	—	—	—	0.1 hPa	Instrument Building
Sigma-Theta(d)	N/A	N/A	N/A	N/A	—	—	N/A	—	1 degree	—	0.1 degrees azimuth	10 m, 60 m
Humidity	N/A	N/A	N/A	N/A	±4%	N/A	N/A	N/a	N/A	0.1%	N/A	N/A

PTN COL 2.3-3

Table 2.3.3-204 (Sheet 2 of 2)
Units 6 & 7 Meteorological System — Operational Configuration

Sensed Parameter	Sensor Type	Manufacturer/ Model	Range	System Accuracy	System Accuracy (per RG 1.23, Revision 1)	System Accuracy (per ANSI/ANS-3.11-2005, Reference 204)	Starting Thresholds	Starting Threshold (RG 1.23, Revision 1)	Measurement Resolution	Measurement Resolution (RG 1.23, Revision 1)	Measurement Resolution (per ANSI/ANS-3.11-2005, Reference 204)	Elevation (Relative to Tower)
LU Tower Instruments												
Wind Speed	Cup 3 Cup Anemometer	Climatronics/ Model Wind Speed F460	0 to 145 mph (0 to 65 m/s)	0.15 mph (±0.07 m/s) or ±1.0% of true air speed (whichever is greater)	±0.45 mph (±0.2 m/s) or 5% of observed wind speed	±0.45 mph (0.2 m/s) or 5% of observed wind speed	0.5 mph (0.22 m/s)	1 mph (<0.45 m/s)	—	0.1 mph (0.1 m/s)	0.1 mph (0.1 m/s)	10 m
Wind Direction	Wind Vane	Climatronics/ Model Wind Direction F460 sensor	0 to 360 degrees — mechanical	±2°	±5°	5°azimuth	0.5 mph (0.22 m/s)	1 mph (<0.45 m/s)	<1 degree	1.0 degree	1.0 degree azimuth	10 m
Precipitation[b]	Tipping Bucket	Climatronics/ P/N 100097	—	+/-3% (Rates of 1 to 6 inches per hour)	±10% for a volume equivalent to 0.1 in (2.54 mm) of precipitation at a rate <2 in/h (<50 mm/h)	±10% for a volume equivalent to 0.1 in (2.54 mm) of precipitation at a rate <2 in/h (<50 mm/h)	—	—	—	0.01 in (0.25 mm)	0.01 in (0.25 mm)	Tower base
Sigma-Theta[d]	N/A	N/A	N/A	N/A	—	—	N/A	—	1 degree	—	0.1 degrees azimuth	10 m

(a) The Differential Temperature value is a calculated value based on arithmetic differences in the Ambient Temperature measurements at 60-meter and 10-meter loca ions.
(b) Water is collected and drained each time an internal bucket fills with 0.01 inches (0.25 mm) of water.
(c) As measured at the output of Foxboro (Primary equipment rack).
(d) The Sigma-Theta value is a calculated value based on the Wind Direction variation measurements, and therefore has the same resolution as the Wind Direction measurements.

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Table 2.3.3-205
Units 6 & 7 Annual Data Recovery Rate (in percent) for Existing Meteorological Monitoring System (2002, 2005, and 2006)

Parameter	2002	2005	2006	3-Year Composite
Wind Speed (10 m)	100.0%	98.9%	99.6%	99.5%
Wind Speed (60 m)	99.9%	90.8%	100.0%	96.9%
Wind Direction (10 m)	99.6%	98.6%	99.6%	99.2%
Wind Direction (60 m)	99.9%	89.6%	100.0%	96.5%
Temperature (60 m–10 m)[a]	94.0%	98.9%	99.6%	97.5%
Ambient Temperature (10 m)	95.0%	99.7%	99.9%	98.2%
Ambient Temperature (60 m)	95.9%	99.8%	99.8%	98.5%
Precipitation	100.0%	99.8%	100.0%	99.9%
Composite Parameters				
WS/WD (10m), T (60m-10m)[a]	93.6%	97.2%	99.2%	96.7%
WS/WD (60m), T (60m-10m)[a]	94.0%	79.7%	99.6%	91.1%
WS/WD (10m)	99.6%	98.2%	99.6%	99.1%
WS/WD (60m)	99.9%	80.6%	100.0%	93.5%

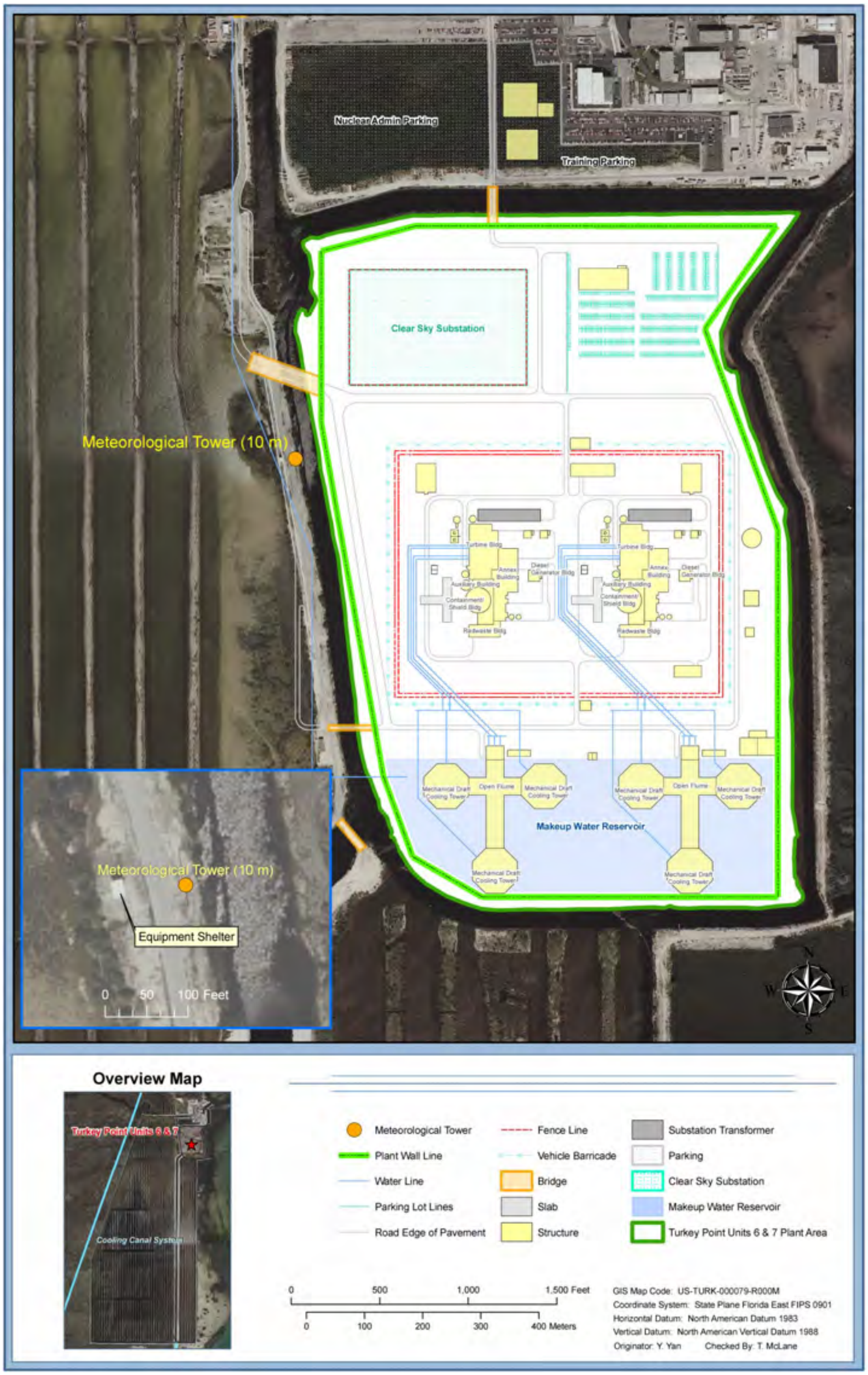
(a) Temperature difference (ΔT) between 60-meter and 10-meter levels.

PTN COL 2.3-3

Figure 2.3.3-201 60-meter Meteorological Tower Site Features

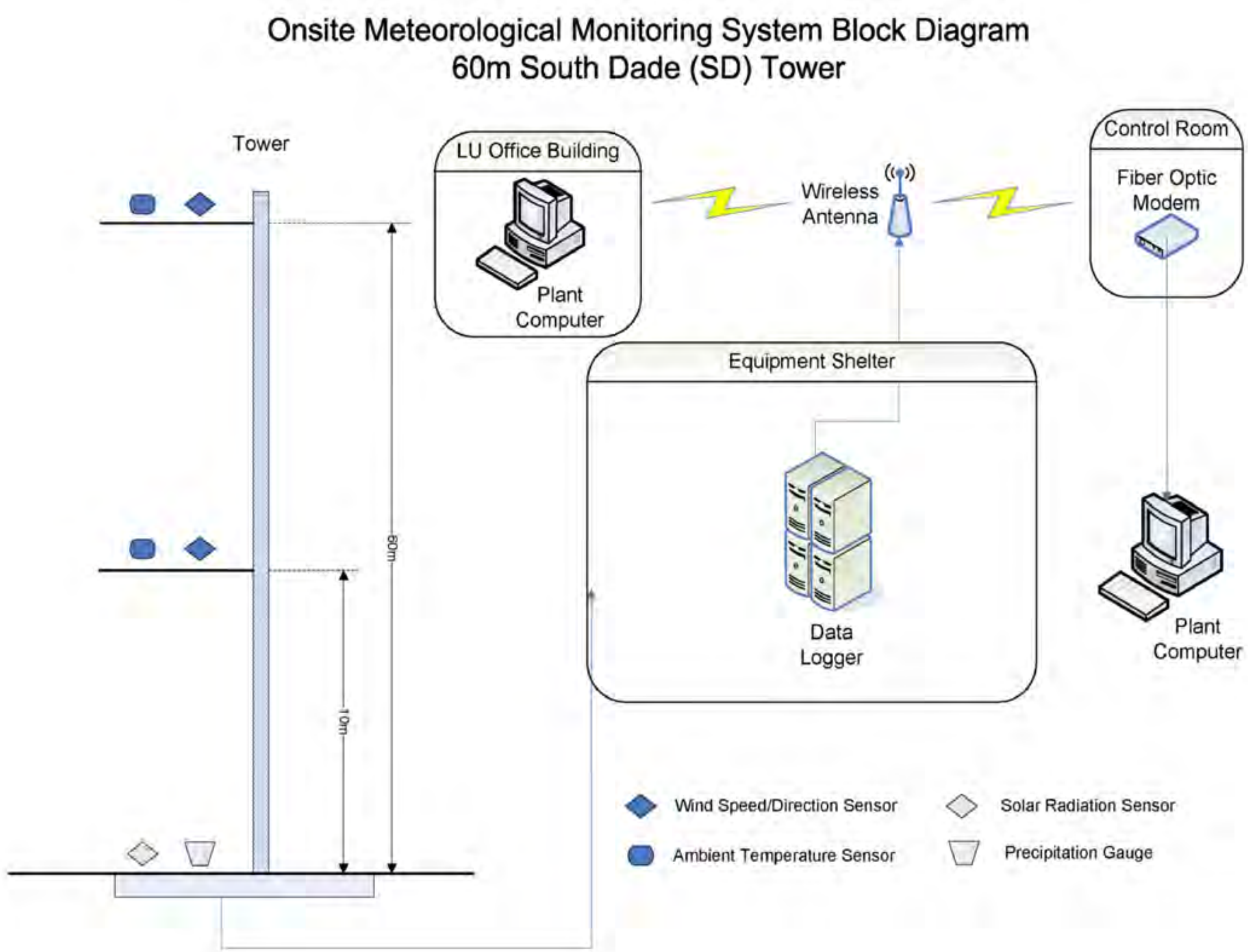
PTN COL 2.3-3

Figure 2.3.3-202 10-meter Meteorological Tower Site Features



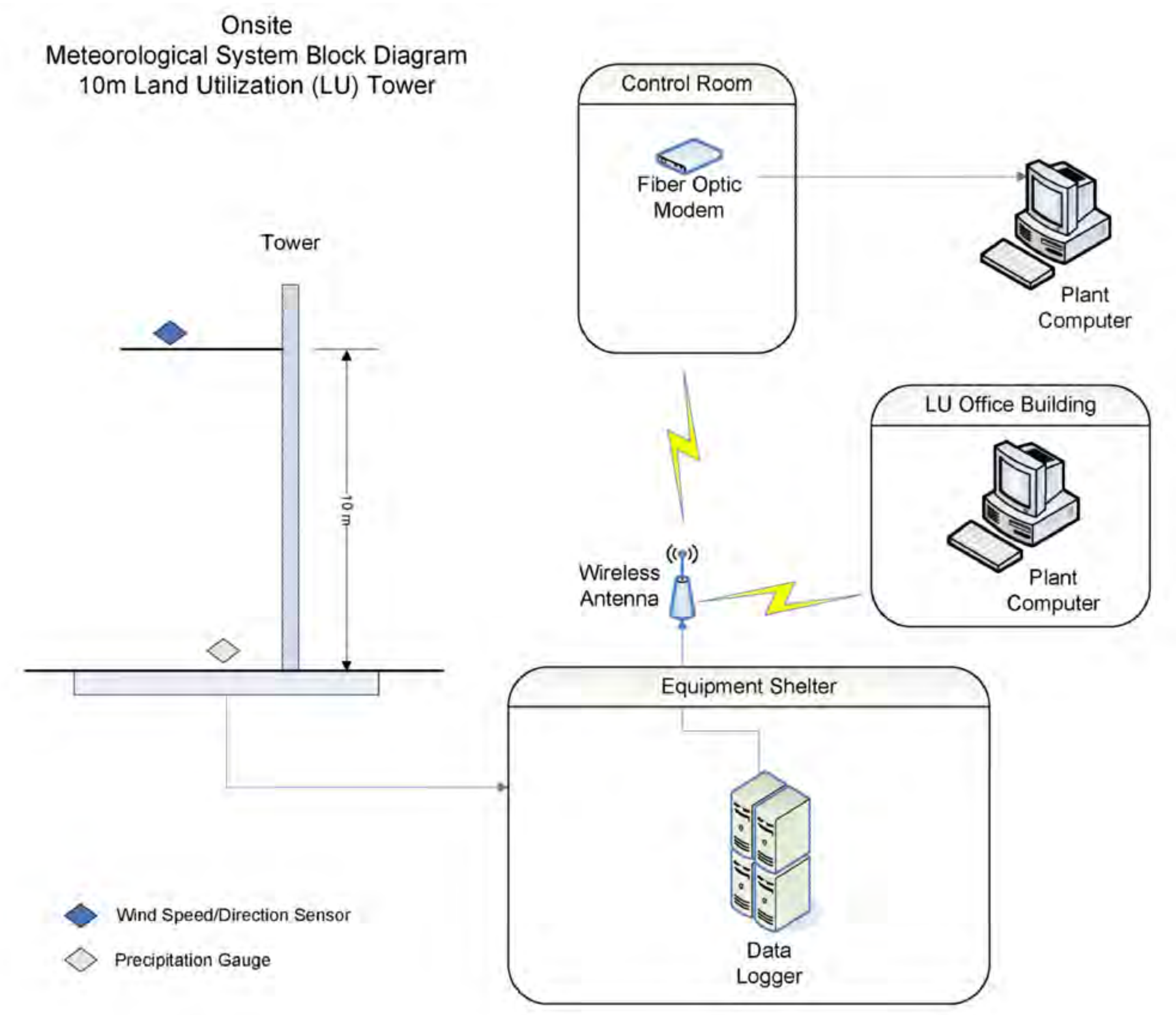
PTN COL 2.3-3

Figure 2.3.3-203 Meteorological System Block Diagram (South Dade Tower — Operational Configuration)



PTN COL 2.3-3

Figure 2.3.3-204 Meteorological System Block Diagram (LU Tower — Operational Configuration)



2.3.4 SHORT-TERM DIFFUSION ESTIMATES

2.3.4.1 Objective

PTN COL 2.3-4 The NRC-sponsored PAVAN computer code (NUREG/CR-2858) is used to estimate relative ground-level atmospheric concentrations (X/Q) at the exclusion area boundary (EAB) and low population zone (LPZ) for potential accidental releases of radioactive material. Control room X/Qs are estimated using the ARCON96 model (NUREG/CR-6331).

According to 10 CFR Part 100, it is necessary to consider the doses for various time periods immediately following the onset of a postulated ground-level release at the EAB and for the duration of exposure at the LPZ. Therefore, the relative X/Qs are estimated for various time periods ranging from 2 hours to 30 days.

According to Subsection B of RG 1.23, the required meteorological data for a combined license that does not reference an early site permit is a consecutive 24-month period of data that is defendable, representative, and complete, but not older than 10 years from the date of application. Site-specific meteorological data covering the 3-year period of record (2002, 2005, and 2006) is used to quantitatively evaluate such a hypothetical accident at the site.

2.3.4.2 PAVAN Modeling Results

Meteorological data is used to determine various postulated accident conditions as specified in RG 1.145**.** Compared to an elevated release, a ground-level release usually results in higher ground level concentrations at downwind receptors because of less dilution from shorter traveling distances. Section 4.4 of the PAVAN code specifies that ground level releases include all release points or areas that are lower than 2.5 times the height of adjacent solid structures. Because the ground level release scenario usually provides a bounding case, and because none of the release heights is higher than 2.5 times the height of the associated reactor shield building, elevated releases are not considered.

According to RG 1.111, the meteorological effects from large bodies of water should be considered in relative dispersion calculations. Therefore, to be conservative, the effects of Biscayne Bay on the dispersion environment were considered in this analysis. The terrain adjustment factors were used for the annual average calculations to account for the airflow recirculation effect

generated by the local land-sea breeze circulation. The terrain in the area is characterized as flat, so adjustments for topography are not required.

The PAVAN program implements the guidance provided in RG 1.145. The code computes X/Qs at the EAB and LPZ for each combination of wind speed and atmospheric stability class for each of 16 downwind direction sectors (i.e., north, north-northeast, northeast, etc.). The X/Q values calculated for each direction sector are then ranked in descending order, and an associated cumulative frequency distribution is derived based on the frequency distribution of wind speeds and stabilities for the complementary upwind direction sector. The X/Q value that is equaled or exceeded 0.5 percent of the total time is designated the maximum sector-dependent X/Q value.

The calculated X/Q values are also ranked independently of wind direction to develop a cumulative frequency distribution for the entire site. The PAVAN program then selects the X/Qs that are equal to or exceeded by 5 percent of the total time.

The larger of the two values (i.e., the maximum sector-dependent 0.5 percent X/Q or the overall site 5 percent X/Q) is used to represent the X/Q value for a 0- to 2-hour time period. To determine X/Qs for longer time periods, the program calculates an annual average X/Q value using the procedure described in RG 1.111). The program then uses logarithmic interpolation between the 0–2 hour X/Qs for each sector and the corresponding annual average X/Qs to calculate the values for intermediate time periods (i.e., 0–8 hours, 8–24 hours, 1–4 days, and 4–30 days). As suggested in NUREG/CR-2858, each of the sector-specific 0–2 hour X/Qs provided in the PAVAN output file are examined for “reasonability” by comparing them with the ordered X/Q also presented in the model output.

The PAVAN model has been configured to calculate offsite X/Q values assuming both “wake-credit allowed” and “wake-credit not allowed.” Several sector distances from the power block area to the EAB (NE, ENE, E, SE, ESE) are within the building wake influence zone. Therefore, credit is taken for building wakes in these four zones for the EAB analysis. Since the LPZ is located farther away from the plant site than the EAB, the “wake-credit not allowed” scenario of the PAVAN results is used for the X/Q analyses at the LPZ.

The PAVAN model input data is presented below:

- Meteorological data: 3-year (2002, 2005, and 2006) composite onsite joint frequency distributions of wind speed, wind direction, and atmospheric stability (see Subsection 2.3.2)
- Type of release: Ground level
- Wind sensor height: 33 feet (10 meters)
- Vertical temperature difference: as measured at the 33-foot (10-meter) and 196.9-foot (60-meter) levels of the primary meteorological tower
- Number of wind speed categories: 13
- Minimum reactor building cross-sectional area: 2636 square meters (see Subsection 2.3.5)
- Shield building height: 69.7 meters above grade
- Distances from release points along the source boundary, which encompasses all potential release points, to the EAB for all downwind sectors (see Table 2.3.4-201)
- Distances from release point to LPZ for all downwind sectors (see Table 2.3.4-201)

The PAVAN model uses building cross-sectional areas and shield building height to estimate wake-related X/Q values. Since the EAB (not including NE, ENE, E, SE, ESE sectors) and the LPZ (all sectors) are both located beyond the building wake influence zone, these two input parameters have no effect in calculating the non-wake X/Q values.

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Units 6 & 7 are conservatively treated as one unit in estimating the shortest distance to each boundary receptor in each direction. This is done by using a source boundary that encloses all potential release points for both Units 6 & 7. Using the source boundary approach, the shortest distance from the source boundary to the EAB is presented in Table 2.3.4-201 for each of the 16 direction sectors.

The maximum sector-dependent 0.5 percent X/Q value and the overall 5 percent X/Q value are conservatively estimated using the source boundary concept.

Similar to the above approach, the shortest distances from the source boundary to the LPZ (Figure 2.1-226) is used in the PAVAN modeling run to determine the X/Q values at the LPZ.

Based on the PAVAN modeling results, the maximum 0–2 hour, 0.5 percent, sector-dependent X/Q value is compared with 5 percent overall site 0–2 hour X/Q value at the EAB. The higher of the two is used as the proper X/Q at the EAB for each time period. The same approach is used to determine the proper X/Qs at the LPZ.

Table 2.3.4-202 (EAB without wake credit), Table 2.3.4-203 (EAB with wake credit), and Table 2.3.4-204 (LPZ with no wake credit) present the X/Qs for each of the 16 downwind sectors for the appropriate time period(s). The sector-dependent 0.5 percent X/Q value at either the EAB (with or without wake credit for select sectors) or the LPZ is higher than the overall site 5 percent X/Q value. The maximum X/Qs are summarized below (s/m^3):

Receptor Location	X/Q 0–2 hours	X/Q 0–8 hours	X/Q 8–24 hours	X/Q 1–4 days	X/Q 4–30 days	X/Q Annual Average
EAB	4.19E–04	+	+	+	+	+
DCD Value	5.1E–04	*Not provided*	*Not provided*	*Not provided*	*Not provided*	*Not provided*
LPZ	+	1.87E–5	1.25E–5	5.25E–6	1.51E–6	+
DCD Value	*Not provided*	2.2E–04	1.6E–04	1.0E–04	8.0E–05	*Not provided*

Note: The plus (+) sign indicates the value is not provided because there is no equivalent DCD value.

The results provided in Table 2.3.4-202, Table 2.3.4-203 and Table 2.3.4-204 show that the X/Q values determined by the PAVAN modeling analyses at the EAB and LPZ, respectively, do not exceed the AP1000 standard plant site design parameters as defined in Table 15A-5 of the DCD. The PAVAN-predicted maximum 0–2 hour EAB X/Q value (4.19E–04 s/m^3) is less than the corresponding DCD EAB XQ value (5.1E–04 s/m^3). The PAVAN-predicted maximum 0–8 hour LPZ X/Q value (1.87E–05 s/m^3) is lower than the corresponding DCD LPZ X/Q value (2.2E–04 s/m^3).

2.3.4.3 Atmospheric Dispersion Factors for Onsite Doses

X/Q values are also estimated at the control room HVAC intake and annex building access door for postulated accidental radioactive airborne releases. These two receptors considered for determination of onsite X/Q values are

identified in Table 15A-7 of the DCD. The release and receptor locations are identified in Figure 2.1-204.

Control room X/Qs are estimated using the ARCON96 model as described in NUREG/CR-6331 and input data such as receptor height, release height, release type, and building area. A composite 3-year (2002, 2005, and 2006) hourly meteorological data collected onsite was used as part of the input for the ARCON96 program. The above averaged three years of the meteorological data all have data recovery rates equal to or greater than 90 percent and are representative of the site dispersion characteristics as described in Subsection 2.3.2.

According to Figure 15A-1 of the DCD, doses to receptors need to consider eight sources: plant vent, passive containment cooling system air diffuser, fuel building blowout panel, radwaste building truck staging area door, steam vent, power-operated relief valve and safety valves, condenser air removal stack, and containment shell. Figure 15A-1 of the DCD shows that among the potential release sources, the containment shell is considered as a diffuse area source; all other releases are considered as point sources. Release types used in the ARCON96 modeling analyses for Units 6 & 7 follow those specified in the DCD.

RG 1.194 provides guidance on the use of ARCON96 for determining X/Qs to be used in design basis evaluation of control room radiological habitability. Section 3.2.2 of RG 1.194 specifies that a stack release should be more than 2.5 times the height of the adjacent structure. All the release heights and receptor heights information are provided in DCD Table 15A-7. As stated in Section 3.2.3 of RG 1.194, the results from the vent releases mode may not be sufficiently conservative for accident analysis; therefore, the vent release mode should not be used in the design basis evaluation. (The plant vent release and condenser air removal stack are considered ground-level releases.)

Control room intake and annex building access door X/Qs for the 95 percent time averaging (0–2 hours, 2–8 hours, 8–24 hours, 1–4 days, and 4–30 days) periods obtained from the ARCON96 modeling results are summarized in Table 2.3.4-205 and Table 2.3.4-206, respectively.

The results provided in Table 2.3.4-205 and Table 2.3.4-206 show that all of the X/Q values determined by the ARCON96 modeling analyses at the control room air intake and annex building access door for reactor building plant stack releases are bounded by the corresponding DCD X/Q values.

2.3.4.4 Hazardous Material Releases

Pollutant concentrations are also estimated at the Unit 6 & 7 control rooms for postulated accidental releases of toxic chemicals for material stored onsite, offsite, and for toxic or flammable material transported on nearby transportation routes. The concentrations at the control room intake and annex building access door due to accidental hazardous chemical releases (toxic vapor and flammable cloud) are determined using the guidance specified in RG 1.78 and NUREG-0570.

Estimated values of control room concentrations due to hazardous material releases are presented in Table 2.2-215. Detailed description of potential accidents to be considered as design basis events and their impacts are described in Subsections 2.2.3.1 and 2.2.3.2.

PTN COL 2.3-4

Table 2.3.4-201
Distances from the Source Boundary Area

Directional Sector	To EAB (feet)	To EAB (meters)	To LPZ (feet)	To LPZ (meters)
S	2,756	840	22,484	6,853
SSW	2,687	819	22,474	6,850
SW	2,375	724	22,411	6,831
WSW	2,559	780	23,284	7,097
W	2,566	782	25,230	7,690
WNW	2,589	789	25,230	7,690
NW	2,513	766	26,568	8,098
NNW	2,516	767	28,330	8,635
N	2,516	767	29,423	8,968
NNE	2,516	767	29,209	8,903
NE	**1,427**	**435**	27,677	8,436
ENE	**1,503**	**458**	26,371	8,038
E	**1,572**	**479**	24,862	7,578
ESE	**1,932**	**589**	23,655	7,210
SE	**1,923**	**586**	22,805	6,951
SSE	2,782	848	22,523	6,865

Bolded values in table represent sector distances eligible for the building wake credit.

PTN COL 2.3-4

Table 2.3.4-202
Units 6 & 7 Ground Level Release PAVAN Output — X/Q Values (s/m^3) at the Exclusion Area Boundary — Building Wake Credit Not Included

DOWNWIND SECTOR	DISTANCE (METERS)	0–2 HOURS	0–8 HOURS	8–24 HOURS	1–4 DAYS	4–30 DAYS	ANNUAL AVERAGE	HRS PER YR MAX 0–2 HR X/Q EXCEEDED IN SECTOR
S	**840**	**2.51E-04**	**1.60E-04**	**1.28E-04**	**7.87E-05**	**3.91E-05**	**1.67E-05**	**6.2**
SSW	**819**	**1.03E-04**	**6.27E-05**	**4.89E-05**	**2.86E-05**	**1.32E-05**	**5.15E-06**	**1.1**
SW	**724**	**1.25E-04**	**8.25E-05**	**6.69E-05**	**4.25E-05**	**2.21E-05**	**9.95E-06**	**2.8**
WSW	**780**	**1.17E-04**	**8.27E-05**	**6.97E-05**	**4.80E-05**	**2.82E-05**	**1.46E-05**	**0.5**
W	**782**	**1.38E-04**	**1.06E-04**	**9.27E-05**	**6.93E-05**	**4.57E-05**	**2.74E-05**	**2.2**
WNW	**789**	**1.33E-04**	**9.65E-05**	**8.23E-05**	**5.83E-05**	**3.55E-05**	**1.94E-05**	**1.7**
NW	**766**	**1.39E-04**	**9.58E-05**	**7.94E-05**	**5.28E-05**	**2.94E-05**	**1.43E-05**	**2**
NNW	**767**	**1.18E-04**	**7.77E-05**	**6.30E-05**	**4.00E-05**	**2.08E-05**	**9.39E-06**	**2.3**
N	**767**	**1.10E-04**	**7.00E-05**	**5.57E-05**	**3.41E-05**	**1.68E-05**	**7.06E-06**	**1.4**
NNE	**767**	**1.23E-04**	**7.73E-05**	**6.13E-05**	**3.71E-05**	**1.80E-05**	**7.44E-06**	**3**
NE	435	3.78E-04	2.35E-04	1.85E-04	1.11E-04	5.29E-05	2.14E-05	36.1
ENE	458	3.66E-04	2.26E-04	1.78E-04	1.05E-04	4.96E-05	1.98E-05	32.6
E	479	4.01E-04	2.55E-04	2.03E-04	1.24E-04	6.09E-05	2.56E-05	39.5
ESE	589	3.51E-04	2.24E-04	1.78E-04	1.09E-04	5.42E-05	2.29E-05	28.6
SE	586	4.25E-04	2.72E-04	2.18E-04	1.35E-04	6.73E-05	2.89E-05	43.7
SSE	**848**	**3.04E-04**	**2.05E-04**	**1.69E-04**	**1.10E-04**	**5.98E-05**	**2.83E-05**	**12.9**
Max 0–2 hr X/Q		4.25E-04	Total Hours Entire Site Max 0–2 hr X/Q Exceeded					216.7

Bolded values indicate sectors not eligible to receive the building wake credit. See Table 2.3.4-203 for sectors with wake credit applied.

PTN COL 2.3-4

Table 2.3.4-203
Units 6 & 7 Ground Level Release PAVAN Output — X/Q Values (s/m^3) at the Exclusion Area Boundary — Building Wake Credit Included

DOWNWIND SECTOR	DISTANCE (METERS)	0–2 HOURS	0–8 HOURS	8–24 HOURS	1–4 DAYS	4–30 DAYS	ANNUAL AVERAGE	HRS PER YR MAX 0–2 HR X/Q EXCEEDED IN SECTOR
S	840	2.48E-04	1.46E-04	1.12E-04	6.30E-05	2.76E-05	1.00E-05	6.4
SSW	819	9.36E-05	5.35E-05	4.05E-05	2.21E-05	9.26E-06	3.19E-06	1.2
SW	724	1.03E-04	6.48E-05	5.14E-05	3.11E-05	1.51E-05	6.26E-06	2.8
WSW	780	1.10E-04	7.30E-05	5.95E-05	3.83E-05	2.03E-05	9.36E-06	0.5
W	782	1.37E-04	9.74E-05	8.21E-05	5.66E-05	3.32E-05	1.72E-05	2.2
WNW	789	1.30E-04	8.81E-05	7.26E-05	4.76E-05	2.60E-05	1.24E-05	1.7
NW	766	1.35E-04	8.63E-05	6.89E-05	4.23E-05	2.10E-05	8.91E-06	2.1
NNW	767	1.10E-04	6.81E-05	5.35E-05	3.17E-05	1.50E-05	5.98E-06	2.4
N	767	1.01E-04	6.01E-05	4.64E-05	2.66E-05	1.19E-05	4.47E-06	1.5
NNE	767	1.17E-04	6.85E-05	5.24E-05	2.93E-05	1.27E-05	4.58E-06	3.1
NE	**435**	**3.54E-04**	**2.03E-04**	**1.54E-04**	**8.46E-05**	**3.57E-05**	**1.24E-05**	**36**
ENE	**458**	**3.26E-04**	**1.87E-04**	**1.42E-04**	**7.80E-05**	**3.30E-05**	**1.15E-05**	**29.1**
E	**479**	**3.92E-04**	**2.28E-04**	**1.74E-04**	**9.68E-05**	**4.17E-05**	**1.49E-05**	**39.1**
ESE	**589**	**3.51E-04**	**2.05E-04**	**1.56E-04**	**8.69E-05**	**3.74E-05**	**1.34E-05**	**29.5**
SE	**586**	**4.19E-04**	**2.47E-04**	**1.89E-04**	**1.06E-04**	**4.64E-05**	**1.69E-05**	**43.7**
SSE	848	2.98E-04	1.86E-04	1.46E-04	8.75E-05	4.17E-05	1.69E-05	13.1
Max 0–2 hr X/Q		4.19E-04	Total Hours Entire Site Max 0–2 hr X/Q Exceeded					214.3

Bolded values indicate sectors elig ble to receive the building wake credit. See Table 2.3.5-202 for sectors without wake credit.

PTN COL 2.3-4

Table 2.3.4-204
Units 6 & 7 Ground Level Release PAVAN Output — X/Q Values (s/m^3) at the Low Population Zone

DOWNWIND SECTOR	DISTANCE (METERS)	0–2 HOURS	0–8 HOURS	8–24 HOURS	1–4 DAYS	4–30 DAYS	ANNUAL AVERAGE	HRS PER YR MAX 0–2 HR X/Q EXCEEDED IN SECTOR
S	6853	3.19E-05	1.37E-05	8.94E-06	3.56E-06	9.50E-07	1.89E-07	21.1
SSW	6850	8.26E-06	3.59E-06	2.37E-06	9.60E-07	2.63E-07	5.38E-08	3.2
SW	6831	7.44E-06	3.52E-06	2.42E-06	1.07E-06	3.34E-07	8.02E-08	3.4
WSW	7097	8.69E-06	4.31E-06	3.04E-06	1.42E-06	4.76E-07	1.25E-07	0.7
W	7690	1.14E-05	5.86E-06	4.20E-06	2.05E-06	7.27E-07	2.05E-07	2.4
WNW	7690	1.05E-05	5.19E-06	3.64E-06	1.69E-06	5.61E-07	1.45E-07	2.3
NW	8098	9.70E-06	4.51E-06	3.08E-06	1.34E-06	4.08E-07	9.49E-08	2.8
NNW	8635	6.86E-06	3.08E-06	2.07E-06	8.70E-07	2.51E-07	5.46E-08	2.8
N	8968	5.29E-06	2.34E-06	1.56E-06	6.46E-07	1.82E-07	3.87E-08	1.6
NNE	8903	7.34E-06	3.13E-06	2.05E-06	8.15E-07	2.17E-07	4.28E-08	3
NE	8436	1.12E-05	4.61E-06	2.95E-06	1.12E-06	2.80E-07	5.12E-08	5.2
ENE	8038	1.23E-05	5.05E-06	3.24E-06	1.23E-06	3.09E-07	5.67E-08	3.7
E	7578	1.85E-05	7.67E-06	4.94E-06	1.90E-06	4.79E-07	8.92E-08	8.7
ESE	7210	2.57E-05	1.07E-05	6.89E-06	2.66E-06	6.77E-07	1.27E-07	15.4
SE	6951	3.00E-05	1.28E-05	8.31E-06	3.28E-06	8.65E-07	1.69E-07	20.4
SSE	6865	4.15E-05	1.87E-05	1.25E-05	5.25E-06	1.51E-06	3.29E-07	43.7
Max 0–2 hr X/Q		4.15E-05	Total Hours Entire Site Max 0–2 hr X/Q Exceeded					140.4

PTN COL 2.3-4

Table 2.3.4-205
ARCON96 X/Q (s/m^3) Values at the Control Room HVAC Intake

Release Point and DCD Values[a]	0–2 hours	2–8 hours	8–24 hours	1–4 days	4–30 days
Plant Vent	1.66E-03	1.05E-03	5.14E-04	3.19E-04	2.02E-04
DCD	**3.00E-03**	**2.50E-03**	**1.00E-03**	**8.00E-04**	**6.00E-04**
PCS Air Diffuser	1.29E-03	7.46E-04	3.44E-04	2.08E-04	1.16E-04
DCD	**3.00E-03**	**2.50E-03**	**1.00E-03**	**8.00E-04**	**6.00E-04**
Fuel Building Blowout Panel	1.44E-03	9.72E-04	4.28E-04	3.14E-04	1.98E-04
DCD	**6.00E-03**	**4.00E-03**	**2.00E-03**	**1.50E-03**	**1.00E-03**
Radwaste Building Truck Staging Area Door	1.21E-03	8.91E-04	3.87E-04	2.87E-04	1.89E-04
DCD	**6.00E-03**	**4.00E-03**	**2.00E-03**	**1.50E-03**	**1.00E-03**
Steam Vent	1.32E-02	7.43E-03	3.33E-03	2.47E-03	1.39E-03
DCD	**2.40E-02**	**2.00E-02**	**7.50E-03**	**5.50E-03**	**5.00E-03**
PORV & Safety Valves	1.19E-02	7.29E-03	3.08E-03	2.26E-03	1.36E-03
DCD	**2.00E-02**	**1.80E-02**	**7.00E-03**	**5.00E-03**	**4.50E-03**
Condenser Air Removal Stack	1.61E-03	1.24E-03	5.15E-04	3.98E-04	3.03E-04
DCD	**6.00E-03**	**4.00E-03**	**2.00E-03**	**1.50E-03**	**1.00E-03**
Containment Shell (As Diffuse Area Source)	1.55E-03	9.55E-04	4.79E-04	3.31E-04	1.96E-04
DCD	**6.00E-03**	**3.60E-03**	**1.40E-03**	**1.80E-03**	**1.50E-03**

(a) Values from DCD Table 15A-6

PTN COL 2.3-4

Table 2.3.4-206
ARCON96 X/Q (s/m^3) Values at the Annex Building Access Door

Release Point and DCD Values[a]	0–2 hours	2–8 hours	8–24 hours	1–4 days	4–30 days
Plant Vent	3.66E-04	2.31E-04	1.13E-04	6.92E-05	4.38E-05
DCD	**1.00E-03**	**7.50E-04**	**3.50E-04**	**2.80E-04**	**2.50E-04**
PCS Air Diffuser	3.56E-04	2.05E-04	9.85E-05	6.03E-05	3.85E-05
DCD	**1.00E-03**	**7.50E-04**	**3.50E-04**	**2.80E-04**	**2.50E-04**
Fuel Building Blowout Panel	3.47E-04	2.22E-04	1.03E-04	6.78E-05	4.14E-05
DCD	**6.00E-03**	**4.00E-03**	**2.00E-03**	**1.50E-03**	**1.00E-03**
Radwaste Building Truck Staging Area Door	3.47E-04	2.33E-04	1.03E-04	7.14E-05	4.37E-05
DCD	**6.00E-03**	**4.00E-03**	**2.00E-03**	**1.50E-03**	**1.00E-03**
Steam Vent	8.05E-04	4.59E-04	2.11E-04	1.20E-04	7.94E-05
DCD	**4.00E-03**	**3.20E-03**	**1.20E-03**	**1.00E-03**	**8.00E-04**
PORV & Safety Valves	8.34E-04	4.73E-04	2.19E-04	1.26E-04	8.23E-05
DCD	**4.00E-03**	**3.20E-03**	**1.20E-03**	**1.00E-03**	**8.00E-04**
Condenser Air Removal Stack	3.01E-03	1.74E-03	8.05E-04	5.33E-04	2.70E-04
DCD	**2.00E-02**	**1.80E-02**	**7.00E-03**	**5.00E-03**	**4.50E-03**
Containment Shell (As Diffuse Area Source)	3.39E-04	1.95E-04	9.67E-05	6.08E-05	3.75E-05
DCD	**1.00E-03**	**7.50E-04**	**3.50E-04**	**2.80E-04**	**2.50E-04**

(a) Values from DCD Table 15A-6

2.3.5 LONG-TERM DIFFUSION ESTIMATES

2.3.5.1 Objective

PTN COL 2.3-5 This section provides estimates of annual average atmospheric dispersion factors (X/Q values) and relative dry deposition factors (D/Q values) to a distance of 50 miles (80 kilometers) from the Units 6 & 7 site for annual average release limit calculations and person-rem estimates.

The NRC-sponsored XOQDOQ computer program was used to estimate X/Q and D/Q values for continuous releases of gaseous effluents to the atmosphere. The XOQDOQ computer code has the primary function of calculating annual average X/Q and D/Q values at receptors of interest (e.g., the exclusion area boundary [EAB], nearest resident, nearest vegetable garden, nearest milk animal, and nearest meat animal). RG 1.206 requires X/Q and D/Q estimates at the above receptor locations. 10 CFR Part 100 requires an “exclusion area” surrounding the reactor in which the reactor licensee has the authority to determine all activities, including exclusion or removal of personnel and property.

The XOQDOQ dispersion model implements the assumptions outlined in RG 1.111. The program assumes that the material released to the atmosphere follows a Gaussian distribution around the plume centerline. In estimating concentrations for longer time periods, the Gaussian distribution is assumed to be evenly distributed within a given directional sector. A straight line trajectory is assumed between the release point and all receptors.

Because the XOQDOQ model is used in the analysis, dispersion coefficients (σ_y and σ_z) as specified in RG 1.145 and implemented by the XOQDOQ code are used in estimating the X/Q and D/Q values. The following input data and assumptions have been used in the XOQDOQ modeling analysis:

- Meteorological Data: 3-year composite (2002, 2005, and 2006) onsite joint frequency distributions of wind speed, wind direction, and atmospheric stability (see Subsection 2.3.2). The determinations for the atmospheric stability classes are based on the vertical ΔT method as specified in RG 1.145.
- Type of release: Ground-level.
- Wind sensor height: 10 meters.

- Vertical temperature difference: (60 meters–10 meters).
- Number of wind speed categories: 13.
- Minimum shield building cross-sectional area: 2636 square meters.
- Shield building height: 69.7 meters above grade.
- Distances from the release point to the nearest residence (including a school), nearest EAB boundaries, milk animals, and vegetable garden (see Table 2.3.5-201).
- No milk cows/goats are identified within 5 miles of the Units 6 & 7 site. It is conservatively assumed that all residents are raising beef cattle for residential consumption.

The AP1000 reactor design is used to calculate the minimum building cross-sectional area as called for in NUREG/CR-2919 for evaluating building downwash effects on dispersion. The containment building features a straight section at the bottom and a tapered-shape structure with a smaller area at the top. The height of the containment building is approximately 228.75 feet (69.7 meters). Because of the shape of the containment building, the midpoint between the high point of the building (69.7 meters) and the point at which the building begins to taper (approximately 170.84 feet or 52.1 meters) was used when determining the building cross-sectional area. This point has a height of 199.8 feet (60.9 meters). The cross-sectional area was determined by multiplying this height by the diameter of the containment building (approximately 142 feet or 43.3 meters). Therefore, based on the cross-sectional area of the reactor structure (2636 square meters) and assuming the entire structure has a rectangular cross section, the equivalent structural height is calculated to be 60.9 meters.

The shortest distances from the Units 6 & 7 power block area (i.e., area encompassing the containment and auxiliary building) to receptors of interest (e.g., nearest resident, meat animal, EAB boundaries, and vegetable garden) are calculated for each directional sector. The results are presented in Table 2.3.5-201. The receptors of interest within 5 miles were evaluated. Directional sectors without a receptor within 5 miles were not modeled. As previously stated, there are no cow/goat receptors within 5 miles of the site.

To account for possible land-water recirculation effects from Biscayne Bay on the local meteorological conditions, default correction factors are implemented in the

XOQDOQ model. These factors are implemented to properly account for possible recirculation due to land-water boundaries, which could raise X/Q values in an open terrain area such as the Units 6 & 7 site.

As addressed in Subsection 2.3.4, site-specific meteorological data covering the 3-year composite period of record is used to quantitatively evaluate diffusion estimates. Therefore, the lower level (10 meter) 3-year composite (2002, 2005, and 2006) joint frequency distributions of wind speed, wind direction, and atmospheric stability are used as input in the XOQDOQ modeling analysis.

2.3.5.2 Calculations

Table 2.3.5-202 summarizes the maximum relative atmospheric dispersion factors (X/Q) and relative dry deposition factors (D/Q values) predicted by the XOQDOQ model for identified sensitive receptors of interest as a result of continuous releases of gaseous effluents. The listed maximum X/Q values reflect several plume depletion scenarios that account for radioactive decay: no decay and the default half-life decay periods of 2.26 and 8 days.

The maximum annual average X/Q values with no decay (along with the direction and distance of the receptor locations relative to the Units 6 & 7 site) is 1.6E–04 sec/m^3 and occurs at Unit 7 as a result of the release from Unit 6. Other X/Q values for receptors of interest are:

- 1.7E–05 s/m^3 for the EAB occurring in the SSE, SE, and W sectors at a distance of 0.53, 0.36, and 0.49 miles, respectively. (Note: this value is bounded by value in Table 2.0-201.)
- 1.4E–07 s/m^3 for the residence and meat animal occurring in the N Sector at a distance of 2.7 miles. (Note the same distance (2.7 miles) is used to estimate the X/Q values for the meat animal)
- 9.6E–08 s/m^3 for the nearest vegetable garden occurring in the NW sector at a distance of 4.8 miles

Tables 2.3.5-203 through 2.3.5-206 summarize the annual average sector X/Q values (for no decay [undepleted], 2.26-day decay [undepleted], and 8-day decay [depleted]), and D/Q values for 22 standard radial distances between 0.25 and 50 miles, and for 10 distance-segment boundaries between 0.5 and 50 miles downwind along each of the 16 standard direction radials separated by 22.5 degrees. Table 2.3.5-207 summarizes the predicted annual X/Q values and D/Q at the sensitive receptors.

2.3.5.3 References

201. *2008 Annual Radiological Environmental Operating Report*, Turkey Point Plant Units 3 & 4, License No. DPR-31 and DPR-41, Docket Nos. 50-250 and 50-251, February 26, 2009.

Table 2.3.5-201
Source to Sensitive Receptor Distances from Units 6 & 7

Sector	Name	Type of Receptor	Latitude	Longitude	Distance From Power Block Area (Miles)
N	Biscayne National Park	Resident	N25.46362	W80.33445	2.7
NNW	Military Canal Residence	Resident/Meat Animal	N25.48945	W80.37138	5.1
NNW	Bananas, plantains, coconuts, lemons	Vegetable Garden	N25.48945	W80.37138	5.1
NW	Satellite School	Resident	N25.44695	W80.35362	1.99
NW	Single-Family Home	Resident/Meat Animal	N25.46278	W80.38112	4.0
NW	Mowry Drive Residence	Vegetable Garden	N25.47028	W80.39112	4.8

Source: Reference 201

Table 2.3.5-202
XOQDOQ Predicted X/Q and D/Q Values at Receptors of Interest

Type of Location	Sector	Distance (miles)	X/Q (s/m^3) (No Decay, no dry deposition)
EAB	SSE	0.53	1.7E-5
	SE	0.36	1.7E-5
	W	0.49	1.7E-5
Residence/Meat Animal	N	2.7	1.4E-7
	NW	4.0	1.3E-7
	NNW	5.1	5.5E-8
Vegetable Garden	NW	4.8	9.6E-8
	NNW	5.1	5.5E-8
Unit 7	W	0.13	1.6E-4
School	NW	1.99	5.7E-7
Site Boundary	SSE	0.35	3.4E-5
Type of Location	**Sector**	**Distance (miles)**	**X/Q (s/m^3) (2.26-Day Decay, no dry deposition)**
EAB	SSE	0.53	1.7E-5
	SE	0.36	1.7E-5
	W	0.49	1.7E-5
Residence/Meat Animal	N	2.7	1.3E-7
	NW	4.0	1.3E-7
	NNW	5.1	5.4E-8
Vegetable Garden	NW	4.8	9.4E-8
	NNW	5.1	5.4E-8
Unit 7	W	0.13	1.6E-4
School	NW	1.99	5.2E-7
Site Boundary	SSE	0.35	3.4E-5
Type of Location	**Sector**	**Distance (miles)**	**X/Q (s/m^3) (8-Day Decay, dry deposition)**
EAB	SE	0.36	1.6E-5
	W	0.49	1.6E-5
Residence/Meat Animal	N	2.7	1.1E-7
	NW	4.0	1.0E-7
	NNW	5.1	4.1E-8
Vegetable Garden	NW	4.8	7.2E-8
	NNW	5.1	4.1E-8
Unit 7	W	0.13	1.5E-4
School	NW	1.99	4.3E-7
Site Boundary	SSE	0.35	3.2E-5
Type of Location	**Sector**	**Distance (miles)**	**D/Q ($1/m^2$)**
EAB	W	0.49	1.4E-7
Residence/Meat Animal	N	2.7	7.5E-10
	NW	4.0	5.8E-10
	NNW	5.1	2.4E-10
Vegetable Garden	NW	4.8	3.8E-10
	NNW	5.1	2.4E-10
Unit 7	W	0.13	1.0E-6
School	NW	1.99	2.9E-9
Site Boundary	SSE	0.35	1.2E-7

Table 2.3.5-203 (Sheet 1 of 2)
XOQDOQ-Predicted Annual Average X/Q Value at the Standard Radial Distances and Distance Segment Boundaries — No Decay, Undepleted

RELEASE POINT GROUND LEVEL NO INTERMITTENT RELEASES
NO DECAY, UNDEPLETED
CORRECTED USING STANDARD OPEN TERRAIN FACTORS

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE IN MILES FROM THE SITE

SECTOR	.250	.500	.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	3.597E 05	1.079E 05	5.472E 06	2.745E 06	1.107E 06	6.119E 07	3.987E 07	2.843E 07	2.155E 07	1.705E 07	1.394E 07
SSW	1.064E 05	3.280E 06	1.745E 06	8.876E 07	3.595E 07	1.968E 07	1.263E 07	8.892E 08	6.668E 08	5.230E 08	4.243E 08
SW	1.673E 05	5.351E 06	2.913E 06	1.481E 06	5.939E 07	3.208E 07	2.029E 07	1.413E 07	1.050E 07	8.168E 08	6.579E 08
WSW	2.761E 05	8.963E 06	5.030E 06	2.577E 06	1.035E 06	5.582E 07	3.520E 07	2.444E 07	1.810E 07	1.405E 07	1.129E 07
W	5.162E 05	1.657E 05	9.278E 06	4.764E 06	1.924E 06	1.042E 06	6.592E 07	4.590E 07	3.409E 07	2.651E 07	2.135E 07
WNW	3.753E 05	1.202E 05	6.649E 06	3.403E 06	1.372E 06	7.415E 07	4.686E 07	3.259E 07	2.419E 07	1.880E 07	1.513E 07
NW	2.636E 05	8.298E 06	4.552E 06	2.332E 06	9.450E 07	5.136E 07	3.263E 07	2.279E 07	1.697E 07	1.323E 07	1.068E 07
NNW	1.776E 05	5.564E 06	2.994E 06	1.519E 06	6.093E 07	3.298E 07	2.092E 07	1.460E 07	1.086E 07	8.467E 08	6.830E 08
N	1.330E 05	4.161E 06	2.250E 06	1.142E 06	4.586E 07	2.484E 07	1.577E 07	1.101E 07	8.201E 08	6.395E 08	5.161E 08
NNE	1.375E 05	4.255E 06	2.256E 06	1.145E 06	4.624E 07	2.526E 07	1.618E 07	1.139E 07	8.532E 08	6.688E 08	5.423E 08
NE	1.429E 05	4.344E 06	2.247E 06	1.138E 06	4.620E 07	2.547E 07	1.649E 07	1.169E 07	8.822E 08	6.955E 08	5.667E 08
ENE	1.447E 05	4.389E 06	2.263E 06	1.149E 06	4.695E 07	2.595E 07	1.681E 07	1.193E 07	9.003E 08	7.099E 08	5.786E 08
E	2.023E 05	6.085E 06	3.110E 06	1.577E 06	6.447E 07	3.574E 07	2.324E 07	1.654E 07	1.252E 07	9.890E 08	8.075E 08
ESE	2.616E 05	7.820E 06	3.961E 06	1.995E 06	8.100E 07	4.494E 07	2.934E 07	2.095E 07	1.589E 07	1.259E 07	1.030E 07
SE	3.274E 05	9.759E 06	4.913E 06	2.473E 06	1.005E 06	5.582E 07	3.646E 07	2.605E 07	1.977E 07	1.566E 07	1.282E 07
SSE	6.209E 05	1.845E 05	9.261E 06	4.638E 06	1.872E 06	1.039E 06	6.799E 07	4.866E 07	3.698E 07	2.933E 07	2.403E 07

DISTANCE IN MILES FROM THE SITE
ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	1.169E 07	6.302E 08	4.218E 08	2.527E 08	1.762E 08	1.334E 08	1.064E 08	8.789E 09	7.454E 09	6.448E 09	5.665E 09
SSW	3.534E 08	1.857E 08	1.221E 08	7.143E 09	4.902E 09	3.666E 09	2.894E 09	2.372E 09	1.997E 09	1.717E 09	1.500E 09
SW	5.445E 08	2.796E 08	1.809E 08	1.035E 08	7.000E 09	5.177E 09	4.051E 09	3.295E 09	2.757E 09	2.357E 09	2.049E 09
WSW	9.326E 08	4.744E 08	3.048E 08	1.725E 08	1.157E 08	8.497E 09	6.610E 09	5.349E 09	4.455E 09	3.793E 09	3.285E 09
W	1.766E 07	9.034E 08	5.828E 08	3.317E 08	2.233E 08	1.645E 08	1.282E 08	1.040E 08	8.675E 09	7.396E 09	6.415E 09
WNW	1.251E 07	6.399E 08	4.128E 08	2.350E 08	1.584E 08	1.168E 08	9.113E 09	7.394E 09	6.173E 09	5.267E 09	4.571E 09
NW	8.851E 08	4.568E 08	2.966E 08	1.704E 08	1.155E 08	8.551E 09	6.698E 09	5.451E 09	4.563E 09	3.902E 09	3.394E 09
NNW	5.662E 08	2.927E 08	1.903E 08	1.097E 08	7.462E 09	5.544E 09	4.354E 09	3.552E 09	2.980E 09	2.553E 09	2.225E 09
N	4.280E 08	2.215E 08	1.442E 08	8.318E 09	5.657E 09	4.203E 09	3.300E 09	2.693E 09	2.259E 09	1.935E 09	1.686E 09
NNE	4.514E 08	2.369E 08	1.557E 08	9.096E 09	6.239E 09	4.665E 09	3.683E 09	3.018E 09	2.541E 09	2.184E 09	1.908E 09
NE	4.737E 08	2.525E 08	1.676E 08	9.931E 09	6.871E 09	5.171E 09	4.104E 09	3.378E 09	2.855E 09	2.462E 09	2.157E 09
ENE	4.837E 08	2.578E 08	1.712E 08	1.014E 08	7.013E 09	5.277E 09	4.187E 09	3.445E 09	2.911E 09	2.510E 09	2.199E 09
E	6.762E 08	3.625E 08	2.416E 08	1.438E 08	9.983E 09	7.531E 09	5.987E 09	4.934E 09	4.175E 09	3.605E 09	3.161E 09
ESE	8.640E 08	4.664E 08	3.123E 08	1.872E 08	1.305E 08	9.880E 09	7.877E 09	6.508E 09	5.518E 09	4.772E 09	4.192E 09
SE	1.076E 07	5.813E 08	3.896E 08	2.338E 08	1.631E 08	1.236E 08	9.856E 09	8.146E 09	6.910E 09	5.978E 09	5.253E 09
SSE	2.019E 07	1.095E 07	7.360E 08	4.433E 08	3.102E 08	2.354E 08	1.881E 08	1.557E 08	1.322E 08	1.145E 08	1.007E 08

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	.00
DIAMETER	(METERS)	.00
EXIT VELOCITY	(METERS)	.00
REP. WIND HEIGHT	(METERS)	10.0
BUILDING HEIGHT	(METERS)	69.7
BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	2636.0
HEAT EMISSION RATE	(CAL/SEC)	.0

Table 2.3.5-203 (Sheet 2 of 2)
XOQDOQ-Predicted Annual Average X/Q Value at the Standard Radial Distances and Distance Segment Boundaries — No Decay, Undepleted

RELEASE POINT - GROUND LEVEL - NO INTERMITTENT RELEASES
NO DECAY, UNDEPLETED
CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

DIRECTION FROM SITE	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	5.442E 06	1.251E 06	4.098E 07	2.180E 07	1.403E 07	6.573E 08	2.563E 08	1.340E 08	8.809E 09	6.456E 09
SSW	1.705E 06	4.046E 07	1.301E 07	6.756E 08	4.273E 08	1.947E 08	7.274E 09	3.687E 09	2.378E 09	1.720E 09
SW	2.818E 06	6.697E 07	2.097E 07	1.065E 07	6.630E 08	2.946E 08	1.058E 08	5.213E 09	3.306E 09	2.361E 09
WSW	4.814E 06	1.166E 06	3.639E 07	1.837E 07	1.138E 07	5.009E 08	1.767E 08	8.561E 09	5.369E 09	3.801E 09
W	8.893E 06	2.163E 06	6.811E 07	3.457E 07	2.151E 07	9.525E 08	3.393E 08	1.657E 08	1.043E 08	7.412E 09
WNW	6.400E 06	1.543E 06	4.843E 07	2.454E 07	1.525E 07	6.748E 08	2.405E 08	1.176E 08	7.420E 09	5.277E 09
NW	4.398E 06	1.061E 06	3.369E 07	1.721E 07	1.076E 07	4.808E 08	1.740E 08	8.608E 09	5.469E 09	3.910E 09
NNW	2.909E 06	6.871E 07	2.160E 07	1.102E 07	6.882E 08	3.080E 08	1.120E 08	5.579E 09	3.563E 09	2.558E 09
N	2.182E 06	5.171E 07	1.629E 07	8.317E 08	5.200E 08	2.330E 08	8.491E 09	4.230E 09	2.701E 09	1.939E 09
NNE	2.206E 06	5.208E 07	1.669E 07	8.645E 08	5.461E 08	2.485E 08	9.265E 09	4.692E 09	3.026E 09	2.187E 09
NE	2.220E 06	5.201E 07	1.697E 07	8.931E 08	5.704E 08	2.639E 08	1.009E 08	5.198E 09	3.386E 09	2.465E 09
ENE	2.241E 06	5.273E 07	1.730E 07	9.114E 08	5.824E 08	2.695E 08	1.030E 08	5.304E 09	3.453E 09	2.513E 09
E	3.090E 06	7.241E 07	2.390E 07	1.267E 07	8.127E 08	3.785E 08	1.460E 08	7.567E 09	4.946E 09	3.610E 09
ESE	3.945E 06	9.130E 07	3.014E 07	1.608E 07	1.036E 07	4.863E 08	1.898E 08	9.924E 09	6.522E 09	4.778E 09
SE	4.905E 06	1.133E 06	3.746E 07	2.000E 07	1.290E 07	6.059E 08	2.370E 08	1.241E 08	8.164E 09	5.986E 09
SSE	9.247E 06	2.116E 06	6.983E 07	3.740E 07	2.418E 07	1.141E 07	4.492E 08	2.364E 08	1.560E 08	1.146E 08

XOQDOQ - FPL COL (3 YEAR COMPOSITE 2002, 2005, 2006 Met Data)

Table 2.3.5-204 (Sheet 1 of 2)
XOQDOQ-Predicted Annual Average X/Q Value at the Standard Radial Distances and Distance Segment Boundaries — 2.26-Day Decay, Undepleted

RELEASE POINT - GROUND LEVEL - NO INTERMITTENT RELEASES
2.260 DAY DECAY, UNDEPLETED
CORRECTED USING STANDARD OPEN TERRAIN FACTORS

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES FROM THE SITE

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	3.594E-05	1.077E-05	5.457E-06	2.735E-06	1.101E-06	6.075E-07	3.951E-07	2.812E-07	2.127E-07	1.680E-07	1.371E-07
SSW	1.063E-05	3.273E-06	1.739E-06	8.837E-07	3.571E-07	1.950E-07	1.248E-07	8.772E-08	6.563E-08	5.137E-08	4.157E-08
SW	1.671E-05	5.341E-06	2.906E-06	1.476E-06	5.908E-07	3.186E-07	2.012E-07	1.398E-07	1.037E-07	8.051E-08	6.472E-08
WSW	2.759E-05	8.951E-06	5.021E-06	2.571E-06	1.031E-06	5.553E-07	3.497E-07	2.425E-07	1.794E-07	1.390E-07	1.116E-07
W	5.159E-05	1.655E-05	9.260E-06	4.752E-06	1.917E-06	1.036E-06	6.548E-07	4.553E-07	3.377E-07	2.623E-07	2.109E-07
WNW	3.751E-05	1.200E-05	6.635E-06	3.393E-06	1.366E-06	7.372E-07	4.652E-07	3.231E-07	2.394E-07	1.858E-07	1.493E-07
NW	2.633E-05	8.284E-06	4.541E-06	2.324E-06	9.403E-07	5.102E-07	3.235E-07	2.255E-07	1.677E-07	1.305E-07	1.051E-07
NNW	1.775E-05	5.553E-06	2.986E-06	1.513E-06	6.060E-07	3.273E-07	2.072E-07	1.443E-07	1.072E-07	8.339E-08	6.714E-08
N	1.329E-05	4.154E-06	2.244E-06	1.138E-06	4.562E-07	2.467E-07	1.563E-07	1.090E-07	8.099E-08	6.303E-08	5.077E-08
NNE	1.373E-05	4.245E-06	2.248E-06	1.140E-06	4.594E-07	2.504E-07	1.601E-07	1.124E-07	8.399E-08	6.568E-08	5.313E-08
NE	1.427E-05	4.333E-06	2.239E-06	1.132E-06	4.585E-07	2.521E-07	1.628E-07	1.152E-07	8.664E-08	6.812E-08	5.536E-08
ENE	1.445E-05	4.379E-06	2.255E-06	1.144E-06	4.662E-07	2.571E-07	1.661E-07	1.176E-07	8.855E-08	6.966E-08	5.664E-08
E	2.020E-05	6.070E-06	3.098E-06	1.569E-06	6.399E-07	3.539E-07	2.295E-07	1.629E-07	1.230E-07	9.691E-08	7.892E-08
ESE	2.612E-05	7.798E-06	3.945E-06	1.984E-06	8.033E-07	4.444E-07	2.893E-07	2.060E-07	1.558E-07	1.231E-07	1.004E-07
SE	3.270E-05	9.737E-06	4.896E-06	2.462E-06	9.983E-07	5.531E-07	3.604E-07	2.569E-07	1.945E-07	1.538E-07	1.255E-07
SSE	6.203E-05	1.841E-05	9.234E-06	4.620E-06	1.861E-06	1.031E-06	6.733E-07	4.809E-07	3.648E-07	2.888E-07	2.361E-07

DISTANCE IN MILES FROM THE SITE
ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)

SECTOR	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	1.148E-07	6.130E-08	4.065E-08	2.391E-08	1.637E-08	1.217E-08	9.530E-09	7.735E-09	6.444E-09	5.477E-09	4.729E-09
SSW	3.454E-08	1.795E-08	1.167E-08	6.672E-09	4.477E-09	3.275E-09	2.529E-09	2.028E-09	1.671E-09	1.406E-09	1.203E-09
SW	5.347E-08	2.719E-08	1.742E-08	9.774E-09	6.484E-09	4.705E-09	3.612E-09	2.883E-09	2.368E-09	1.988E-09	1.697E-09
WSW	9.204E-08	4.651E-08	2.969E-08	1.658E-08	1.097E-08	7.952E-09	6.105E-09	4.877E-09	4.010E-09	3.370E-09	2.882E-09
W	1.742E-07	8.851E-08	5.671E-08	3.183E-08	2.113E-08	1.535E-08	1.181E-08	9.444E-09	7.774E-09	6.540E-09	5.598E-09
WNW	1.233E-07	6.258E-08	4.006E-08	2.247E-08	1.492E-08	1.084E-08	8.332E-09	6.663E-09	5.482E-09	4.610E-09	3.944E-09
NW	8.696E-08	4.448E-08	2.862E-08	1.614E-08	1.074E-08	7.817E-09	6.015E-09	4.811E-09	3.958E-09	3.328E-09	2.845E-09
NNW	5.554E-08	2.843E-08	1.830E-08	1.034E-08	6.892E-09	5.020E-09	3.866E-09	3.093E-09	2.546E-09	2.140E-09	1.830E-09
N	4.202E-08	2.155E-08	1.389E-08	7.863E-09	5.248E-09	3.826E-09	2.950E-09	2.363E-09	1.946E-09	1.638E-09	1.402E-09
NNE	4.412E-08	2.288E-08	1.486E-08	8.478E-09	5.679E-09	4.147E-09	3.198E-09	2.560E-09	2.107E-09	1.770E-09	1.512E-09
NE	4.616E-08	2.428E-08	1.591E-08	9.180E-09	6.190E-09	4.541E-09	3.514E-09	2.821E-09	2.326E-09	1.958E-09	1.675E-09
ENE	4.724E-08	2.488E-08	1.632E-08	9.442E-09	6.381E-09	4.693E-09	3.639E-09	2.928E-09	2.420E-09	2.041E-09	1.750E-09
E	6.592E-08	3.489E-08	2.296E-08	1.333E-08	9.021E-09	6.639E-09	5.151E-09	4.144E-09	3.424E-09	2.887E-09	2.473E-09
ESE	8.401E-08	4.471E-08	2.953E-08	1.722E-08	1.168E-08	8.610E-09	6.685E-09	5.381E-09	4.446E-09	3.749E-09	3.211E-09
SE	1.051E-07	5.614E-08	3.720E-08	2.181E-08	1.488E-08	1.102E-08	8.598E-09	6.952E-09	5.771E-09	4.887E-09	4.204E-09
SSE	1.980E-07	1.064E-07	7.080E-08	4.183E-08	2.872E-08	2.139E-08	1.678E-08	1.363E-08	1.137E-08	9.672E-09	8.357E-09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT (METERS)	.00	REP. WIND HEIGHT (METERS)	10.0
DIAMETER (METERS)	.00	BUILDING HEIGHT (METERS)	60.9
EXIT VELOCITY (METERS)	.00	BLDG.MIN.CRS.SEC.AREA (SQ.METERS)	2636.0
		HEAT EMISSION RATE (CAL/SEC)	.0

Table 2.3.5-204 (Sheet 2 of 2)
XOQDOQ-Predicted Annual Average X/Q Value at the Standard Radial Distances and Distance Segment Boundaries — 2.26-Day Decay, Undepleted

RELEASE POINT - GROUND LEVEL - NO INTERMITTENT RELEASES
2.260 DAY DECAY, UNDEPLETED
CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

DIRECTION FROM SITE	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	5.428E-06	1.245E-06	4.062E-07	2.153E-07	1.380E-07	6.401E-08	2.428E-08	1.223E-08	7.756E-09	5.486E-09
SSW	1.700E-06	4.021E-07	1.287E-07	6.651E-08	4.187E-08	1.885E-08	6.807E-09	3.297E-09	2.035E-09	1.410E-09
SW	2.812E-06	6.666E-07	2.079E-07	1.052E-07	6.523E-08	2.869E-08	1.001E-08	4.742E-09	2.895E-09	1.993E-09
WSW	4.805E-06	1.162E-06	3.616E-07	1.820E-07	1.125E-07	4.915E-08	1.700E-08	8.018E-09	4.897E-09	3.379E-09
W	8.877E-06	2.155E-06	6.767E-07	3.426E-07	2.125E-07	9.341E-08	3.260E-08	1.547E-08	9.483E-09	6.557E-09
WNW	6.387E-06	1.537E-06	4.809E-07	2.429E-07	1.505E-07	6.606E-08	2.302E-08	1.092E-08	6.690E-09	4.622E-09
NW	4.387E-06	1.057E-06	3.341E-07	1.700E-07	1.059E-07	4.687E-08	1.651E-08	7.877E-09	4.830E-09	3.336E-09
NNW	2.902E-06	6.838E-07	2.141E-07	1.087E-07	6.766E-08	2.995E-08	1.057E-08	5.057E-09	3.105E-09	2.145E-09
N	2.177E-06	5.147E-07	1.615E-07	8.214E-08	5.116E-08	2.270E-08	8.040E-09	3.855E-09	2.372E-09	1.642E-09
NNE	2.199E-06	5.177E-07	1.651E-07	8.512E-08	5.351E-08	2.404E-08	8.652E-09	4.176E-09	2.570E-09	1.774E-09
NE	2.212E-06	5.165E-07	1.676E-07	8.773E-08	5.573E-08	2.542E-08	9.346E-09	4.570E-09	2.830E-09	1.962E-09
ENE	2.233E-06	5.239E-07	1.710E-07	8.966E-08	5.701E-08	2.604E-08	9.611E-09	4.722E-09	2.938E-09	2.045E-09
E	3.079E-06	7.192E-07	2.360E-07	1.245E-07	7.944E-08	3.648E-08	1.355E-08	6.679E-09	4.157E-09	2.893E-09
ESE	3.930E-06	9.062E-07	2.974E-07	1.577E-07	1.011E-07	4.670E-08	1.749E-08	8.659E-09	5.397E-09	3.756E-09
SE	4.890E-06	1.126E-06	3.704E-07	1.968E-07	1.263E-07	5.860E-08	2.215E-08	1.108E-08	6.973E-09	4.896E-09
SSE	9.222E-06	2.105E-06	6.917E-07	3.690E-07	2.376E-07	1.109E-07	4.244E-08	2.150E-08	1.367E-08	9.688E-09

XOQDOQ - FPL COL (3 YEAR COMPOSITE 2002, 2005, 2006 Met Data)

Table 2.3.5-205 (Sheet 1 of 2)
XOQDOQ-Predicted Annual Average X/Q Value at the Standard Radial Distances and Distance Segment Boundaries — 8-Day Decay, Depleted

RELEASE POINT GROUND LEVEL NO INTERMITTENT RELEASES
8 000 DAY DECAY, DEPLETED
CORRECTED USING STANDARD OPEN TERRAIN FACTORS

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) DISTANCE IN MILES FROM THE SITE

SECTOR	0 250	0 500	0 750	1 000	1 500	2 000	2 500	3 000	3 500	4 000	4 500
S	3 403E 05	9 849E 06	4 872E 06	2 401E 06	9 386E 07	5 056E 07	3 221E 07	2 252E 07	1 675E 07	1 304E 07	1 049E 07
SSW	1 007E 05	2 993E 06	1 554E 06	7 760E 07	3 048E 07	1 625E 07	1 019E 07	7 036E 08	5 180E 08	3 995E 08	3 190E 08
SW	1 583E 05	4 884E 06	2 594E 06	1 295E 06	5 036E 07	2 651E 07	1 640E 07	1 119E 07	8 163E 08	6 245E 08	4 951E 08
WSW	2 613E 05	8 182E 06	4 480E 06	2 254E 06	8 783E 07	4 616E 07	2 846E 07	1 937E 07	1 409E 07	1 075E 07	8 509E 08
W	4 885E 05	1 513E 05	8 263E 06	4 167E 06	1 632E 06	8 613E 07	5 330E 07	3 637E 07	2 653E 07	2 029E 07	1 608E 07
WNW	3 552E 05	1 097E 05	5 922E 06	2 976E 06	1 163E 06	6 130E 07	3 788E 07	2 583E 07	1 882E 07	1 439E 07	1 140E 07
NW	2 494E 05	7 574E 06	4 054E 06	2 039E 06	8 014E 07	4 245E 07	2 636E 07	1 805E 07	1 320E 07	1 012E 07	8 037E 08
NNW	1 681E 05	5 078E 06	2 666E 06	1 328E 06	5 167E 07	2 725E 07	1 690E 07	1 156E 07	8 445E 08	6 471E 08	5 139E 08
N	1 259E 05	3 798E 06	2 003E 06	9 989E 07	3 889E 07	2 053E 07	1 274E 07	8 721E 08	6 377E 08	4 889E 08	3 884E 08
NNE	1 300E 05	3 883E 06	2 008E 06	1 001E 06	3 920E 07	2 087E 07	1 307E 07	9 011E 08	6 628E 08	5 108E 08	4 076E 08
NE	1 352E 05	3 964E 06	2 001E 06	9 946E 07	3 915E 07	2 103E 07	1 331E 07	9 249E 08	6 849E 08	5 308E 08	4 256E 08
ENE	1 369E 05	4 006E 06	2 015E 06	1 005E 06	3 980E 07	2 143E 07	1 357E 07	9 438E 08	6 992E 08	5 421E 08	4 348E 08
E	1 914E 05	5 553E 06	2 768E 06	1 378E 06	5 464E 07	2 951E 07	1 876E 07	1 308E 07	9 717E 08	7 549E 08	6 066E 08
ESE	2 475E 05	7 135E 06	3 526E 06	1 744E 06	6 863E 07	3 709E 07	2 367E 07	1 656E 07	1 233E 07	9 602E 08	7 731E 08
SE	3 098E 05	8 906E 06	4 374E 06	2 162E 06	8 520E 07	4 610E 07	2 944E 07	2 061E 07	1 535E 07	1 196E 07	9 634E 08
SSE	5 875E 05	1 683E 05	8 246E 06	4 055E 06	1 587E 06	8 583E 07	5 492E 07	3 852E 07	2 874E 07	2 242E 07	1 808E 07

DISTANCE IN MILES FROM THE SITE
ANNUAL AVERAGE CHI/Q (SEC/METER CUBED)

SECTOR	5 000	7 500	10 000	15 000	20 000	25 000	30 000	35 000	40 000	45 000	50 000
S	8 669E 08	4 408E 08	2 804E 08	1 547E 08	1 007E 08	7 189E 09	5 435E 09	4 277E 09	3 465E 09	2 871E 09	2 422E 09
SSW	2 617E 08	1 297E 08	8 099E 09	4 356E 09	2 789E 09	1 964E 09	1 468E 09	1 144E 09	9 195E 10	7 563E 10	6 336E 10
SW	4 038E 08	1 955E 08	1 202E 08	6 330E 09	3 998E 09	2 785E 09	2 065E 09	1 599E 09	1 277E 09	1 045E 09	8 718E 10
WSW	6 926E 08	3 326E 08	2 033E 08	1 061E 08	6 654E 09	4 613E 09	3 407E 09	2 629E 09	2 095E 09	1 711E 09	1 425E 09
W	1 311E 07	6 332E 08	3 885E 08	2 039E 08	1 283E 08	8 921E 09	6 604E 09	5 105E 09	4 074E 09	3 332E 09	2 777E 09
WNW	9 288E 08	4 483E 08	2 750E 08	1 443E 08	9 091E 09	6 323E 09	4 683E 09	3 622E 09	2 892E 09	2 365E 09	1 972E 09
NW	6 565E 08	3 196E 08	1 972E 08	1 043E 08	6 604E 09	4 610E 09	3 423E 09	2 653E 09	2 122E 09	1 738E 09	1 451E 09
NNW	4 198E 08	2 046E 08	1 264E 08	6 706E 09	4 259E 09	2 980E 09	2 218E 09	1 722E 09	1 379E 09	1 132E 09	9 458E 10
N	3 174E 08	1 550E 08	9 585E 09	5 089E 09	3 233E 09	2 263E 09	1 685E 09	1 308E 09	1 048E 09	8 601E 10	7 191E 10
NNE	3 343E 08	1 654E 08	1 032E 08	5 543E 09	3 546E 09	2 495E 09	1 864E 09	1 452E 09	1 166E 09	9 587E 10	8 027E 10
NE	3 505E 08	1 760E 08	1 109E 08	6 037E 09	3 893E 09	2 755E 09	2 068E 09	1 617E 09	1 303E 09	1 074E 09	9 013E 10
ENE	3 581E 08	1 799E 08	1 134E 08	6 177E 09	3 986E 09	2 822E 09	2 120E 09	1 659E 09	1 337E 09	1 103E 09	9 261E 10
E	5 004E 08	2 528E 08	1 600E 08	8 750E 09	5 662E 09	4 018E 09	3 022E 09	2 367E 09	1 910E 09	1 577E 09	1 325E 09
ESE	6 389E 08	3 248E 08	2 065E 08	1 136E 08	7 382E 09	5 253E 09	3 960E 09	3 108E 09	2 511E 09	2 075E 09	1 745E 09
SE	7 965E 08	4 058E 08	2 583E 08	1 425E 08	9 278E 09	6 615E 09	4 996E 09	3 927E 09	3 178E 09	2 631E 09	2 216E 09
SSE	1 496E 07	7 657E 08	4 890E 08	2 711E 08	1 772E 08	1 267E 08	9 597E 09	7 563E 09	6 135E 09	5 089E 09	4 296E 09

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT (METERS)	00	REP WIND HEIGHT (METERS)	10 0
DIAMETER (METERS)	00	BUILDING HEIGHT (METERS)	60 9
EXIT VELOCITY (METERS)	00	BLDG MIN CRS SEC AREA (SQ METERS)	2636 0
		HEAT EMISSION RATE (CAL/SEC)	0

Table 2.3.5-205 (Sheet 2 of 2)
XOQDOQ-Predicted Annual Average X/Q Value at the Standard Radial Distances and Distance Segment Boundaries — 8-Day Decay, Depleted

RELEASE POINT - GROUND LEVEL - NO INTERMITTENT RELEASES
8.000 DAY DECAY, DEPLETED
CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

DIRECTION	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	4.880E-06	1.071E-06	3.323E-07	1.698E-07	1.057E-07	4.642E-08	1.586E-08	7.257E-09	4.299E-09	2.881E-09
SSW	1.528E-06	3.463E-07	1.055E-07	5.259E-08	3.216E-08	1.374E-08	4.491E-09	1.986E-09	1.151E-09	7.592E-10
SW	2.526E-06	5.736E-07	1.701E-07	8.297E-08	4.996E-08	2.083E-08	6.558E-09	2.821E-09	1.610E-09	1.050E-09
WSW	4.314E-06	9.989E-07	2.954E-07	1.433E-07	8.588E-08	3.551E-08	1.101E-08	4.675E-09	2.648E-09	1.719E-09
W	7.969E-06	1.853E-06	5.528E-07	2.696E-07	1.623E-07	6.751E-08	2.113E-08	9.038E-09	5.141E-09	3.346E-09
WNW	5.735E-06	1.322E-06	3.930E-07	1.913E-07	1.150E-07	4.780E-08	1.496E-08	6.405E-09	3.647E-09	2.376E-09
NW	3.941E-06	9.090E-07	2.733E-07	1.341E-07	8.108E-08	3.401E-08	1.079E-08	4.667E-09	2.671E-09	1.746E-09
NNW	2.607E-06	5.884E-07	1.752E-07	8.582E-08	5.185E-08	2.177E-08	6.938E-09	3.016E-09	1.733E-09	1.136E-09
N	1.956E-06	4.429E-07	1.321E-07	6.480E-08	3.919E-08	1.648E-08	5.263E-09	2.290E-09	1.317E-09	8.637E-10
NNE	1.977E-06	4.458E-07	1.352E-07	6.730E-08	4.110E-08	1.753E-08	5.717E-09	2.523E-09	1.461E-09	9.624E-10
NE	1.990E-06	4.450E-07	1.374E-07	6.947E-08	4.290E-08	1.859E-08	6.208E-09	2.784E-09	1.626E-09	1.078E-09
ENE	2.008E-06	4.512E-07	1.401E-07	7.092E-08	4.382E-08	1.900E-08	6.351E-09	2.852E-09	1.668E-09	1.107E-09
E	2.769E-06	6.196E-07	1.936E-07	9.853E-08	6.112E-08	2.665E-08	8.988E-09	4.058E-09	2.380E-09	1.582E-09
ESE	3.536E-06	7.811E-07	2.441E-07	1.250E-07	7.788E-08	3.420E-08	1.166E-08	5.304E-09	3.124E-09	2.082E-09
SE	4.398E-06	9.693E-07	3.035E-07	1.556E-07	9.705E-08	4.271E-08	1.461E-08	6.677E-09	3.947E-09	2.639E-09
SSE	8.292E-06	1.812E-06	5.660E-07	2.913E-07	1.821E-07	8.051E-08	2.778E-08	1.279E-08	7.600E-09	5.105E-09

XOQDOQ - FPL COL (3 YEAR COMPOSITE 2002, 2005, 2006 Met Data)

Table 2.3.5-206 (Sheet 1 of 2)
XOQDOQ-Predicted Annual Average D/Q value at the Standard Radial Distances and Distance Segment Boundaries

RELEASE POINT - GROUND LEVEL - NO INTERMITTENT RELEASES
CORRECTED USING STANDARD OPEN TERRAIN FACTORS

RELATIVE DEPOSITION PER UNIT AREA (M**-2) AT FIXED POINTS BY DOWNWIND SECTORS

DIRECTION	DISTANCES IN MILES										
FROM SITE	.25	.50	.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
S	1.312E-07	4.436E-08	2.278E-08	1.083E-08	3.889E-09	1.929E-09	1.136E-09	7.437E-10	5.233E-10	3.878E-10	2.988E-10
SSW	5.059E-08	1.711E-08	8.784E-09	4.176E-09	1.500E-09	7.439E-10	4.380E-10	2.868E-10	2.018E-10	1.496E-10	1.153E-10
SW	1.466E-07	4.957E-08	2.545E-08	1.210E-08	4.346E-09	2.155E-09	1.269E-09	8.310E-10	5.847E-10	4.333E-10	3.339E-10
WSW	2.370E-07	8.015E-08	4.115E-08	1.956E-08	7.027E-09	3.485E-09	2.052E-09	1.344E-09	9.455E-10	7.007E-10	5.400E-10
W	4.078E-07	1.379E-07	7.081E-08	3.366E-08	1.209E-08	5.997E-09	3.531E-09	2.312E-09	1.627E-09	1.206E-09	9.291E-10
WNW	3.077E-07	1.040E-07	5.342E-08	2.540E-08	9.122E-09	4.524E-09	2.664E-09	1.744E-09	1.227E-09	9.095E-10	7.009E-10
NW	1.928E-07	6.520E-08	3.347E-08	1.591E-08	5.716E-09	2.835E-09	1.669E-09	1.093E-09	7.691E-10	5.700E-10	4.392E-10
NNW	1.380E-07	4.667E-08	2.396E-08	1.139E-08	4.092E-09	2.029E-09	1.195E-09	7.824E-10	5.505E-10	4.080E-10	3.144E-10
N	1.027E-07	3.474E-08	1.784E-08	8.480E-09	3.046E-09	1.511E-09	8.895E-10	5.824E-10	4.098E-10	3.037E-10	2.340E-10
NNE	7.283E-08	2.463E-08	1.265E-08	6.012E-09	2.160E-09	1.071E-09	6.306E-10	4.129E-10	2.905E-10	2.153E-10	1.659E-10
NE	5.551E-08	1.877E-08	9.639E-09	4.582E-09	1.646E-09	8.163E-10	4.806E-10	3.147E-10	2.215E-10	1.641E-10	1.265E-10
ENE	4.950E-08	1.674E-08	8.594E-09	4.086E-09	1.468E-09	7.278E-10	4.286E-10	2.806E-10	1.975E-10	1.463E-10	1.128E-10
E	5.807E-08	1.964E-08	1.008E-08	4.793E-09	1.722E-09	8.538E-10	5.027E-10	3.292E-10	2.316E-10	1.717E-10	1.323E-10
ESE	6.472E-08	2.189E-08	1.124E-08	5.342E-09	1.919E-09	9.517E-10	5.604E-10	3.669E-10	2.582E-10	1.913E-10	1.474E-10
SE	9.289E-08	3.141E-08	1.613E-08	7.667E-09	2.754E-09	1.366E-09	8.042E-10	5.266E-10	3.705E-10	2.746E-10	2.116E-10
SSE	2.081E-07	7.037E-08	3.613E-08	1.718E-08	6.171E-09	3.060E-09	1.802E-09	1.180E-09	8.302E-10	6.152E-10	4.741E-10

DIRECTION	DISTANCES IN MILES										
FROM SITE	5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
S	2.374E-10	1.055E-10	6.389E-11	3.229E-11	1.954E-11	1.310E-11	9.390E-12	7.051E-12	5.482E-12	4.379E-12	3.574E-12
SSW	9.157E-11	4.068E-11	2.464E-11	1.245E-11	7.538E-12	5.054E-12	3.622E-12	2.719E-12	2.114E-12	1.689E-12	1.379E-12
SW	2.653E-10	1.179E-10	7.139E-11	3.608E-11	2.184E-11	1.464E-11	1.049E-11	7.879E-12	6.126E-12	4.893E-12	3.994E-12
WSW	4.290E-10	1.906E-10	1.154E-10	5.835E-11	3.531E-11	2.368E-11	1.697E-11	1.274E-11	9.905E-12	7.912E-12	6.458E-12
W	7.381E-10	3.279E-10	1.986E-10	1.004E-10	6.077E-11	4.074E-11	2.919E-11	2.192E-11	1.704E-11	1.362E-11	1.111E-11
WNW	5.568E-10	2.474E-10	1.498E-10	7.574E-11	4.584E-11	3.073E-11	2.202E-11	1.654E-11	1.286E-11	1.027E-11	8.383E-12
NW	3.489E-10	1.550E-10	9.390E-11	4.746E-11	2.873E-11	1.926E-11	1.380E-11	1.036E-11	8.058E-12	6.436E-12	5.254E-12
NNW	2.498E-10	1.110E-10	6.722E-11	3.397E-11	2.056E-11	1.379E-11	9.879E-12	7.418E-12	5.768E-12	4.607E-12	3.761E-12
N	1.859E-10	8.260E-11	5.004E-11	2.529E-11	1.531E-11	1.026E-11	7.354E-12	5.522E-12	4.294E-12	3.430E-12	2.799E-12
NNE	1.318E-10	5.856E-11	3.547E-11	1.793E-11	1.085E-11	7.276E-12	5.214E-12	3.915E-12	3.044E-12	2.432E-12	1.985E-12
NE	1.005E-10	4.464E-11	2.704E-11	1.367E-11	8.272E-12	5.546E-12	3.974E-12	2.984E-12	2.320E-12	1.853E-12	1.513E-12
ENE	8.959E-11	3.980E-11	2.411E-11	1.219E-11	7.375E-12	4.945E-12	3.543E-12	2.661E-12	2.069E-12	1.652E-12	1.349E-12
E	1.051E-10	4.669E-11	2.828E-11	1.429E-11	8.652E-12	5.801E-12	4.157E-12	3.121E-12	2.427E-12	1.939E-12	1.582E-12
ESE	1.171E-10	5.204E-11	3.152E-11	1.593E-11	9.643E-12	6.466E-12	4.633E-12	3.479E-12	2.705E-12	2.161E-12	1.764E-12
SE	1.681E-10	7.468E-11	4.524E-11	2.287E-11	1.384E-11	9.280E-12	6.649E-12	4.993E-12	3.882E-12	3.101E-12	2.531E-12
SSE	3.767E-10	1.673E-10	1.014E-10	5.123E-11	3.101E-11	2.079E-11	1.490E-11	1.119E-11	8.698E-12	6.948E-12	5.671E-12

XOQDOQ - FPL COL (3 YEAR COMPOSITE 2002, 2005, 2006 Met Data)

Table 2.3.5-206 (Sheet 2 of 2)
XOQDOQ-Predicted Annual Average D/Q value at the Standard Radial Distances and Distance Segment Boundaries

RELEASE POINT GROUND LEVEL NO INTERMITTENT RELEASES
RELATIVE DEPOSITION PER UNIT AREA (M** 2) BY DOWNWIND SECTORS

SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5 1	1 2	2 3	3 4	4 5	5 10	10 20	20 30	30 40	40 50
S	2.226E 08	4.560E 09	1.190E 09	5.346E 10	3.024E 10	1.163E 10	3.365E 11	1.334E 11	7.122E 12	4.408E 12
SSW	8.586E 09	1.759E 09	4.591E 10	2.062E 10	1.166E 10	4.486E 11	1.298E 11	5.143E 12	2.747E 12	1.700E 12
SW	2.488E 08	5.095E 09	1.330E 09	5.974E 10	3.380E 10	1.300E 10	3.760E 11	1.490E 11	7.958E 12	4.926E 12
WSW	4.022E 08	8.239E 09	2.151E 09	9.660E 10	5.465E 10	2.101E 10	6.080E 11	2.410E 11	1.287E 11	7.964E 12
W	6.921E 08	1.418E 08	3.701E 09	1.662E 09	9.403E 10	3.616E 10	1.046E 10	4.146E 11	2.214E 11	1.370E 11
WNW	5.221E 08	1.069E 08	2.792E 09	1.254E 09	7.094E 10	2.728E 10	7.892E 11	3.128E 11	1.670E 11	1.034E 11
NW	3.272E 08	6.702E 09	1.750E 09	7.858E 10	4.445E 10	1.709E 10	4.945E 11	1.960E 11	1.047E 11	6.479E 12
NNW	2.342E 08	4.798E 09	1.252E 09	5.625E 10	3.182E 10	1.224E 10	3.540E 11	1.403E 11	7.493E 12	4.638E 12
N	1.743E 08	3.571E 09	9.323E 10	4.187E 10	2.369E 10	9.109E 11	2.635E 11	1.044E 11	5.577E 12	3.452E 12
NNE	1.236E 08	2.532E 09	6.610E 10	2.969E 10	1.679E 10	6.458E 11	1.868E 11	7.405E 12	3.954E 12	2.447E 12
NE	9.421E 09	1.930E 09	5.038E 10	2.263E 10	1.280E 10	4.922E 11	1.424E 11	5.644E 12	3.014E 12	1.865E 12
ENE	8.400E 09	1.721E 09	4.492E 10	2.017E 10	1.141E 10	4.389E 11	1.270E 11	5.032E 12	2.687E 12	1.663E 12
E	9.854E 09	2.019E 09	5.269E 10	2.367E 10	1.339E 10	5.149E 11	1.489E 11	5.903E 12	3.152E 12	1.951E 12
ESE	1.098E 08	2.250E 09	5.873E 10	2.638E 10	1.492E 10	5.739E 11	1.660E 11	6.580E 12	3.514E 12	2.175E 12
SE	1.576E 08	3.229E 09	8.430E 10	3.786E 10	2.142E 10	8.236E 11	2.383E 11	9.444E 12	5.043E 12	3.121E 12
SSE	3.532E 08	7.234E 09	1.889E 09	8.482E 10	4.798E 10	1.845E 10	5.338E 11	2.116E 11	1.130E 11	6.993E 12

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	.00	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS)	.00	BUILDING HEIGHT	(METERS)	69.7
EXIT VELOCITY	(METERS)	.00	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	2636.0
			HEAT EMISSION RATE	(CAL/SEC)	.0

ALL GROUND LEVEL RELEASES.
XOQDOQ FPL COL (3 YEAR COMPOSITE 2002, 2005, 2006 Met Data)

Table 2.3.5-207
XOQDOQ-Predicted Annual Average X/Q and D/Q Values at Sensitive Receptors

RELEASE POINT GROUND LEVEL NO INTERMITTENT RELEASES
CORRECTED USING STANDARD OPEN TERRAIN FACTORS
SPECIFIC POINTS OF INTEREST

RELEASE ID	TYPE OF LOCATION	DIRECTION FROM SITE	DISTANCE (MILES)	DISTANCE (METERS)	X/Q (SEC/CUB.METER) NO DECAY UNDEPLETED	X/Q (SEC/CUB.METER) 2.260 DAY DECAY UNDEPLETED	X/Q (SEC/CUB.METER) 8.000 DAY DECAY DEPLETED	D/Q (PER SQ.METER)
A	Residential	NW	3.97	6388.	1.3E 07	1.3E 07	1.0E 07	5.8E 10
A	Residential	NNW	5.06	8145.	5.5E 08	5.4E 08	4.1E 08	2.4E 10
A	Residential	N	2.69	4333.	1.4E 07	1.3E 07	1.1E 07	7.5E 10
A	Vegetable	NW	4.78	7692.	9.6E 08	9.4E 08	7.2E 08	3.8E 10
A	Vegetable	NNW	5.06	8145.	5.5E 08	5.4E 08	4.1E 08	2.4E 10
A	UNIT 7	W	.13	215.	1.6E 04	1.6E 04	1.5E 04	1.0E 06
A	School	NW	1.99	3198.	5.2E 07	5.2E 07	4.3E 07	2.9E 09
A	EAB	S	.52	840.	1.0E 05	1.0E 05	9.1E 06	4.1E 08
A	EAB	SSW	.51	819.	3.2E 06	3.2E 06	2.9E 06	1.7E 08
A	EAB	SW	.45	724.	6.3E 06	6.3E 06	5.8E 06	5.9E 08
A	EAB	WSW	.48	780.	9.4E 06	9.3E 06	8.6E 06	8.4E 08
A	EAB	W	.49	782.	1.7E 05	1.7E 05	1.6E 05	1.4E 07
A	EAB	WNW	.49	789.	1.2E 05	1.2E 05	1.1E 05	1.1E 07
A	EAB	NW	.48	766.	8.9E 06	8.9E 06	8.2E 06	7.1E 08
A	EAB	NNW	.48	767.	6.0E 06	6.0E 06	5.5E 06	5.0E 08
A	EAB	N	.48	767.	4.5E 06	4.5E 06	4.1E 06	3.8E 08
A	EAB	NNE	.48	767.	4.6E 06	4.6E 06	4.2E 06	2.7E 08
A	EAB	NE	.27	435.	1.2E 05	1.2E 05	1.2E 05	4.9E 08
A	EAB	ENE	.28	458.	1.1E 05	1.1E 05	1.1E 05	4.1E 08
A	EAB	E	.30	479.	1.5E 05	1.5E 05	1.4E 05	4.5E 08
A	EAB	ESE	.37	589.	1.3E 05	1.3E 05	1.2E 05	3.6E 08
A	EAB	SE	.36	586.	1.7E 05	1.7E 05	1.6E 05	5.2E 08
A	EAB	SSE	.53	848.	1.7E 05	1.7E 05	1.5E 05	6.5E 08
A	Prop Line	S	.36	577.	1.9E 05	1.9E 05	1.8E 05	7.5E 08
A	Prop Line	SSW	2.72	4373.	1.1E 07	1.1E 07	8.6E 08	3.6E 10
A	Prop Line	SW	1.50	2409.	6.0E 07	5.9E 07	5.1E 07	4.4E 09
A	Prop Line	WSW	1.36	2195.	1.3E 06	1.3E 06	1.1E 06	8.9E 09
A	Prop Line	W	1.35	2173.	2.4E 06	2.4E 06	2.1E 06	1.6E 08
A	Prop Line	WNW	1.80	2903.	9.2E 07	9.2E 07	7.7E 07	5.8E 09
A	Prop Line	NW	1.64	2641.	7.8E 07	7.7E 07	6.6E 07	4.6E 09
A	Prop Line	NNW	1.51	2430.	6.0E 07	6.0E 07	5.1E 07	4.0E 09
A	Prop Line	N	1.12	1797.	8.9E 07	8.8E 07	7.7E 07	6.4E 09
A	Prop Line	NNE	1.10	1773.	9.2E 07	9.1E 07	8.0E 07	4.7E 09
A	Prop Line	NE	.39	624.	6.7E 06	6.6E 06	6.2E 06	2.8E 08
A	Prop Line	ENE	.40	647.	6.3E 06	6.3E 06	5.8E 06	2.4E 08
A	Prop Line	E	.39	635.	9.1E 06	9.1E 06	8.4E 06	2.9E 08
A	Prop Line	ESE	.43	688.	1.0E 05	1.0E 05	9.4E 06	2.8E 08
A	Prop Line	SE	.37	595.	1.6E 05	1.6E 05	1.5E 05	5.1E 08
A	Prop Line	SSE	.35	564.	3.4E 05	3.4E 05	3.2E 05	1.2E 07

VENT AND BUILDING PARAMETERS:

RELEASE HEIGHT	(METERS)	.00	REP. WIND HEIGHT	(METERS)	10.0
DIAMETER	(METERS)	.00	BUILDING HEIGHT	(METERS)	60.9
EXIT VELOCITY	(METERS)	.00	BLDG.MIN.CRS.SEC.AREA	(SQ.METERS)	2636.0
			HEAT EMISSION RATE	(CAL/SEC)	.0

Note: “Prop Line” refers to the site boundary.

2.3.6 COMBINED LICENSE INFORMATION

2.3.6.1 Regional Climatology

PTN COL 2.3-1 This COL Item is addressed in Subsection 2.3.1.

2.3.6.2 Local Meteorology

PTN COL 2.3-2 This COL Item is addressed in Subsection 2.3.2.

2.3.6.3 Onsite Meteorological Measurement Programs

PTN COL 2.3-3 This COL Item is addressed in Subsection 2.3.3.

2.3.6.4 Short-Term Diffusion Estimates

PTN COL 2.3-4 This COL Item is addressed in Subsection 2.3.4.

2.3.6.5 Long-Term Diffusion Estimates

PTN COL 2.3-5 This COL Item is addressed in Subsection 2.3.5.

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SUBSECTION 2.4.1: HYDROLOGIC DESCRIPTION
TABLE OF CONTENTS

SUBSECTION 2.4.1 LIST OF TABLES

SUBSECTION 2.4.1 LIST OF FIGURES

2.4 HYDROLOGIC ENGINEERING

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

Subsection 2.4.1 of the DCD is renumbered as Section 2.4.15. This is being done to accommodate the incorporation of Regulatory Guide 1.206 numbering conventions for Section 2.4.

STD DEP 1.1-1

2.4.1 HYDROLOGIC DESCRIPTION

PTN COL 2.4-1

This subsection describes the hydrological setting at the Units 6 & 7 site and presents the plant's interface with the hydrosphere. The subsection also provides a list of surface water users whose intakes could be affected by Units 6 & 7. Groundwater hydrology and groundwater use are described in Subsection 2.4.12.

2.4.1.1 Site and Facilities

The Units 6 & 7 plant area is part of the larger Turkey Point plant property located approximately 25 miles south of Miami in unincorporated Miami-Dade County, Florida. The approximate 9400-acre Turkey Point plant property includes two gas/oil-fired steam electric generating units, Units 1 & 2, one natural gas combined cycle plant, Unit 5, and four nuclear powered steam electric generating units, Units 3 & 4 (Reference 201) and Units 6 & 7. Figure 2.4.1-201 shows the Turkey Point site and the surrounding area. Major hydrologic features near the plant property are also identified on the figure. The topography of the area in the immediate vicinity of the plant is shown on Figure 2.4.1-202.

Units 6 & 7 are located immediately south of the Units 3 & 4 on a plant area of approximately 218 acres. Most of the Units 6 & 7 plant features are located on an area bounded on all four sides by the permitted industrial wastewater facility/ cooling canals. The cooling canals serve as part of the closed-loop cooling water supply for Units 1 through 4 (Figure 2.4.1-203). For Unit 5, cooling tower makeup water is supplied from the Upper Floridan aquifer and the blowdown is routed to the cooling canals (Reference 201).

The Units 6 & 7 plant area within the bounds of cooling canals is raised to a higher elevation above surrounding grade. The grade elevations in the plant area vary

from 19 feet to 25.5 feet in North American Vertical Datum of 1988 (NAVD 88). The area is surrounded by a retaining wall structure with the top of wall elevation varying from 20 feet to 21.5 feet NAVD 88. The NAVD 88 is the plant reference elevation datum for Units 6 & 7 and is used in this and subsequent subsections. Conversions to NAVD 88 are provided when elevations referencing to other vertical datum are cited. The general arrangement of Units 6 & 7 are shown on Figure 2.4.1-204.

FPL selected the Westinghouse AP1000 certified plant design for Units 6 & 7. The design plant grade for all safety-related facilities is at 26.0 feet NAVD 88 (which is equivalent to the design plant grade elevation of 100 feet or 30.48 meters in the DCD reference datum as defined in the DCD). The safety-related structures for the AP1000 design include the containment/shield building and the auxiliary building. Finished grade elevations at the plant area are shown in Figure 2.4.2-202. Before construction, the area where the plant is located was occupied by sparsely vegetated, low-lying mudflats and was isolated by the surrounding cooling canals. The preconstruction elevations ranged from approximately –2.4 feet to 0.8 foot NAVD 88.

The AP1000 reactor design employs a safety-related passive containment cooling system that serves as the ultimate heat sink for design basis accident events. As indicated in the DCD, the passive containment cooling system does not require offsite water sources to perform its safety functions. Units 6 & 7 use mechanical draft cooling towers for nonsafety-related circulating water system cooling, with makeup water from two independent water sources, each capable of supplying 100 percent of the makeup water demand, as addressed in Subsection 2.4.11. The units also use mechanical draft cooling towers for nonsafety-related service water system cooling, with makeup water supplied from the Miami-Dade Water and Sewer District potable water system.

The two makeup water sources for the plant's nonsafety-related circulating water system are reclaimed water and saltwater. Reclaimed water is supplied by the Miami-Dade Water and Sewer Department from its wastewater treatment facilities via a pipeline system to the FPL reclaimed water treatment facility. The treated reclaimed water from the facility is stored in the makeup water reservoir, which is shown on Figure 2.4.1-204. Details of the makeup water reservoir are described in Subsection 2.4.8. The maximum makeup water requirement, when the circulating water system is operating with reclaimed water, is approximately 38,400 gallons per minute for both Units 6 & 7. Saltwater is supplied from radial collector wells to the cooling tower basins and is used to supplement reclaimed water as needed to meet the makeup water demand. The maximum makeup

water rate when the circulating water system is operating with saltwater is approximately 86,400 gallons per minute for both units. The circulating water system is also capable of operating on any combination of the two types of makeup water. Locations of the water supply sources are shown on Figures 2.4.11-201 and 2.4.11-202. The cooling tower blowdown and other plant wastewater streams are collected in a common collection sump for injection into a deep injection well, as described in Subsection 2.4.12. Consequently, none of the surrounding surface water bodies are used as a water supply source, waste effluent discharge point, or heat sink for Units 6 & 7.

The Units 6 & 7 plant property is surrounded by the low-lying areas of the Everglades drainage basin (Figure 2.4.1-205). There are no major rivers, lakes, or dams located nearby, as shown in Figures 2.4.1-202 and 2.4.1-203. However, a network of drainage canals, which includes canals from the Everglades National Park-South Dade Conveyance System (ENP-SDCS) and local project (drainage) canals, provides freshwater supply to the Everglades and controlled drainage from southeast Florida to Biscayne Bay. Consequently, the hydrology near Units 6 & 7 is mainly governed by the Biscayne Bay. In addition to Biscayne Bay, other major hydrologic features near Units 6 & 7 include the Everglades and the drainage canal system of southeast Florida, as described in Subsection 2.4.1.2.

Potential flooding events and the determination of the design basis flood elevation that may affect the Units 6 & 7 safety-related facilities are described in Subsection 2.4.2. Because the design plant grade, including the elevation of the openings and entrances to the Units 6 & 7 safety-related buildings, is located above the design basis flood elevation, as described in Subsection 2.4.2, the safety-related functions of the plant will not be adversely impacted by flooding events. Subsection 2.4.10 describes the flooding protection requirements for Units 6 & 7.

2.4.1.2 Hydrosphere

Units 6 & 7 are located adjacent to the Biscayne Bay within the Everglades drainage basin of the south Florida watershed subregion, as shown on Figure 2.4.1-205. As described in Subsection 2.5.1.1, the plant property is located in the Southern Slope subprovince of the Southern Zone subregion of the Florida Platform within the Atlantic Coastal Plain physiographic province (see Figure 2.5.1-202). The physiographic features in the Southern Zone subregion that govern surface water flows southward from Lake Okeechobee include the Immokalee Rise, Big Cypress Spur, Atlantic Coastal Ridge, and the Everglades physiographic sub-provinces (Figure 2.5.1-202). Higher topographic relief of the

Immokalee Rise and Big Cypress Spur in the west and the Atlantic Coastal Ridge in the east of the Everglades historically guided the stormwater runoff and freshwater flows from Lake Okeechobee to drain south and southeast into the Everglades. However, flood control structures and an elaborate drainage canal system constructed in the past century has since modified the natural drainage pattern, its freshwater discharge, and its interaction with the coastal bays in the Atlantic Ocean and Gulf of Mexico. The interaction of surface water and groundwater within the area further complicates the hydrology of the area (References 202, 203, and 204).

2.4.1.2.1 The Everglades

The Everglades is the largest wetland in the continental United States and was part of the larger, natural Kissimmee-Okeechobee-Everglades watershed that once extended south from Lake Okeechobee to the southernmost extremity of peninsular Florida. Elevations within the Everglades, which were formed on limestone bedrock, are lower than the elevations in the Flatwoods or Atlantic Coastal Ridge physiographic provinces and slope toward the south with an average gradient less than 2 inches per mile (References 204 and 205). The freshwater flow from Lake Okeechobee and the flat terrain of the basin supported the accumulation of layers of peat and mud that formed the historical Everglades wetlands over an area of approximately 4500 square miles (References 202 and 205).

Before the beginning of drainage development in the late 1800s, overflows from Lake Okeechobee slowly moved through the Everglades as sheet flows. The overflow also provided the freshwater supply that sustained the ecosystem functions within the wetlands that were dominated by sawgrass and tree islands, the small, forested islands that are a prominent feature of the Everglades (Reference 204). From the Everglades, water drained south to the Gulf of Mexico through a series of open-water sloughs. Hydrological features and natural direction of historical surface water flows are shown in Figure 2.4.1-206.

The Atlantic Coastal ridge that separates the Everglades from the Atlantic coastline has a maximum elevation of approximately 20 feet above MSL datum (Reference 205), which is equivalent to the National Geodetic Vertical Datum of 1929 (NGVD 29). At the National Oceanic and Atmospheric Administration (NOAA) tide gage station located at Virginia Key, Florida, the NGVD 29 is located approximately 1.6 feet below the NAVD 88. This datum relationship is also considered applicable to Units 6 & 7. Applying the datum conversion, the maximum elevation of the Atlantic Coastal Ridge is approximately 18.4 feet NAVD

88. Historically, nearly all of southeast Florida, except for the Atlantic Coastal ridge, was flooded annually (Reference 205). The floodwater discharged to Biscayne Bay through the Miami, New, and Hillsborough rivers and other sloughs that formed the transverse glades in the Atlantic Coastal ridge, as shown in Figure 2.4.1-206.

Since the late nineteenth century, the south Florida watershed subregion has been affected by anthropogenic alterations (Reference 202). Land reclamation for agriculture, construction of flood control levees and drainage canals, and urbanization irreversibly modified the hydrology of the region. Canals were first dug through the Everglades to drain water from the area south of Lake Okeechobee, thus enabling agriculture to develop during the late nineteenth and early twentieth centuries (Reference 202). By the late 1920s, major canals were constructed and rivers in the transverse glades were modified to connect Lake Okeechobee with the Gulf of Mexico and Atlantic Ocean (Figure 2.4.1-207). In the west, the Caloosahatchee Canal connected Lake Okeechobee with the Gulf of Mexico. St. Lucie Canal in the east connected Lake Okeechobee with the St. Lucie River and estuary. In the southeast, the West Palm Beach, Hillsborough, North New River, South New River, and Miami (River) Canals connected Lake Okeechobee with the Biscayne Bay and Atlantic Ocean (References 202 and 204). Government-initiated flood control measures, including levee construction and drainage channel modification, began in the 1930s (Reference 204).

U.S. Congress authorized the Central and Southern Florida Flood Control Project (C&SF project) in 1948 with a mandate to provide flood protection, water supply, prevention of saltwater intrusion, and protection of fish and wildlife resources (References 202 and 204). The state of Florida formed the Central and Southern Florida Flood Control District in 1949, which later became the South Florida Water Management District (SFWMD), to work with the C&SF project. The C&SF project adopted a water management plan for Lake Okeechobee and three water conservation areas (WCAs) to provide flood protection and water supply. As part of the water management plan, the Everglades Agricultural Area (EAA) was also drained for agricultural development. The locations of the EAA and the WCAs are shown in Figure 2.4.1-207.

The construction of these flood control canals, levees, and structures by the C&SF project has caused a large portion of runoff that originally flowed from the Kissimmee River and Lake Okeechobee into the Everglades to be diverted directly to the Gulf of Mexico by the Caloosahatchee Canal and to the Atlantic Ocean by the St. Lucie Canal. Before flood control, agriculture, and urbanization

development, which began in the late nineteenth century, the natural water level in Lake Okeechobee overflowed its southern bank at elevations 20 to 21 feet NGVD 29 (18.4 to 19.4 feet NAVD 88). Currently, the lake water level is maintained at approximately 13 to 16 feet NGVD 29 (11.4 to 14.4 feet NAVD 88) (Reference 205). Surface water flows from the EAA into the WCAs are maintained by pumping, resulting in alterations in the timing and spatial distribution of historical (prior to the construction of the canals) flows as well as a reduction in the volume of water discharged. As a result, water levels in the Everglades generally are shallower and have shorter hydroperiods than water levels prior to late-nineteenth century development (References 202 and 205). Post-development drainage patterns in the Everglades are shown in Figure 2.4.1-207.

By 2000, approximately 50 percent of the historic Everglades basin in Florida remained undeveloped. The rest of the area has been altered for agriculture or urban growth (Reference 204). Most of the undeveloped portions of the Everglades at present are protected by public parks including the Everglades National Park, Big Cypress National Preserve, Loxahatchee National Wildlife Refuge, the WCAs, Fakahatchee Strand State Preserve, and other state lands (Reference 202). The Everglades National Park was established in 1947 on marshland south of the WCAs and now covers approximately 1.4 million acres (Reference 202). The park is approximately 15 miles west of the plant property and is adjacent to the southeast Florida drainage canal system.

In 2000, the federal Water Resources Development Act authorized a Comprehensive Everglades Restoration Plan (CERP) to provide a framework and guide the restoration, protection, and preservation of the water resources of central and southern Florida, including the Everglades (Reference 206). The plan has more than 60 elements, covers 16 counties over an area of 18,000 square miles and focuses on updating the C&SF project (Reference 206). The CERP projects intend to restore water flows that have changed over the past century, and plan on capturing and storing freshwater flows in surface and subsurface reservoirs, which are currently released to the Atlantic Ocean and Gulf of Mexico.

The freshwater would be directed to the wetlands, lakes, rivers, and estuaries of southern Florida while also ensuring future urban and agricultural water supplies (Reference 206). The surface and subsurface reservoirs would mainly be located within the low-lying areas of the EAA and WCAs. Failure of these reservoirs would not adversely affect the functioning of the Units 6 & 7 safety-related structures that are located at an elevation of 26 feet NAVD 88.

2.4.1.2.2 Everglades National Park-South Dade Conveyance System

The systematic and elaborate construction of drainage canals in southern Miami-Dade County was initiated in the 1960s. The Federal Flood Control Act (FCA) of 1962 authorized the C&SF project for southern Miami-Dade County. The C&SF project implemented a system of canals and structures to provide drainage for urban development, prevent over-drainage of agricultural lands, and prevent contamination of groundwater by saltwater intrusion (Reference 207). The conveyance system relies on gravity drainage through a primary network of 12 canals with outlets to serve a system of secondary canals (Reference 207). The stages of development of the canals during the 1950s and 1960s are shown on Figure 2.4.1-208.

The canal system was modified in the 1970s to meet the hydrologic needs of the Everglades National Park, as authorized by the updated FCA of 1968, by implementing the ENP-SDCS (Reference 207). ENP-SDCS interconnected several drainage basins of the C&SF drainage project (Reference 208). Gated control structures were first installed at the eastern (coastal) end of the primary canals to release excess stormwater runoff to the coastal water bodies during the wet seasons and to manage saltwater intrusion during the dry seasons. Secondary controls on the inland reaches of the canals were then installed to regulate flow eastward, control inland and agricultural flooding, and maintain higher water levels in the surficial aquifer system where appropriate (Reference 209). The surface water canal system was fully developed in the 1980s when the ENP-SDCS was completed. Figure 2.4.1-209 shows the partially completed canal system in the 1970s, and the fully developed system in the 1990s. The conveyance system met its objectives by providing agricultural water supply, control flooding, and mitigating saltwater intrusion (Reference 209).

The ENP-SDCS was mandated to supply 55,000 acre-feet of water per year to the Everglades National Park. It made use of the existing canals from the C&SF project (Reference 208). The existing north-south directed borrow canals L-30 and L-31N/L-31W were enlarged to convey water from the Miami Canal (C-6) to the Everglades. The west-east running canals provide drainage from the southern Dade development corridor to the Biscayne Bay by control structures at the mouth of the canals (Reference 209). The locations of present-day ENP-SDCS and C&SF project drainage canals are shown in Figure 2.4.1-210. The western borrow canal of the L-31E Levee (L-31E Canal) runs parallel to the coastline of Biscayne Bay in southern Miami-Dade County, separating the coastal wetlands along the

bay from the mainland. Starting north of Black Creek Canal (C-1) and extending to Card Sound Road in the south, the L-31E Levee has a crest elevation of approximately 7 feet NAVD 88. The levee and canal are located immediately west of the Turkey Point cooling canals (Reference 210).

Based on hydrology of the area, the U.S. Army Corps of Engineers (USACE) delineated water management subbasins in southern Miami-Dade County (Reference 208). The water management area includes 17 subbasins that contribute flow to the Biscayne Bay and Everglades, as shown on Figure 2.4.1-211. Surface water flows from the drainage subbasins to the Biscayne Bay or the Everglades are controlled by numerous flow control structures. Flow control structures also regulate flow between the subbasin areas. The subbasins' names are based on the major canal in the subbasin. A summary of the subbasins (with names corresponding to the primary canal servicing each of the areas), drainage areas, and the control structures at basin outlets that regulate flow to the Biscayne Bay is provided in Table 2.4.1-201. The locations of the control structures are shown on Figure 2.4.1-210.

Detailed flow and water level monitoring and measurements are performed as part of the operation of the structures in the ENP-SDCS. A search in the SFWMD database (DBHYDRO) for flow and water level monitoring data within the subbasins listed in Table 2.4.1-201 returned approximately 700 records (Reference 211). The DBHYDRO database includes data from stations maintained by various agencies including U.S. Geological Survey (USGS), SFWMD, and the Everglades National Park. Monthly mean flow rates and water levels at four stations near Units 6 & 7, S-197, S-20, S-21A, and S-21, are obtained from the SFWMD database. Details of the station locations and available data records are presented in Table 2.4.1-202. Monthly mean flow rates and water levels at the selected locations are presented in Tables 2.4.1-203 through 2.4.1-210.

2.4.1.2.3 Biscayne Bay

Biscayne Bay is a shallow coastal lagoon located on the lower southeast coast of Florida (Reference 212). The bay is approximately 38 miles long, approximately 11.2 miles wide on average, and has an area of approximately 428 square miles (References 213 and 214). The bay began forming between 5000 and 3000 years ago as sea level rose and filled a limestone depression (Reference 203). The eastern boundary of the Biscayne Bay is composed of barrier islands that form a part of the Florida Keys and separates the bay from the Atlantic Ocean

(Reference 215). Coral reefs east of the barrier islands make up the northern extent of the Florida reef tract (Reference 213). Several canals on the western shore discharge surface water into the bay, as described in Subsection 2.4.1.2.2. The Biscayne Bay is connected to the Atlantic Ocean by a wide and shallow opening of coral shoal near the middle of the bay that is known as the Safety Valve, and by several channels and cuts (Reference 215).

Because the Biscayne Bay is not a drowned river valley, unlike most estuaries, sediment inflow to the bay from rivers/canals is insignificant. Near the plant property, part of the Biscayne Bay is within the designated boundaries of the Biscayne National Park that contains a narrow fringe of mangrove forest along the mainland. Similar mangrove zones are present along the southern expanse of the Biscayne Bay, and in the northernmost islands of the Florida Keys including Elliott Key (Reference 216).

For basin-wide planning purposes, the Biscayne Bay is divided into three subregions: North Bay, Central Bay, and South Bay (Reference 213). North Bay extends from approximately 5 miles north of the Miami-Dade/Broward County boundary to the shoreline near Miami, Florida; Central Bay extends from the shoreline near Miami, Florida to the Featherbed Banks east of Black Creek Canal; and South Bay extends from the Featherbed Banks east of Black Creek Canal to Barnes Sound (Figure 2.4.1-210). The Turkey Point plant property is located adjacent to South Bay, which is generally undeveloped and fringed by mangrove wetlands. South Bay (also identified as the Lower Biscayne Bay) is approximately 100 square miles in area (Reference 201).

The average depth of the Biscayne Bay is approximately 6 feet with a maximum depth of approximately 13 feet (Reference 217). The volume at mean low water is approximately 1.5E10 cubic feet (Reference 201). The mean low water datum at the NOAA Virginia Key, Florida, station is located at –1.9 feet NAVD 88 (Reference 218). NOAA maintains tidal stations in the Biscayne Bay and surrounding areas (Reference 219). A list of selected stations near Units 6 & 7 and their estimated tidal ranges is presented in Table 2.4.1-211. The stations currently in operation with more than 10 years of record include Virginia Key, Florida (NOAA station 8723214); Vaca Key, Florida (8723970); and Key West, Florida (8724580) (References 220, 221, and 222). The Virginia Key, Florida, station is located approximately 25 miles north-northeast of Units 6 & 7. The Vaca Key, Florida, and Key West, Florida, stations are located approximately 70 miles and 110 miles southwest of Units 6 & 7, respectively. Other stations, as listed in Table 2.4.1-211, are located within the Biscayne Bay and Card Sound with only

short periods of tidal data and are no longer active. The locations of the tidal stations are shown on Figure 2.4.1-212.

Within the Biscayne Bay, the great diurnal tide range, which is the difference between the mean higher high and mean lower low tide levels, is higher near the entrance of the bay, as shown in Table 2.4.1-211. At Cutler station in the Biscayne Bay, the great diurnal range is 2.13 feet; near Turkey Point, the range is 1.78 feet; and in the southern Biscayne Bay at the Card Sound Bridge station, the range is reduced to 0.63 foot.

Studies of the Biscayne Bay show the principal circulation forces to be tidal, although winds that persist for longer than a complete tidal cycle of 12 to 13 hours cause relatively large water movements (Reference 201). Measurements of tidal flow past discrete points such as Cutter Bank (east of the cooling canals) average approximately 50,000 acre-feet per day, or a continuous flow of 60,000 acre-feet per half of a tidal cycle. Tidal exchange between the Biscayne Bay and the ocean is estimated to be less than 10,000 acre-feet per day (Reference 201).

The South Bay also includes Card Sound and Barnes Sound south of Biscayne Bay. Card Sound is part of the Biscayne Bay Aquatic Preserve of the Upper Florida Keys. Freshwater input to Card Sound is primarily surficial sheet flow with additional flow from groundwater upwelling (Reference 223). Circulation within Card Sound and Barnes Sound is restricted because of the enclosed configuration of the sounds by barrier islands that increases residence times of its waters (Reference 223). The tidal range within Card Sound is presented in Table 2.4.1-211.

2.4.1.2.4 Units 6 & 7 Plant Area

The Units 1 though 7 plant area is bounded by the Biscayne Bay and L-31E Canal to the east and west, respectively, by the Florida City Canal to the north and by Card Sound Road and Card Sound to the south. The L-31E Levee intercepts the freshwater flows that historically discharged as sheet flow to the coastal wetlands and the Biscayne Bay east of the canal. Outflow from the canals north and west of Units 6 & 7 (Mowry Canal, North Canal, Florida City Canal, and Model Land Canal) is controlled by two flow control structures, S-20 and S-20F. Public works projects in this area for mosquito control and land reclamation in the early 1900s resulted in the construction of shallow ditches approximately 6 to 10 feet wide. The shallow ‘mosquito ditches’ run north-south, and the drainage ditches run east-west to provide quick drainage of the wetlands. Remnants of the ditches can still be identified in the area (Reference 224). The SFWMD has undertaken an

elaborate plan (Biscayne Bay Coastal Wetlands Project) to restore the Biscayne Bay ecosystem in the areas surrounding the Turkey Point plant property (Reference 225). FPL is maintaining a wetland area in the northern area of the Turkey Point plant property shown as TP-5 Mitigation Area in Figure 2.4.1-203. In addition, FPL is implementing a wetland mitigation project southwest of Units 6 & 7 (shown as Everglades Mitigation Bank on Figure 2.4.1-203). Future hydrologic changes in the Biscayne Bay Coastal Wetlands project are not expected to have adverse flooding and water use impact on the safety-related functions of Units 6 & 7.

The Federal Emergency Management Agency (FEMA) flood insurance study for Miami-Dade County indicates that the most severe flooding in the county would result from hurricane storm surges (Reference 226). The flood insurance study estimated the surge elevations (still water level) at transect locations along the shoreline of Biscayne Bay for different return periods. Units 6 & 7 lie between Transect 30 in the north to Transect 31 in the south. The maximum still water levels in the transects range between elevation 8.5 feet NGVD 29 (6.9 feet NAVD 88) for a 10-year return period to 12.4 feet NGVD 29 (10.8 feet NAVD 88) for a 500-year return period (Reference 226).

2.4.1.2.5 Dams and Reservoirs

There are no dams or reservoirs near Units 6 & 7. The only flow regulation and control near Units 6 & 7 is for the ENP-SDCS that regulates drainage from the Everglades and saltwater intrusion from Biscayne Bay. An assessment of dam failure potential is provided in Subsection 2.4.4.

2.4.1.2.6 Surface Water Users

Approximately 90 percent of all consumptive water use in southern Florida comes from groundwater sources, while the remaining 10 percent is supplied from surface water sources (Reference 227). SFWMD administers water use permits for the south Florida region. As of October 13, 2008, 139 permits were in use within Miami-Dade County. Permitted surface water uses within 10 miles of Units 6 & 7 are tabulated in Table 2.4.1-212 (Reference 228). Approximately 83 percent of the permitted surface water use is for landscape irrigation. The remaining use is for irrigation of golf courses, agriculture, aquaculture, nursery irrigation, industrial uses, and dewatering. There are no surface water withdrawals permitted for potable water supply. The nearest surface water user is approximately 6 miles west-northwest of Units 6 & 7.

The major non-consumptive surface water uses near Units 6 & 7 includes recreation, fishing, and navigation. The Biscayne National Park and Homestead Bayfront Park support nearly all of non-consumptive water use near Units 6 & 7.

2.4.1.2.7 Groundwater Characteristics

The local and regional hydrogeology characterization is addressed in Subsection 2.4.12. A detailed list of current nondomestic groundwater users, groundwater well locations, and the withdrawal rates in the vicinity of Units 6 & 7 is presented in Subsection 2.4.12.2.

2.4.1.3 References

201. Florida Power & Light Company, *Site Certification Application, Turkey Point Uprate Project*, January 2008.

202. McPherson, B., and R. Halley, T*he South Florida Environment: A Region Under Stress*, Circular 1134, National Water-Quality Assessment Program, U.S. Geological Survey, 1997.

203. Wolfert-Lohmann, M et al., *U.S. Geological Survey Science Support Strategy for Biscayne National Park and Surrounding Areas in Southeastern Florida*, U.S. Geological Survey, Open-File Report 2007-1288, 2007.

204. Godfrey, M. (with contribution by T.Catton), *River of Interests: Water Management in South Florida and the Everglades*, 1948–2000, U.S. Army Corps of Engineers, June 2006.

205. Galloway, D., D. Jones, and S. Ingebritsen, *Land Subsidence in the United States*, U.S. Geological Survey, Circular 1182, 1999.

206. Comprehensive Everglades Restoration Plan, *About CERP: A Brief Overview, Comprehensive Everglades Restoration Plan*. Available at http://www.evergladesplan.org/about/about_cerp_brief.aspx, accessed October 17, 2008.

207. U.S. Army Corps of Engineers, *Design Modifications for the Canal 111 (C-111) Project*, Miami-Dade County, Florida, Draft Environmental Assessment, Jacksonville District, June 2007.

208. Cooper, R., and J. Lane, *An Atlas of Eastern Dade County Surface Water Management Basins*, Technical Memorandum, South Florida Water Management District, October 1987.

209. Renken, R. et al., *Impact of Anthropogenic Development on Coastal Ground—Water Hydrology in Southeastern Florida*, 1900–2000, U.S. Geological Survey, Circular 1275, 2005.

210. South Florida Water Management District, *Preliminary Design Report Cutler Wetlands C-1 Flow Way and L-31E Culverts, Biscayne Bay Coastal Wetlands—Phase 1*, 2006.

211. South Florida Water Management District, *DBHYDRO Browser*. Available at http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.main _ menu, accessed October 19, 2008.

212. Langevin, C., *Simulation of Groundwater Discharge to Biscayne Bay, Southeast Florida*, U.S. Geological Survey, Water-Resources Investigations Report 00-4251, 2001.

213. U.S. Geological Survey, *Novel Geophysical and Geochemical Techniques Used to Study Submarine Groundwater Discharge in Biscayne Bay, Florida*, Fact Sheet 2004-3117, September 2004.

214. Wingard, G. et al., *Ecosystem History of Southern and Central Biscayne Bay: Summary Report on Sediment Core Analyses—Year Two*, U.S. Geological Survey, Open-File Report 2004-1312, October 2004.

215. Cantillo, A., K. Hale, E. Collins, L. Pikula, and R. Caballero, *Biscayne Bay: Environmental History and Annotated Bibliography,* NOAA Technical Memorandum NOS NCCOS CCMA 145, U.S. Department of Commerce, July 2000.

216. U.S. National Park Service, *Biscayne National Park—Environmental Factors*. Available at http://www.nps.gov/bisc/naturescience/environmental factors.htm, accessed October 19, 2008.

217. Caccia, V., and J. Boyer, *Spatial Pattering of Water Quality in Biscayne Bay, Florida as a Function of Land Use and Water Management,* Marine Pollution Bulletin, Vol. 50, pp. 1416–1429, 2005.

218. National Oceanic and Atmospheric Administration, *Virginia Key, Florida, Datums*. Available at http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=8723214%20Virginia%20Key,%20FL&type=Datums, accessed February 2, 2008.

219. National Oceanic and Atmospheric Administration, *Historic Tide Data-Station Selection*. Available at http://tidesandcurrents.noaa.gov/station_retrieve.shtml?type=Historic%20Tide%20Data&state=Florida&id1=872, accessed October 27, 2008.

220. National Oceanic and Atmospheric Administration, *Tides and Currents, Virginia Key, Florida*, Available at http://tidesandcurrents.noaa.gov/station_info.shtml?stn=8723214 Virginia Key, Florida, accessed February 2, 2008.

221. National Oceanic and Atmospheric Administration, *Tides and Currents, Vaca Key, Florida*. Available at http:/tidesandcurrents.noaa.gov/station_info.shtml?stn=8723970 Vaca Key, Florida, accessed February 2, 2008.

222. National Oceanic and Atmospheric Administration, *Tides and Currents, Key West, Florida*. Available at http:/tidesandcurrents.noaa.gov/station_info.shtml?stn=8724580 Key West, Florida, accessed February 2, 2008.

223. Ishman, S., *Ecosystem History of South Florida: Biscayne Bay Sediment Core Descriptions*, U.S. Geological Survey, Open-File Report 97-437, 1997.

224. Ruiz, P., and M. Ross, *Hydrological Restoration of the Biscayne Bay Coastal Wetlands: Mosquito and Drainage Ditch Inventory and Recommendations,* Southeast Environment Research Center, Florida International University, August 2004.

225. Comprehensive Everglades Restoration Project, *Biscayne Bay Coastal Wetlands.* Available at http://www.evergladesplan.org/pmprojects/proj_28_biscayne_bay.aspx, accessed November 12, 2008.

226. Federal Emergency Management Agency, *Flood Insurance Study,* Dade County, Florida and Incorporated Areas, March 1994.

227. South Florida Water Management District, *Draft Water Conservation Program Plan*, Fourth Iteration, April 2008.

228. South Florida Water Management District, *Application and Permit Information Database*. Available at http://my.sfwmd.gov/ePermitting/Login.do, accessed October 13, 2008.

229. Marella, R., *Water Withdrawals, Use, Discharge, and Trends in Florida,* 1995, U.S. Geological Survey, Water-Resources Investigations Report 99-4002, prepared in cooperation with the Florida Department of Environmental Protection, 1999.

230. Lietz, A., *Methodology for Estimating Nutrient Loads Discharged from the East Coast Canals to Biscayne Bay, Miami-Dade County, Florida,* U.S. Geological Survey, Water-Resources Investigations Report 99-4094, 1999.

PTN COL 2.4-1

Table 2.4.1-201
East Miami-Dade County Drainage Subbasin Areas and Outfall Structures

Subbasin Name	Major Canal	Drainage Area Square Miles	Outfall Structure	Structure Type	Design Headwater Stage Feet NGVD 29	Structure Design Discharge Cubic Feet per Second
C-9[a]	Snake Creek Canal (C-9)	98	S-29	Spillway, 4 gates	3.0	4780
C-8	Biscayne Bay Canal (C-8)	31.5	S-28	Spillway, 2 gates	2.3	3220
C-7	Little River Canal (C-7)	35	S-27	Spillway, 2 gates	3.2	2800
C-6	Miami Canal (C-6)	69	S-26 S-25B	Spillway, 2 gates Spillway, 2 gates	4.4 4.4	3400 2000
C-5	Comfort Canal (C-5)	2.3	S-25	Culvert	2.5	260
C-4	Tamiami Canal (C-4)[b]	60.9	S-25A	Gated Culvert	N/A[c]	N/A
C-3	Coral Gables Canal (C-3)	18	G-97	Weir	4.5	640
C-2	Snapper Creek Canal (C-2)	53	S-22	Spillway, 2 gates	3.5	1950
C-100	C-100 Canal	40.6	S-123	Spillway, 2 gates	2.0	2300
C-1	Black Creek Canal (C-1)	56.9	S-21	Spillway, 3 gates	1.9	2560
C-102	C-102 Canal	25.4	S-21A	Spillway, 2 gates	1.9	1330
C-103	Mowry Canal (C-103)	40.6	S-20F	Spillway, 3 gates	1.9	2900
Homestead	Military Canal	4.7	S-20G	Spillway, 1 gate	2.0	900
North Canal	North Canal[d]	7.8	S-20F	Spillway, 3 gates	1.9	2900
Florida City	Florida City Canal[e]	12.5	—	—	—	—
Model Land	Model Land Canal	28.1	S-20	Spillway, 1 gate	1.5	450
C-111	C-111 Canal	100	S-197	Gated Culvert	1.4	550

(a) Subbasin C-9 combines areas C-9 West and C-9 East, as shown in Figure 2.4.1-211
(b) Joins with Subbasins C-5 and C-6 and outflows through S-25 and S-25B
(c) N/A indicates data not available
(d) Outflows through S-20F
(e) No outflow structure; joins with L-31E Canal
Source: Reference 210

PTN COL 2.4-1

Table 2.4.1-202
Summary of Data Records for Gage Stations at S-197, S-20, S-21A, and S-21 Flow Control Structures

Struc-ture	Database Key[(a)]	Station[(b)]	Latitude[(c)]	Subbasin	Subbasin[(d)]	Data Type[(e)]	Fre-quency	Statis-tics	Agency	Start Date	End Date
S-197	04994	S197_C	251713.4	802629.2	MODEL	FLOW	Daily	Mean	SFWMD	6/23/1969	3/30/2000
	HA458	S197_C	251713.4	802629.2	MODEL	FLOW	Daily	Mean	SFWMD	12/31/1997	Ongoing
	15763	S197_C	251713.4	802629.2	MODEL	FLOW	Daily	Mean	SFWMD	1/1/1970	Ongoing
	04990	S197_H	251713.4	802629.2	MODEL	STG	Daily	Mean	SFWMD	6/23/1969	4/28/1993
	13093	S197_H	251713.4	802629.2	MODEL	STG	Daily	Mean	SFWMD	9/21/1990	6/29/1999
	HA459	S197_H	251713.4	802629.2	MODEL	STG	Daily	Mean	SFWMD	1/29/1998	Ongoing
S-20	13037	S20_H	252201.4	802235.2	FLA CITY	STG	Daily	Mean	SFWMD	5/30/1990	Ongoing
	03846	S20_H	252201.4	802235.2	FLA CITY	STG	Daily	Mean	SFWMD	12/28/1967	5/26/1992
	13036	S20_S	252201.4	802235.2	FLA CITY	FLOW	Daily	Mean	SFWMD	5/30/1990	Ongoing
	03850	S20_S	252201.4	802235.2	FLA CITY	FLOW	Daily	Mean	SFWMD	2/29/1968	8/26/1991
S-21A	04708	S21A_H	253109.4	802046.2	C1	STG	Daily	Mean	SFWMD	8/18/1972	1/30/1990
	06601	S21A_H	253109.4	802046.2	C1	STG	Daily	Mean	SFWMD	8/31/1985	Ongoing
	04712	S21A_S	253109.4	802046.2	C1	FLOW	Daily	Mean	SFWMD	1/16/1974	1/30/1990
	06777	S21A_S	253109.4	802046.2	C1	FLOW	Daily	Mean	SFWMD	8/31/1985	Ongoing
S-21	06597	S21_H	253235.5	801951.4	DA-4	STG	Daily	Mean	SFWMD	1/17/1984	Ongoing
	00677	S21_H	253235.5	801951.4	DA-4	STG	Daily	Mean	USGS	10/1/1967	10/20/2004
	06776	S21_S	253235.5	801951.4	DA-4	FLOW	Daily	Mean	SFWMD	1/17/1984	Ongoing
	00679	S21_S	253235.5	801951.4	DA-4	FLOW	Daily	Mean	USGS	11/1/1969	9/30/2004

(a) Record identification number for SFWMD DBHYDRO database
(b) Suffix designation: C – Culvert, H – Headwaters, S – Spillway
(c) Latitude/longitude format: ddmmss.s, dd – Degrees, mm – Minutes, ss.s – Seconds, latitudes in degrees North, longitudes in degrees West
(d) MODEL - Model Land subbasin, FLA CITY – Florida City subbasin, C1 – C1 subbasin, DA-4 – Dade subbasin 4
(e) Flow – flow discharge, STG – stage
Source: Reference 212

PTN COL 2.4-1

Table 2.4.1-203 (Sheet 1 of 2)
Monthly Mean Flows at the Canal C-111 Structure S-197

YEAR	Monthly Mean in Cubic Feet per Second											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	0	0	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	19.278	96.74	45	15.411	8.538	4.083	0	0
1973	0	0	0	0	0	0	3.64	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	4.905	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	79.304	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	26.519	17.269	0	0
1979	0	0	0	0	65.356	0	0	0	47.398	49.93	0	0
1980	0	0	0	0	0	0	76.507	78.337	240.179	29.640	112.646	0
1981	0	52.891	0	0	0	0	0	239.978	536.729	105.378	0	0
1982	0	0	0	0	0	170.247	28.94	0	63.522	129.102	144.590	0
1983	96.527	373.798	452.039	79.333	0	334.074	100.896	157.914	328.885	12.586	0	0
1984	0	0	51.403	0	82.276	0	116.553	43.698	14.174	0	0	0
1985	0	0	0	0	0	0	60.308	0	134.999	0	0	0
1986	0	0	0	0	0	60.811	0	290.441	110.000	0	8.963	6.990
1987	58.032	0	0	0	0	0	0	0	41.852	250.42	92.859	0
1988	0	0	0	0	0	342.095	0	916.717	39.972	92.99	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	46.051	0	0
1992	0	0	0	0	0	459.429	94.048	115.695	82.059	0	0	0
1993	0	0	0	0	0	0	0	0	0	41.968	0	0
1994	0	0	0	0	0	0	0	0	74.269	95.552	332.916	0
1995	0	0	0	0	0	341.752	125.366	269.349	122.944	690.039	8.278	0

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Table 2.4.1-203 (Sheet 2 of 2)
Monthly Mean Flows at the Canal C-111 Structure S-197

YEAR	Monthly Mean in Cubic Feet per Second											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1996	0	0	0	0	0	257.087	8.231	0	0	178.448	0	0
1997	0	0	0	0	0	505.727	0	0	82.344	0	0	16.801
1998	0	0	0	0	0	0	0	0	472.435	0	27.967	0
1999	0	0	0	0	0	0	0	0	74.81	608.412	0	0
2000	0	0	0	0	0	0	0	0	21.391	393.893	0	0
2001	0	0	0	0	0	0	0	80.273	40.494	219.259	0	0
2002	0	0	0	0	0	134.37	132.425	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	30.410	26.294	0	0
2004	0	0	0	0	0	0	0	0	0	38.366	0	0
2005	0	0	0	0	0	113.481	0	444.112	349.756	167.782	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	24.685	0	0	0	113.736	0	0
2008	0	0	0	0	0	0	0	70.182	—[(a)]	—	—	—
Mean	3.963	10.941	12.909	2.034	4.280	74.867	20.303	69.923	77.465	87.137	19.164	0.626

(a) — Indicates data not available when retrieved from SFWMD database (Reference 212)

Source: Reference 212

PTN COL 2.4-1

Table 2.4.1-204 (Sheet 1 of 2)
Monthly Mean Water Level at the Canal C-111 Structure S-197 (Headwater)

Year	Monthly Mean in Feet NGVD 29											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970	1.518	1.506	1.290	0.732	0.232	1.346	1.513	1.316	1.350	1.519	1.464	1.207
1971	0.851	0.619	0.136	–0.467	–0.535	0.461	1.224	1.278	1.451	1.519	1.529	1.407
1972	1.348	1.315	1.148	1.284	1.364	1.717	1.660	1.490	1.675	1.667	1.654	1.512
1973	1.465	1.407	1.188	0.790	0.376	0.760	1.477	1.676	1.721	1.690	1.538	1.375
1974	1.389	1.027	0.348	–0.239	–0.072	1.076	1.347	1.444	1.477	1.580	1.387	1.395
1975	1.197	0.856	0.231	–0.468	0.375	1.179	1.628	1.574	1.497	1.516	1.513	1.289
1976	1.011	0.905	0.733	0.594	1.041	1.697	1.485	1.706	1.778	1.617	1.499	1.389
1977	1.414	1.328	1.114	0.521	1.267	1.593	1.388	1.483	1.866	1.679	1.565	1.608
1978	1.556	1.611	1.590	1.334	1.505	1.629	1.749	1.728	1.999	1.995	1.832	1.608
1979	1.579	1.415	1.009	0.503	1.697	1.625	1.581	1.603	1.820	1.934	1.682	1.723
1980	1.594	1.620	1.476	1.359	1.328	1.736	1.749	1.778	1.865	1.893	1.838	1.797
1981	1.617	1.592	1.565	0.976	0.536	1.133	1.317	1.536	1.929	1.791	1.774	1.558
1982	1.366	1.168	0.940	1.038	1.477	1.741	1.593	1.686	1.796	2.079	2.014	1.805
1983	1.848	2.122	2.107	2.161	1.549	1.955	1.807	2.030	2.272	2.161	2.004	1.698
1984	1.576	1.372	1.289	1.248	0.922	1.773	1.912	2.099	2.150	2.094	1.759	1.612
1985	1.472	1.354	1.226	1.336	1.257	1.346	2.023	2.215	2.358	2.522	2.310	1.900
1986	1.862	1.548	1.552	1.664	1.245	1.847	2.315	2.353	2.405	1.914	1.818	1.854
1987	1.952	1.607	1.782	1.466	1.482	1.414	1.713	1.841	2.091	2.633	2.621	2.381
1988	1.953	1.623	1.357	0.927	1.564	2.350	2.629	2.309	2.627	2.455	1.883	1.664
1989	1.488	1.205	1.028	1.279	1.155	1.025	1.792	1.983	2.032	1.801	1.661	1.560
1990	1.334	1.014	0.972	1.034	0.859	1.492	1.548	2.160	2.095	2.147	1.707	1.614
1991	1.529	1.345	1.350	1.172	1.335	2.170	1.965	2.021	2.493	2.594	2.114	1.715
1992	1.617	1.583	1.396	1.305	0.857	1.848	2.145	1.982	2.428	2.068	2.120	1.830
1993	2.138	1.821	1.667	1.555	1.290	2.121	2.018	2.014	2.316	2.472	2.224	1.722
1994	1.721	1.937	1.852	1.537	1.785	1.992	1.595	2.078	2.569	2.531	2.414	2.500
1995	2.445	2.122	1.899	1.685	1.962	2.194	2.427	2.549	2.656	2.603	2.392	1.931

PTN COL 2.4-1

Table 2.4.1-204 (Sheet 2 of 2)
Monthly Mean Water Level at the Canal C-111 Structure S-197 (Headwater)

Year	Monthly Mean in Feet NGVD 29											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1996	1.894	1.602	1.421	1.093	1.339	2.271	2.043	1.811	2.167	2.400	1.929	1.687
1997	1.684	1.654	1.382	1.144	1.354	2.385	2.258	2.356	2.574	2.275	1.760	2.185
1998	1.928	2.180	2.268	2.016	1.962	1.743	1.719	2.103	2.195	2.373	2.281	1.937
1999	1.926	1.718	1.441	0.877	1.035	1.957	2.152	2.217	2.521	2.549	2.379	2.172
2000	2.190	2.125	1.878	1.796	1.319	1.801	2.117	2.431	2.519	2.514	1.996	1.949
2001	1.648	1.314	1.116	0.832	1.212	1.253	1.994	2.368	2.433	2.560	2.446	2.229
2002	2.078	1.777	1.586	1.110	0.709	2.231	2.507	2.369	2.368	2.023	1.710	1.905
2003	1.605	1.326	1.423	1.763	1.953	2.376	2.073	2.396	2.583	2.411	2.419	2.266
2004	1.856	1.941	1.560	1.140	0.976	0.827	1.239	2.257	2.349	2.269	2.253	1.939
2005	1.640	1.503	1.439	1.450	1.399	2.321	2.422	2.445	2.732	2.645	2.354	2.230
2006	1.797	1.584	1.360	1.337	1.208	1.551	2.340	2.308	2.540	2.233	1.906	1.711
2007	1.666	1.595	1.531	1.596	1.715	2.311	2.547	2.291	2.169	2.519	2.189	1.765
2008	1.600	1.528	1.343	1.597	1.255	1.593	2.152	2.345	2.456	—(a)	—	—
Mean	1.650	1.509	1.333	1.130	1.161	1.688	1.876	1.990	2.162	2.138	1.946	1.780

(a) — Indicates data not available when retrieved from SFWMD database (Reference 212)

Source: Reference 212

PTN COL 2.4-1

Table 2.4.1-205 (Sheet 1 of 2)
Monthly Mean Flows in the Canal L-31E at Structure S-20

YEAR	Monthly Mean in Cubic Feet per Second											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	N/A[(a)]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.2	0
1969	1.507	0	25.242	4.747	0	42.24	32.724	0	106.301	80.99	284.187	
1970	0	0	0	0	0	4.567	–0.173	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0.289	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0.777	0.052	1.165	0.085
1975	0	0	0	0	0	0	0.078	0	0.17	0	0	0
1976	0	0	0	0	0	0	0	3.701	75.683	0.243	0	0
1977	0	0	0	0	30.657	59.678	0	0	116.304	9.482	0	0
1978	0	0	0	0	0	4.948	1.159	16.284	21.56	45.93	24.549	0
1979	0	0	0	0	0	0	0	8.022	57.789	80.121	0	0
1980	23.595	0	0	0	0	59.211	35.737	26.648	45.653	40.799	26.491	0
1981	0	0	0	0	0	0	0	105.314	128.263	83.247	0	0
1982	0	0	0	0	0	40.808	0	0	0	11.921	0	0
1983	40.372	0	0	0	2.832	0	0	0	106.754	0	0.219	0
1984	0	0	0	0	0	0	0	0	0.582	38.388	0	0
1985	0	0	0	0	0	0	57.109	58.302	22.063	38.642	0	0
1986	0	0	0	0	0	15.749	41.475	0.087	0	15.926	1.833	0
1987	43.152	0	23.583	0.016	0	0	0	0	22.114	106.246	46.753	0
1988	0	0	0	0	0	161.759	149.41	179.534	38.577	0	0	0
1989	0	0	0	0	0	0	0	38.758	0.219	0	0	0
1990	0	0	0	0	0	0	0	106.017	45.836	10.81	0	0
1991	0	0.095	0.159	2.227	0.251	0	0	0	0	149.682	49.295	
1992	N/A	0	2.307	0	0	81.074	149.633	62.117	86.822	0	0	0
1993	0	0	0	0	0	0	0	25.621	57.057	N/A	N/A	N/A

PTN COL 2.4-1

Table 2.4.1-205 (Sheet 2 of 2)
Monthly Mean Flows in the Canal L-31E at Structure S-20

YEAR	Monthly Mean in Cubic Feet per Second											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	N/A	N/A	0	0	0	0	0	0.115	63.734	108.26	103.73	70.832
1995	0	0	0.868	0	0	95.945	57.231	90.961	109.186	201.169	28.057	0
1996	0	0	0	0	0	187.071	114.843	0.298	0	49.303	0	0.033
1997	0	0.078	0	0	0	603.788	0	143.963	399.966	7.812	0	63.708
1998	0	17.561	0	0	0	N/A	N/A	N/A	N/A	0	0.027	0.038
1999	N/A	N/A	N/A	0	0	59.886	22.741	52.061	52.330	119.456	42.276	0.188
2000	1.274		0	0	0	0	0	0	51.708	76.003	–4.708	0
2001	0	0	0	0	0	20.359	21.717	51.343	76.752	31.414	19.377	0
2002	–4.001	0	0	0	0	102.642	129.294	0.003	0	0	0.000	0.042
2003	0.003	0.010	0	0	0	0	0.001	0	39.591	60.012	51.666	0.023
2004	0.066	0	0.052	0	0	0	0.001	0	0	0	N/A	N/A
2005	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2006	0	0	0	0	0	0	108.994	0.008	0.000	0.035	0.001	0
2007	0	0	0	0	0	88.319	76.108	0	35.958	–19.527	N/A	N/A
2008	0	0	0	0	0	0	0	102.019	0	—[(b)]	—	—
Mean	3.117	0.522	1.450	0.189	0.912	45.230	27.733	29.755	48.937	38.469	19.945	4.217

(a) N/A indicates data not available
(b) — Indicates data not available when retrieved from SFWMD database (Reference 212)

Source: Reference 212

PTN COL 2.4-1

Table 2.4.1-206 (Sheet 1 of 2)
Monthly Mean Water Levels in the Canal L-31E at Structure S-20 (Headwaters)

YEAR	Monthly Mean in feet NGVD 29											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	0.924	0.785	0.574	0.216	1.697	2.092	2.096	1.763	1.877	2.454	1.469	1.016
1969	1.272	1.089	1.232	1.121	1.277	2.006	1.744	1.557	1.846	2.004	1.873	1.404
1970	1.228	1.210	0.867	0.496	0.435	1.566	1.622	1.205	1.485	1.783	1.473	1.067
1971	0.790	0.761	0.401	–0.040	–0.102	0.793	1.295	1.465	1.617	1.755	1.901	1.550
1972	1.379	1.320	1.003	1.333	1.480	1.832	1.678	1.532	1.958	1.894	1.855	1.473
1973	1.496	1.496	1.356	1.258	0.826	1.004	1.853	1.788	2.091	2.175	1.875	1.600
1974	1.382	1.014	0.706	0.594	0.902	1.428	1.811	1.869	1.800	2.299	1.823	1.702
1975	1.364	1.234	0.968	0.551	1.082	1.601	2.265	1.977	1.827	1.801	1.800	1.451
1976	1.132	0.984	0.956	0.982	1.230	2.230	1.964	1.948	2.087	1.954	1.655	1.424
1977	1.318	1.230	1.209	0.982	1.754	1.844	1.506	1.762	2.071	1.994	1.806	1.732
1978	1.491	1.566	1.535	1.344	1.592	1.949	1.846	1.889	2.110	2.259	2.179	1.731
1979	1.645	1.234	1.015	0.803	1.762	1.883	1.592	1.642	2.054	2.153	1.947	1.807
1980	1.523	1.617	1.312	1.412	1.285	1.925	2.036	2.018	2.132	2.045	2.067	1.830
1981	1.432	1.505	1.342	0.956	1.030	1.318	1.367	2.010	2.354	2.408	2.348	1.683
1982	1.140	1.194	1.092	1.459	1.854	2.192	2.039	2.079	1.894	2.336	2.350	1.927
1983	1.814	2.101	1.809	1.422	0.902	1.729	1.870	2.041	2.170	2.278	2.064	1.592
1984	1.587	1.321	1.318	1.186	1.066	2.177	2.191	2.125	2.202	2.273	1.980	1.639
1985	1.429	1.378	1.390	1.300	1.488	1.685	2.212	2.184	2.378	2.334	2.058	1.895
1986	1.731	1.390	1.356	1.486	1.432	1.967	1.944	1.978	2.137	2.029	1.830	1.944
1987	1.901	1.539	1.831	1.441	1.618	1.632	1.886	2.063	2.108	2.384	2.301	1.946
1988	1.748	1.564	1.362	1.228	1.825	2.289	2.256	2.335	2.123	2.237	1.933	1.590
1989	1.406	1.339	1.355	1.504	1.548	1.548	2.073	2.198	2.224	2.154	1.886	1.722
1990	1.513	1.338	1.433	1.508	1.414	1.900	2.035	2.149	2.023	2.083	1.918	1.564
1991	1.355	1.242	1.358	1.233	1.380	2.260	2.004	1.730	2.260	2.529	2.207	1.636
1992	1.507	1.495	1.303	1.436	1.104	2.018	2.228	1.847	1.808	2.090	1.872	1.592
1993	1.951	1.789	1.450	1.459	1.253	2.179	1.892	2.072	2.057	2.197	1.728	1.624

PTN COL 2.4-1

Table 2.4.1-206 (Sheet 2 of 2)
Monthly Mean Water Levels in the Canal L-31E at Structure S-20 (Headwaters)

YEAR	Monthly Mean in feet NGVD 29											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	1.688	1.784	1.782	1.351	1.674	2.031	1.670	1.961	2.201	2.295	2.391	2.083
1995	1.814	1.467	1.495	1.399	1.708	2.150	2.140	2.141	2.267	2.332	1.985	1.598
1996	1.640	1.378	1.242	1.137	1.428	2.039	1.901	1.730	2.156	2.235	1.985	1.655
1997	1.760	1.782	1.342	1.364	1.720	2.291	2.159	2.082	2.158	2.124	1.775	1.963
1998	1.739	2.067	1.955	1.412	1.359	1.658	1.684	1.952	2.069	1.966	2.063	1.724
1999	1.716	1.443	1.213	0.969	1.433	2.181	2.010	2.159	2.282	2.679	2.085	1.758
2000	1.380	1.230	1.347	1.211	1.782	2.063	2.022	2.096	2.435	1.771	1.964	0.000
2001	1.615	1.158	1.233	1.099	1.599	1.631	2.125	1.997	2.073	2.216	2.179	1.737
2002	1.411	1.417	1.475	1.162	1.167	2.172	2.055	2.047	2.101	1.802	1.787	1.724
2003	1.356	1.232	1.365	1.653	1.789	1.948	1.698	1.924	2.118	1.937	2.050	1.729
2004	1.458	1.626	1.305	1.188	1.170	0.980	1.296	1.846	1.958	2.034	1.932	1.446
2005	1.275	1.303	1.211	1.240	1.302	2.127	2.025	2.180	2.300	2.035	1.533	1.371
2006	1.227	1.321	1.086	1.355	1.413	1.980	1.880	1.914	1.989	2.051	1.804	1.659
2007	1.553	1.491	1.266	1.682	1.914	2.205	2.066	2.049	2.083	2.375	N/A[a]	N/A
2008	1.437	1.409	1.378	1.437	1.263	1.658	1.921	1.988	2.108	—[b]	—	—
Mean	1.476	1.386	1.274	1.179	1.362	1.858	1.901	1.934	2.073	2.144	1.942	1.605

(a) N/A indicates data not available
(b) — Indicates data not available when retrieved from SFWMD database (Reference 212)

Source: Reference 212

PTN COL 2.4-1

Table 2.4.1-207 (Sheet 1 of 2)
Monthly Mean Flows in the Princeton Canal at Structure S-21A

YEAR	Monthly Mean in Cubic Feet per Second											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974	9.435	0	0	0	0	0	32.84	55.339	54.278	49.674	75.27	82.035
1975	4.747	0	0	0	0	3.025	95.608	35.223	30.335	33.959	20.947	1.215
1976	0	7.712	0	0	18.548	117.709	44.113	73.103	83.76	38.139	35.222	32.355
1977	2.655	4.198	0	0	64.372	112.828	64.626	83.935	176.795	65.827	45.415	19.826
1978	20.417	38.995	37.522	43.604	38.447	102.558	84.474	59.364	N/A[(a)]	N/A	N/A	N/A
1979	N/A	N/A	13.417	68.191	1051.47	307.851	375.055	372.993	98.64	376.168	320.883	294.474
1980	67.74	21.967	56.912	57.65	13.838	210.051	179.707	187.95	114.565	153.029	195.734	102.176
1981	44.347	51.843	37.898	10.1	0	0	0	383.346	285.008	73.878	119.334	23.698
1982	0.007	11.398	0.647	125.831	83.497	313.143	153.097	154.617	100.653	215.819	250.798	102.82
1983	189.691	469.708	1333.76	334.007	57.05	99.966	60.42	160.741	274.665	139.755	111.76	93.85
1984	70.448	74.615	81.103	63.543	27.797	94.174	142.746	41.639	69.896	73.726	79.649	66.527
1985	27.484	3.726	21.169	4.88	6.728	8.845	62.25	22.043	31.973	25.926	14.955	45.541
1986	78.845	27.175	61.792	31.395	1.78	57.659	33.898	58.089	107.032	52.864	69.996	60.653
1987	50.722	24	59.869	8.248	8.674	15.223	92.143	57.107	126.581	189.892	164.684	94.396
1988	47.966	33.688	31.374	0.239	40.66	258.467	68.005	212.75	34.153	55.578	32.958	11.474
1989	21.769	12.651	9.38	33.061	17.165	2.189	33.193	84.996	39.75	47.731	28.744	9.885
1990	0	0	8.298	29.27	34.061	36.054	88.441	137.671	87.143	123.553	53.003	4.9
1991	0	0.76	7.084	1.446	86.171	172.545	100.563	63.064	121.688	253.953	107.368	75.455
1992	64.85	52.447	54.478	54.825	1.999	382.2	96.134	243.132	127.167	122.511	221.32	86.207
1993	171.185	68.823	78.011	69.455	55.609	143.798	73.026	43.203	105.048	182.708	135.688	91.928
1994	85.937	152.05	83.005	99.623	56.702	73.905	46.621	122.298	196.47	137.074	381.629	128.094
1995	117.867	44.154	39.982	51.118	79.55	238.251	124.943	179.08	151.179	346.364	120.264	52.75
1996	66.487	35.889	30.943	18.43	63.053	269.232	83.949	99.303	115.444	185.69	66.505	30.116
1997	107.126	33.513	23.898	28.421	10.995	350.415	61.169	118.172	232.901	92.902	68.711	132.915
1998	67.46	118.244	130.06	43.857	7.093	9.721	31.652	138.74	275.595	98.768	186.898	49.636
1999	96.239	55.918	28.174	0.003	6.797	183.58	105.567	152.807	247.516	507.426	136.659	128.483

PTN COL 2.4-1

Table 2.4.1-207 (Sheet 2 of 2)
Monthly Mean Flows in the Princeton Canal at Structure S-21A

YEAR	Monthly Mean in Cubic Feet per Second											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	97.294	80.866	56.941	63.135	17.474	67.439	108.355	131.344	138.044	474.344	79.037	223.266
2001	55.809	16.575	34.604	25.216	38.249	82.513	157.76	169.212	321.322	382.933	201.383	110.312
2002	75.508	74.604	102.733	30.66	5.745	280.486	364.62	80.11	369.277	123.284	147.597	107.289
2003	34.029	7.663	65.534	90.772	164.064	226.718	70.154	240.216	237.285	162.985	231.379	112.74
2004	114.212	121.945	54.576	14.329	1.654	0.009	44.222	183.182	225.799	285.275	147.807	103.87
2005	55.799	33.831	52.935	17.276	19.514	365.851	145.679	423.939	408.996	253.485	161.395	56.957
2006	67.375	94.428	66.376	42.824	44.279	46.991	180.394	117.288	185.094	102.259	108.915	93.871
2007	68.548	67.974	17.493	40.3	45.059	186.579	176.821	78.382	141.404	203.069	135.269	26.473
2008	8.28	5.932	19.43	72.587	11.467	110.57	103.732	217.908	122.309	—[b]	—	—
Mean	58.538	54.332	77.126	44.980	62.273	140.873	105.314	142.351	159.934	170.623	129.005	80.491

(a) N/A indicates data not available
(b) — Indicates data not available when retrieved from SFWMD database (Reference 212)

Source: Reference 212

PTN COL 2.4-1

Table 2.4.1-208 (Sheet 1 of 2)
Monthly Mean Water Levels in the Princeton Canal at Structure S-21A (Headwaters)

YEAR	Monthly Mean in Feet NGVD 29											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974	1.332	1.129	1.138	0.815	0.959	1.213	1.383	1.555	1.725	1.901	2.253	0.76
1975	1.475	1.187	0.842	0.42	0.528	N/A[(a)]	N/A	N/A	N/A	N/A	N/A	N/A
1976	N/A	1.731	1.827	1.914	2.001	2.088	2.168	2.158	2.137	2.116	2.096	2.022
1977	1.579	1.6	1.174	1.016	1.433	1.496	1.628	1.763	2.147	2.218	2.095	1.846
1978	1.694	1.558	1.754	1.783	1.895	1.975	1.989	1.992	1.968	1.947	1.742	1.721
1979	1.683	1.463	1.345	0.744	1.157	1.369	1.689	2.014	2.245	2.086	1.609	2.028
1980	1.761	1.765	1.683	1.666	1.922	1.801	1.819	1.97	1.945	1.819	1.665	1.566
1981	1.4	1.453	1.454	1.538	1.262	1.44	2.134	2.087	1.684	1.665	2.071	1.903
1982	2.068	1.969	1.73	1.786	1.762	1.576	1.732	1.953	2.169	2.073	1.928	1.579
1983	1.659	1.106	1.466	1.458	1.512	1.603	1.504	1.695	1.498	1.878	N/A	N/A
1984	N/A	N/A	N/A	1.369	1.314	1.208	1.398	2.145	2.113	1.998	1.931	1.73
1985	1.553	1.556	1.501	1.722	1.623	1.738	1.69	1.501	1.832	1.931	1.815	1.803
1986	1.584	1.391	1.591	1.543	1.84	1.912	1.985	2.058	2.13	2.151	1.909	1.629
1987	1.535	1.941	1.629	1.724	1.839	1.905	1.97	2.037	2.103	2.023	1.727	1.522
1988	1.611	1.66	1.709	1.834	2.025	1.798	1.714	1.692	2.036	2.098	1.443	1.598
1989	1.759	1.689	1.598	1.557	1.736	1.759	1.793	1.828	1.863	1.868	1.818	1.536
1990	1.746	1.595	1.773	1.694	1.636	2.098	2.051	1.999	2.056	1.847	1.891	1.89
1991	1.722	1.719	1.866	1.714	1.616	2.056	2.07	2.09	2.061	1.864	1.613	1.373
1992	1.534	1.619	1.668	1.684	1.609	1.682	2.038	1.885	1.913	1.782	1.449	1.284
1993	1.318	1.57	1.493	1.655	1.818	1.941	2.077	2.106	2.046	1.753	1.376	1.356
1994	1.284	1.444	1.497	1.55	2.039	2.078	2.089	2.046	1.682	1.484	1.528	1.433
1995	1.254	1.437	1.685	1.675	1.77	1.787	1.864	1.582	1.659	1.571	1.206	1.619
1996	1.677	1.705	1.608	1.705	2.041	1.736	1.818	2.047	1.94	1.548	1.459	1.64
1997	1.416	1.719	1.728	1.723	2.086	1.801	2.037	2.03	1.843	1.701	1.433	1.439
1998	1.66	1.373	1.486	1.537	2.002	2.045	2.113	1.668	1.802	1.7	1.35	1.726
1999	1.615	1.663	1.717	1.734	1.969	1.727	1.957	1.955	1.934	1.869	1.409	1.303

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Table 2.4.1-208 (Sheet 2 of 2)
Monthly Mean Water Levels in the Princeton Canal at Structure S-21A (Headwaters)

YEAR	Monthly Mean in Feet NGVD 29											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	1.434	1.654	1.68	1.728	1.923	1.968	2.043	1.997	2.017	1.711	1.45	1.597
2001	1.681	1.733	1.71	1.717	2.064	2.062	1.999	1.555	1.608	1.693	1.515	1.309
2002	1.457	1.634	1.616	1.698	1.614	1.599	1.646	2.074	1.624	1.393	1.303	1.277
2003	1.622	1.949	1.834	1.666	1.63	1.514	1.663	1.526	1.621	1.524	1.495	1.311
2004	1.275	1.348	1.682	1.733	1.941	1.463	1.73	1.476	1.394	1.523	1.384	1.261
2005	1.502	1.724	1.695	1.726	1.997	1.518	1.885	1.908	1.607	1.646	1.46	1.967
2006	1.66	1.654	1.665	1.815	1.875	2.094	1.732	1.862	2.018	1.731	1.364	1.425
2007	1.668	1.67	1.812	2.039	2.114	1.998	2.002	2.068	2.003	1.78	1.451	1.846
2008	1.816	1.721	1.911	1.894	2.003	1.998	2.04	1.791	1.867	—[(b)]	—	—
Mean	1.577	1.592	1.605	1.588	1.730	1.766	1.866	1.886	1.891	1.815	1.632	1.572

(a) N/A indicates data not available
(b) — Indicates data not available when retrieved from SFWMD database (Reference 212)

Source: Reference 212

PTN COL 2.4-1

Table 2.4.1-209 (Sheet 1 of 2)
Monthly Mean Flows in the Black Creek Canal at Structure S-21

YEAR	Monthly Mean in Cubic Feet per Second											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1969	N/A[(a)]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	363.533	203.935
1970	113.071	86.357	87.516	3.667	32.742	223.973	405.839	136.645	144.733	199.161	113.723	5.71
1971	0	0	0	0	0	11.4	38.977	206.452	433.767	141.00	161.8	56.194
1972	23.742	17.586	31.645	26.88	152.213	392.303	206.742	170.774	249.433	173.613	150.133	71.348
1973	49.839	54.571	9.935	3.523	0	10.5	94.742	299.419	334.667	159.29	43.053	10.806
1974	64.00	0	0	0	0	0	152.871	123.103	135.767	189.419	76.113	71.452
1975	1.677	0	0	0	4.323	62.08	195.323	132.29	126.833	212.452	184.2	45.71
1976	0	19.041	3.774	0	72.548	403.567	146.774	322.29	373.1	133.355	156.533	81.00
1977	82.871	39.336	3.548	0	337.871	256.533	212.935	208.806	714.2	227.71	169.133	149.706
1978	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	286.452	266.867	53.077
1979	39.742	2.118	0.742	147.133	376.935	121.4	168.226	126.129	342.033	348.968	87.667	115.574
1980	83.00	81.807	55.581	70.833	102.323	263.8	206.968	268.516	320.7	165.226	193.333	60.00
1981	28.419	80.036	26.903	0	0	0	0	551.645	791.133	303.129	142.473	66.839
1982	81.161	146.786	81.174	236.367	187.329	417.567	153.903	231.968	496.067	318.935	367.033	144.194
1983	109.871	325.332	387.806	190.7	42.774	1151.23	184.968	433.868	459.6	316.29	126.667	86.29
1984	46.903	31.966	127.577	31.583	136.739	355.8	463.613	516.097	558.567	595.677	26.067	0
1985	0	0.304	0.003	0	0	11.647	245.968	135.132	195.9	143.968	139.593	135.384
1986	89.077	9.621	89.677	20.667	25.842	146.213	95.161	130.929	108.333	73.032	50.967	77.935
1987	85.839	44.893	47.226	28.467	53.29	7.467	42.161	10.226	83.133	219.226	69.138	46.903
1988	25.774	14.759	8.871	4.333	59.8	531.967	153.323	422.467	46.367	70.867	24.207	3.567
1989	4.1	4.607	3.733	2.933	57.259	15.133	63.00	52.129	33.2	38.097	30.233	13.355
1990	34.52	149.292	256.088	160.496	33.442	317.631	131.319	198.869	94.819	146.608	35.793	7.291
1991	0.484	0.357	0.286	14.881	48.113	207.505	179.625	284.815	375.555	528.618	116.626	4.474
1992	0.381	1.42	15.937	13.568	7.465	347.896	171.25	192.409	474.359	89.909	226.841	29.021
1993	222.444	47.409	44.073	110.976	85.589	354.5	119.3	90.136	152.886	342.589	109.203	9.018
1994	43.762	174.738	71.703	60.836	110.167	167.21	89.916	271.454	594.523	575.636	662.847	268.017

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Table 2.4.1-209 (Sheet 2 of 2)
Monthly Mean Flows in the Black Creek Canal at Structure S-21

YEAR	Monthly Mean in Cubic Feet per Second											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995	367.651	226.985	80.073	65.508	106.159	450.776	403.799	619.149	566.021	832.155	396.028	81.116
1996	94.213	56.224	32.052	0	84.74	588.074	207.946	126.247	266.319	176.66	169.56	10.228
1997	28.792	11.903	0	16.576	73.356	24.883	186.66	252.386	464.535	166.624	24.263	239.284
1998	208.252	351.905	334.38	133.637	129.326	31.362	128.917	109.435	152.856	408.19	451.057	94.114
1999	228.022	91.506	23.212	6.516	51.438	306.899	273.907	341.364	249.443	–199.16	184.773	36.565
2000	22.748	37.451	24.186	71.223	18.967	60.176	195.201	283.803	194.159	323.833	49.375	190.364
2001	21.085	0	2.363	12.046	85.385	80.084	290.448	528.428	312.307	332.213	118.061	116.599
2002	157.957	69.728	212.451	13.274	6.501	321.608	655.617	475.612	429.076	150.229	349.113	285.442
2003	118.357	50.457	89.819	80.03	421.771	648.237	298.798	488.602	586.424	384.12	430.864	51.456
2004	15.993	234.295	20.356	4.065	33.779	0.119	15.127	551.962	468.00	461.935	424.301	229.754
2005	3.429	0	6.63	1.704	33.513	576.389	566.696	248.34	430.815	343.049	65.844	157.406
2006	72.209	53.517	26.728	15.268	24.845	25.007	473.775	339.882	546.94	263.886	149.359	65.278
2007	15.796	12.107	0.003	54.565	18.664	398.945	192.742	83.746	172.323	470.974	287.835	9.794
2008	6.197	21.613	6.103	62.842	16.64	231.963	372.791	593.504	367.183	—[b]	—	—
Mean	68.194	67.106	58.215	43.818	79.785	250.575	215.403	277.869	338.055	266.156	184.467	86.774

(a) N/A indicates data not available
(b) — Indicates data not available when retrieved from SFWMD database (Reference 212)

Source: Reference 212

PTN COL 2.4-1

Table 2.4.1-210 (Sheet 1 of 2)
Monthly Mean Water Levels in the Black Creek Canal at Structure S-21

YEAR	Monthly Mean in Feet NGVD 29											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1969	1.784	1.799	1.747	1.867	1.792	1.798	1.972	2.015	2.062	2.064	2.043	1.796
1970	2.043	2.052	2.064	2.182	1.794	1.995	2.026	2.144	2.154	2.153	2.196	2.192
1971	1.905	1.659	1.279	0.768	0.564	1.41	2.192	2.162	2.042	2.082	2.111	2.177
1972	2.198	2.157	2.042	1.887	1.961	1.942	1.909	1.973	2.013	2.002	1.971	2.033
1973	2.06	2.041	2.107	1.611	1.075	1.176	1.99	1.931	1.946	1.995	2.046	2.024
1974	2.012	2.042	1.42	0.858	0.793	1.643	2.006	2.025	2.028	2.073	2.11	2.072
1975	2.257	1.944	1.467	0.752	1.193	2.092	1.928	2.059	2.008	2.015	2.029	2.133
1976	2.144	2.017	2.059	1.565	1.93	1.933	2.088	1.959	1.927	2.008	2.076	2.162
1977	2.197	2.26	2.207	1.669	1.795	1.901	1.994	1.948	1.928	1.949	1.969	1.909
1978	N/A[(a)]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.157	2.13	2.197
1979	2.244	2.203	1.934	1.476	2.066	2.175	2.105	2.148	2.079	2.135	2.274	2.213
1980	2.26	2.276	2.282	2.304	2.319	2.194	2.135	2.136	2.118	2.175	2.159	2.238
1981	2.349	2.239	2.32	1.932	1.695	1.965	2.197	2.005	1.95	2.202	2.459	2.116
1982	1.903	1.925	1.946	1.916	2.079	2.109	2.12	1.94	2.221	2.07	2.089	2.237
1983	2.07	1.886	1.843	1.668	1.863	1.842	2.221	2.166	1.876	2.029	1.833	1.818
1984	1.891	1.917	1.905	1.986	1.736	2.119	2.021	2.103	2.145	2.152	2.253	2.23
1985	2.03	2.071	2.05	2.079	1.898	2.122	2.142	2.235	2.211	2.208	2.274	2.256
1986	2.04	2.356	1.982	2.207	2.247	2.178	2.223	2.214	1.973	2.248	2.328	2.105
1987	1.838	1.888	2.172	2.048	2.128	2.281	2.263	2.356	2.268	2.133	2.225	2.245
1988	2.273	2.332	2.304	2.154	2.287	2.032	2.197	1.647	2.353	2.207	2.317	2.206
1989	2.196	2.142	1.983	2.021	1.974	1.924	2.225	2.264	2.298	2.293	2.269	2.229
1990	2.072	1.891	1.999	2.298	2.084	2.32	2.243	2.223	2.232	2.21	2.303	2.233
1991	1.959	1.904	2.034	1.952	1.925	2.229	2.181	2.097	2.098	2.095	2.256	2.251
1992	2.276	2.351	2.126	2.346	1.955	1.814	2.104	2.08	N/A	2.115	1.795	2.214
1993	2.044	2.185	2.116	2.138	2.234	1.653	1.926	2.123	2.059	2.07	2.132	2.28
1994	2.209	1.969	2.164	2.18	2.13	2.037	2.156	2.054	1.657	1.838	1.853	1.655

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Table 2.4.1-210 (Sheet 2 of 2)
Monthly Mean Water Levels in the Black Creek Canal at Structure S-21

YEAR	Monthly Mean in Feet NGVD 29											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995	1.536	1.497	1.681	1.938	2.106	1.854	1.978	1.636	1.656	1.561	1.507	1.743
1996	1.713	1.764	1.831	2.137	2.195	1.781	1.866	2.182	2.001	1.884	1.808	2.113
1997	2.165	2.264	2.243	2.223	2.098	1.863	2.065	2.03	1.817	2.078	2.255	1.939
1998	2.008	1.695	1.846	2.08	2.132	2.21	2.078	1.97	1.838	1.64	1.581	2.035
1999	1.985	2.173	2.265	2.241	2.211	1.951	1.98	1.964	1.997	1.72	1.947	2.214
2000	2.259	2.227	2.251	2.117	2.206	2.146	2.074	1.957	2.059	1.849	1.863	2.039
2001	2.259	2.138	2.074	2.193	2.174	2.162	1.971	1.968	1.81	1.924	1.794	1.692
2002	1.563	1.958	1.977	2.199	1.9	1.841	1.818	2.201	1.859	1.782	1.679	1.54
2003	1.691	1.774	1.685	1.729	1.969	2.023	1.919	1.929	2.017	2.096	2.076	2.206
2004	2.221	1.948	2.249	2.216	2.188	1.873	1.958	1.859	1.74	1.838	1.751	1.771
2005	2.037	2.179	2.227	2.147	2.188	1.701	2.014	1.86	1.798	1.814	1.829	2.036
2006	2.209	2.203	2.238	2.244	2.121	2.262	2.054	1.961	2.032	2.122	1.713	1.814
2007	2.29	2.263	2.224	2.152	2.246	1.887	2.048	2.128	2.106	2.102	2.093	2.302
2008	2.269	2.196	2.154	2.135	2.237	2.171	1.881	1.673	1.876	—[b]	—	—
Mean	2.057	2.039	2.006	1.931	1.928	1.957	2.050	2.023	1.996	2.022	2.030	2.062

(a) N/A indicates data not available
(b) — Indicates data not available when retrieved from SFWMD database (Reference 212)

Source: Reference 212

PTN COL 2.4-1

Table 2.4.1-211
NOAA Tide Gages near Units 6 & 7 and Corresponding Tidal Range

Site Number	Site Name	Latitude	Longitude	Start Date	End Date	Great Diurnal Tide Range[(a)] Feet
8723289	Cutler, Biscayne Bay, FL	25° 36.9'	80° 18.3'	5/1/1970	3/31/1972	2.13
8723355	Ragged Key No. 5, Biscayne Bay, FL	25° 31.4'	80° 10.5'	8/1/1987	9/30/1987	1.68
8723393	Elliott Key (Outside), FL	25° 28.6'	80° 10.8'	7/1/1974	7/31/1974	2.53
8723409	Elliott Key Harbor, Elliott Key, FL	25° 27.2'	80° 11.8'	7/1/1974	8/31/1987	1.66
8723423	Turkey Point, Biscayne Bay, FL	25° 26.2'	80° 19.8'	5/1/1970	8/31/1993	1.78
8723465	East Arsenicker, Card Sound, FL	25° 22.4'	80° 17.4'	12/1/1971	2/29/1972	1.02
8723439	Billys Point, Elliott Key, FL	25° 24.9'	80° 12.6'	7/1/1974	7/31/1974	1.64
8723506	Pumpkin Key, Card Sound, FL	25° 19.5'	80° 17.6'	8/1/1987	9/30/1987	0.75
8723534	Card Sound Bridge, FL	25° 17.3'	80° 22.2'	5/1/1970	7/31/1971	0.63
8723214[(b)]	Virginia Key, FL	25° 43.9'	80° 9.7'	1/1/1996	9/30/2008	2.24
8723970[(b)]	Vaca Key, FL	24° 42.7'	81° 6.3'	12/1/1995	9/30/2008	0.97
8724580[(b)]	Key West, FL	24° 33.2'	81° 48.5'	11/27/1973	9/30/2008	1.81

(a) Great diurnal tide range is the difference between the mean higher high and mean lower low tide levels
(b) Active stations
Source: References 219, 220, 221, and 222

PTN COL 2.4-1

Table 2.4.1-212 (Sheet 1 of 3)
SFWMD Water Use Permits Within a 10-Mile Radius

Permit No.	Expiration Date	Permit Type	Land Use	Acres	Water Source	Permitted Allocation (million gallons)			Location from the Site	
						Annual	Max. Monthly	Max. Daily	Direction	Distance (miles)
13-00168-W	2/28/2013	General (>3, <=15 MGM)	Golf Course	100	Onsite Lake(s)	115.8	14.7		WNW	7
13-00221-W	9/26/2009	General	Landscape	4.02	SFWMD Canal(C-1)	—	—	18,300 gal	NNW	9
13-02079-W	9/16/2023	General (<3 MGM)	Landscape	15.64	Onsite Lake(s)	17.383	2.1178		NW	7
13-02354-W	10/6/2024	General (minor)	Landscape	26.41	Onsite Lake(s)	20.73	2.8		WNW	7.5
13-02429-W	11/16/2024	General (<3 MGM)	Landscape	8.09	Onsite Lake(s)/Pond(s)	6.3503	0.868		NW	6.5
13-02461-W	12/15/2024	General (<3 MGM)	Landscape	15	Onsite Lake(s)	11.7744	1.6095		N	9
13-02518-W	3/8/2025	General (<3 MGM)	Landscape	6.64	Onsite Lake(s)/Pond(s)	5.2121	0.7125		NW	6.5
13-02571-W	7/17/2025	General (minor)	Landscape	10.75	Onsite Lake(s)/Pond(s)	8.4383	1.1534		NW	7.2
13-02578-W	1/9/2026	General (<3 MGM)	Landscape	4.24	Onsite Lake(s)	3.3282	0.4549		N	9
13-02613-W	9/16/2025	General (<3 MGM)	Landscape	6.1	Biscayne Aquifer/ Onsite Canal(s)	7.0618	0.8956		NW	8
13-02624-W	1/30/2027	General (<3 MGM)	Landscape	21.3	Onsite Lake(s)/Pond(s)	21.2379	2.6613		N	9
13-02633-W	6/30/2026	General (<3 MGM)	Agricultural	27.5	Onsite Lake(s)	21.5864	2.9507		NNW	6.6
13-02643-W	10/17/2025	General (<3 MGM)	Landscape	3.82	Onsite Lake(s)/Pond(s)	2.9986	0.4099		NW	6.5

PTN COL 2.4-1

Table 2.4.1-212 (Sheet 2 of 3)
SFWMD Water Use Permits Within a 10-Mile Radius

Permit No.	Expiration Date	Permit Type	Land Use	Acres	Water Source	Permitted Allocation (million gallons)			Location from the Site	
						Annual	Max. Monthly	Max. Daily	Direction	Distance (miles)
13-02723-W	5/1/2026	General (<3 MGM)	Landscape	10.37	Onsite Lake(s)/Pond(s)	8.14	1.1127		WNW	8
13-02754-W	4/9/2026	General (<3 MGM)	Landscape	7.93	Onsite Lake(s)/Pond(s)	6.2247	0.8509		WNW	6
13-02778-W	5/27/2026	General (<3 MGM)	Landscape	6.32	Onsite Lake(s)	6.199	0.9793		N	9
13-02823-W	1/14/2027	General (<3 MGM)	Landscape	9.64	Onsite Lake(s)	—	—		N	9
13-02844-W	10/26/2026	General (<3 MGM)	Landscape	7.22	Biscayne Aquifer/ Onsite Lake(s)	5.6517	0.7725		N	9
13-02858-W	8/13/2026	General (<3 MGM)	Landscape	9.5	Onsite Lake(s)/Pond(s)	7.4571	1.0193		NW	7.2
13-02864-W	8/13/2026	General (<3 MGM)	Landscape	6.67	Onsite Lake(s)/Pond(s)	5.2357	0.7157		NW	7.2
13-02886-W	9/23/2026	General (<3 MGM)	Landscape	0.82	SFWMD Canal (C-103)	0.9493	0.1204		NW	8
13-02911-W	8/22/2026	General (<3 MGM)	Landscape	5.25	Onsite Canal(s)	6.0778	0.7708		NW	8
13-02915-W	1/12/2027	General (<3 MGM)	Landscape	1.5	SFWMD Canal(C-1)	1.1774	0.1609		NNW	9
13-03023-W	12/18/2026	General (<3 MGM)	Landscape	8	Onsite Lake(s)/Pond(s)	9.2614	1.1746		NW	7.5
13-03046-W	12/22/2026	General (<3 MGM)	Landscape	8.32	Onsite Lake(s)	8.2957	1.0395		N	9
13-03105-W	2/16/2027	General (<3 MGM)	Landscape	2.2	Onsite Lake(s)	2.5469	0.323		WNW	8
13-03201-W	4/3/2027	General (<3 MGM)	Landscape	1	SFWMD Canal (C-1)	—	—	5,000 gal	NNW	10

PTN COL 2.4-1

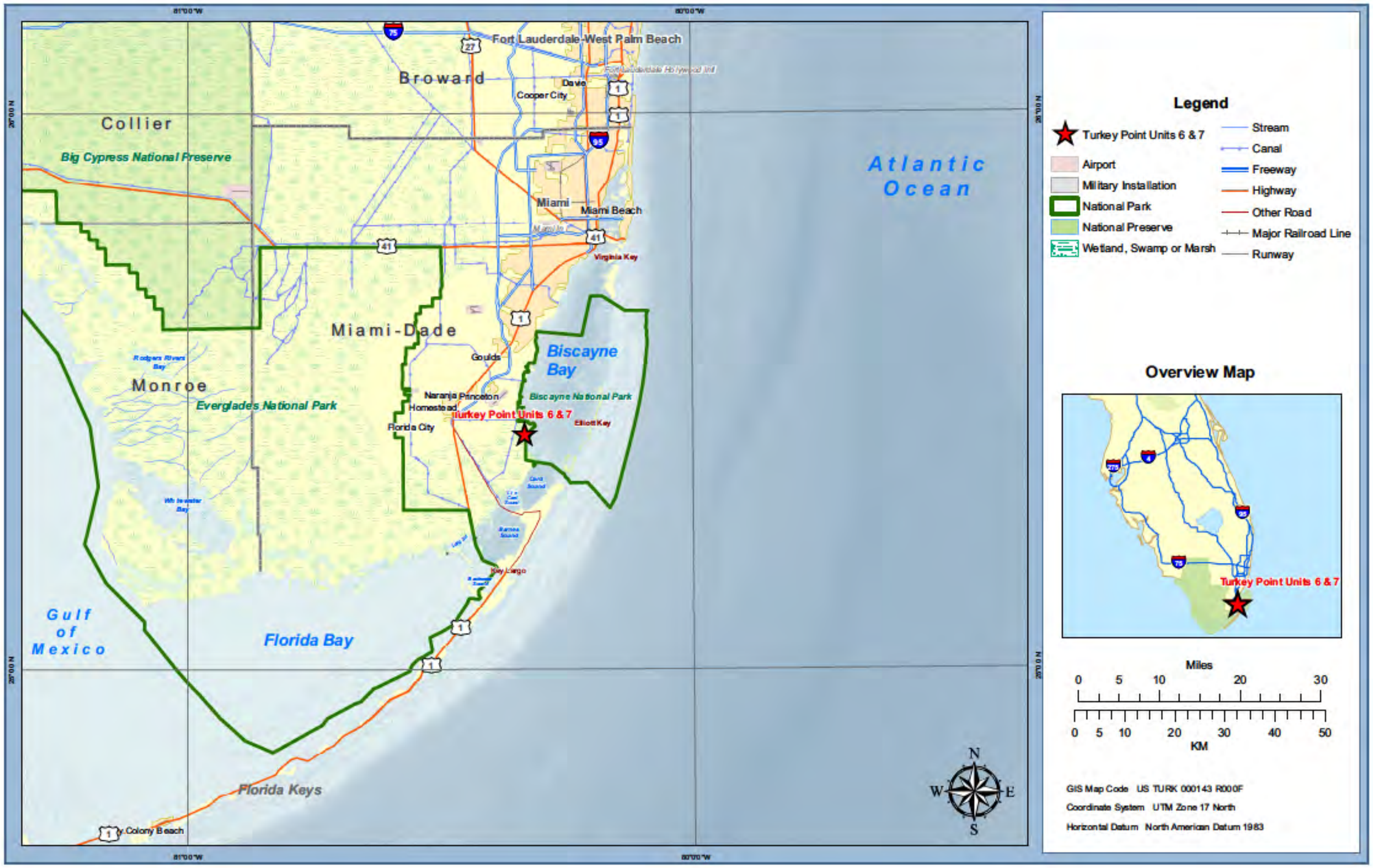
Table 2.4.1-212 (Sheet 3 of 3)
SFWMD Water Use Permits Within a 10-Mile Radius

Permit No.	Expiration Date	Permit Type	Land Use	Acres	Water Source	Permitted Allocation (million gallons)			Location from the Site	
						Annual	Max. Monthly	Max. Daily	Direction	Distance (miles)
13-03469-W	5/18/2027	General (<3 MGM)	Landscape	10.91	Onsite Lake(s)/Pond(s)	12.6302	1.6019		NW	8.2
13-03492-W	7/12/2012	General (minor)	Landscape	62.17	Onsite Lake(s)	71.9727	9.1282		NNW	8.5
13-03586-W	5/20/2027	General (<3 MGM)	Landscape	18	Onsite Lake(s)/Pond(s)	14.1293	1.9313		WNW	6.3
13-03796-W	7/13/2009	Individual	Industrial	320	Onsite Borrow Pit(s)	504	42		WNW	7
13-03960-W	11/4/2028	General (<3 MGM)	Landscape	6.6	Biscayne Aquifer/ Onsite Lake(s)	7.6407	0.9691		WNW	7.5
13-04010-W	1/8/2028	General (<3 MGM)	Landscape	5	Onsite Lake(s)/Pond(s)	3.9248	0.5365		WNW	9
13-04043-W	3/14/2028	General (<3 MGM)	Landscape	15	Biscayne Aquifer/ Onsite Lake(s)	11.7744	1.6095		NNW	9

Note: MGM = millions of gallons per month
Source: Reference 228

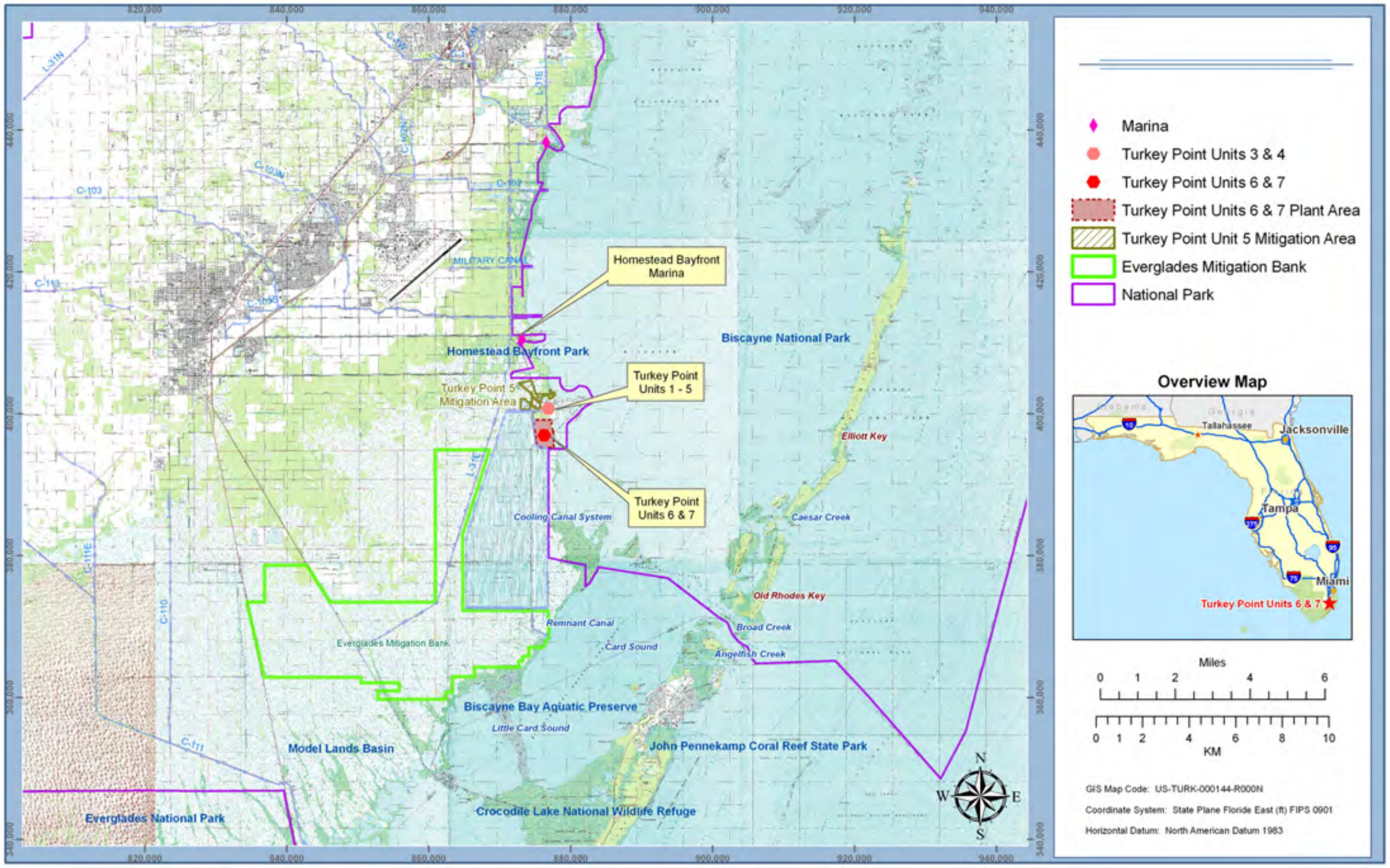
PTN COL 2.4-1

Figure 2.4.1-201 Major Hydrological Features near Units 6 & 7



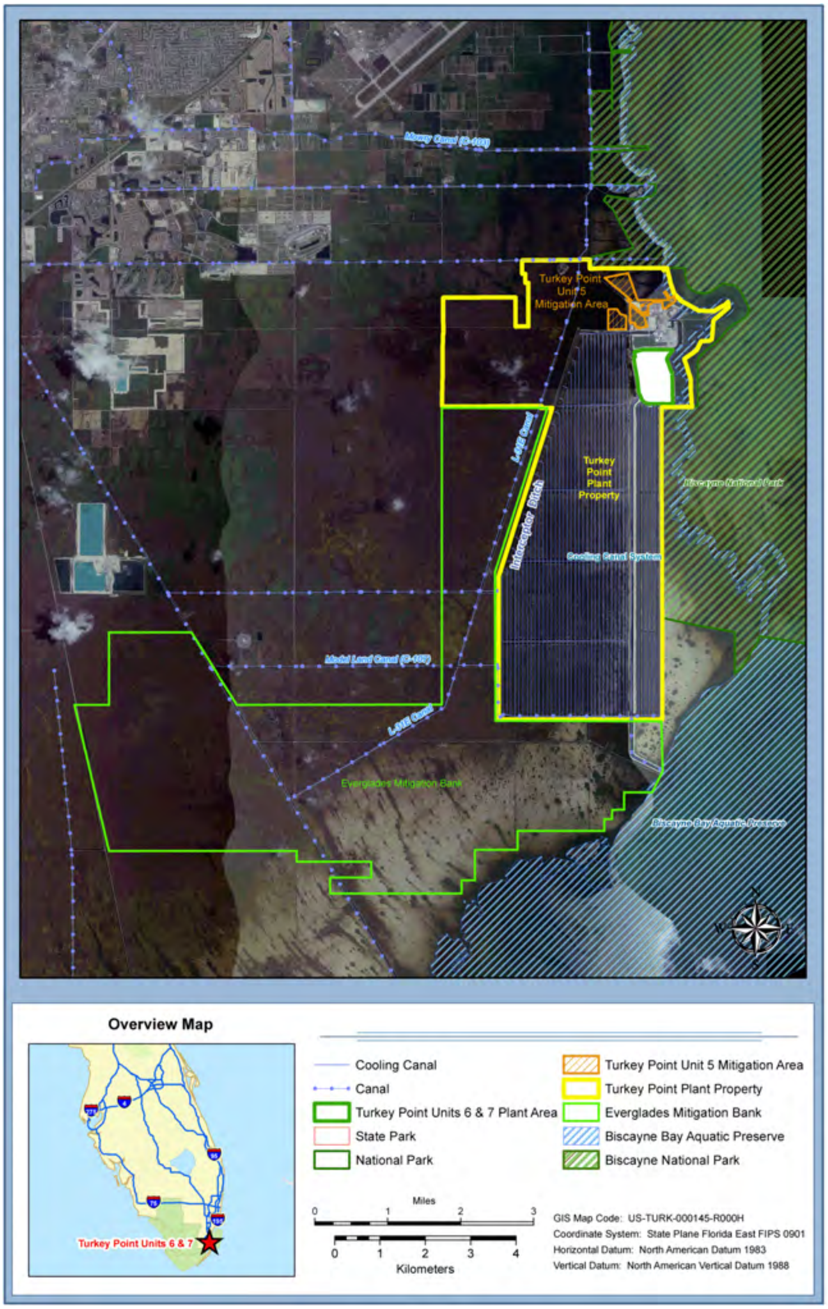
PTN COL 2.4-1

Figure 2.4.1-202 Areas Surrounding Units 6 & 7



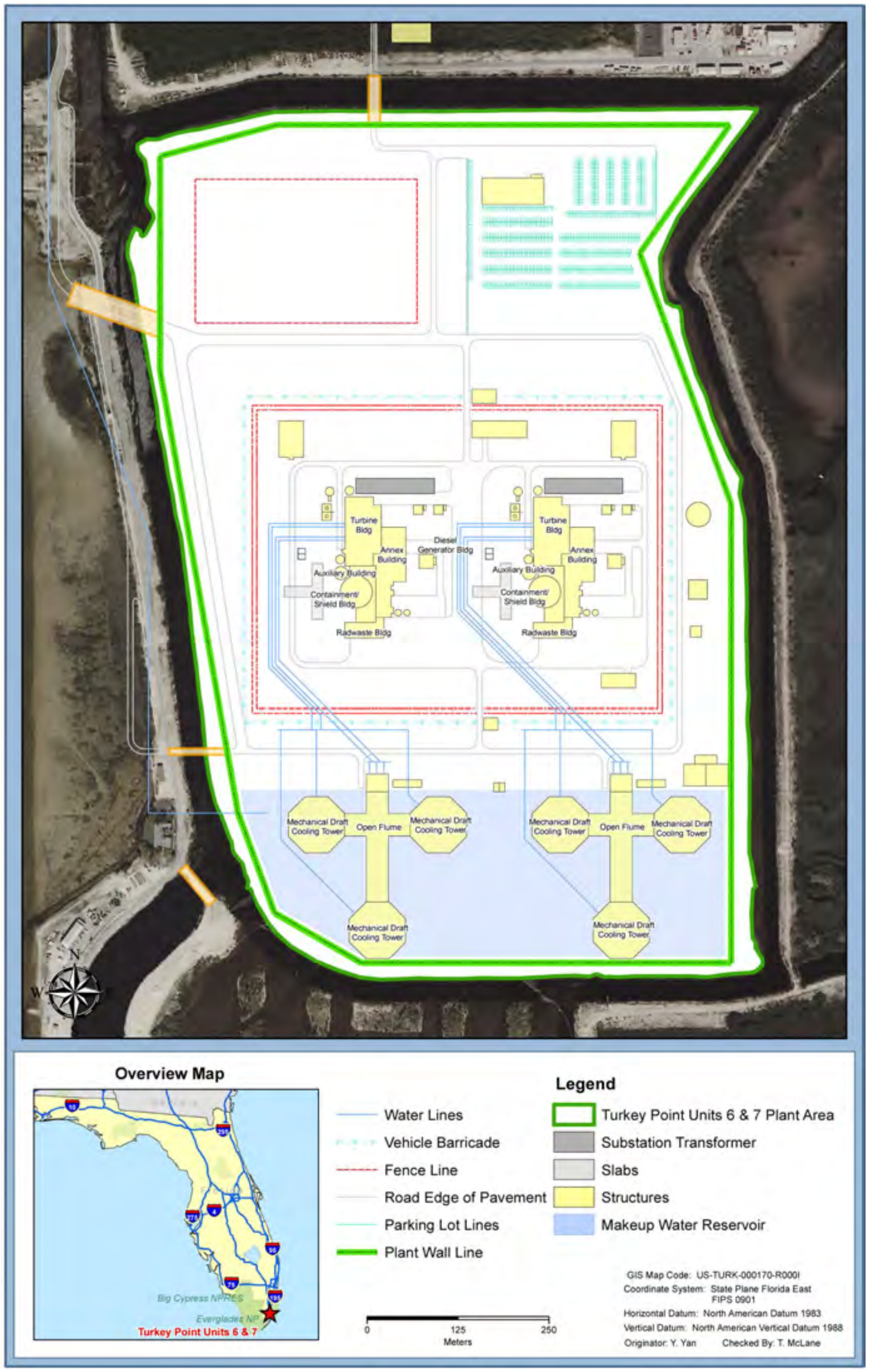
PTN COL 2.4-1

Figure 2.4.1-203 Units 6 & 7 and the Cooling Canals for Units 1 through 4



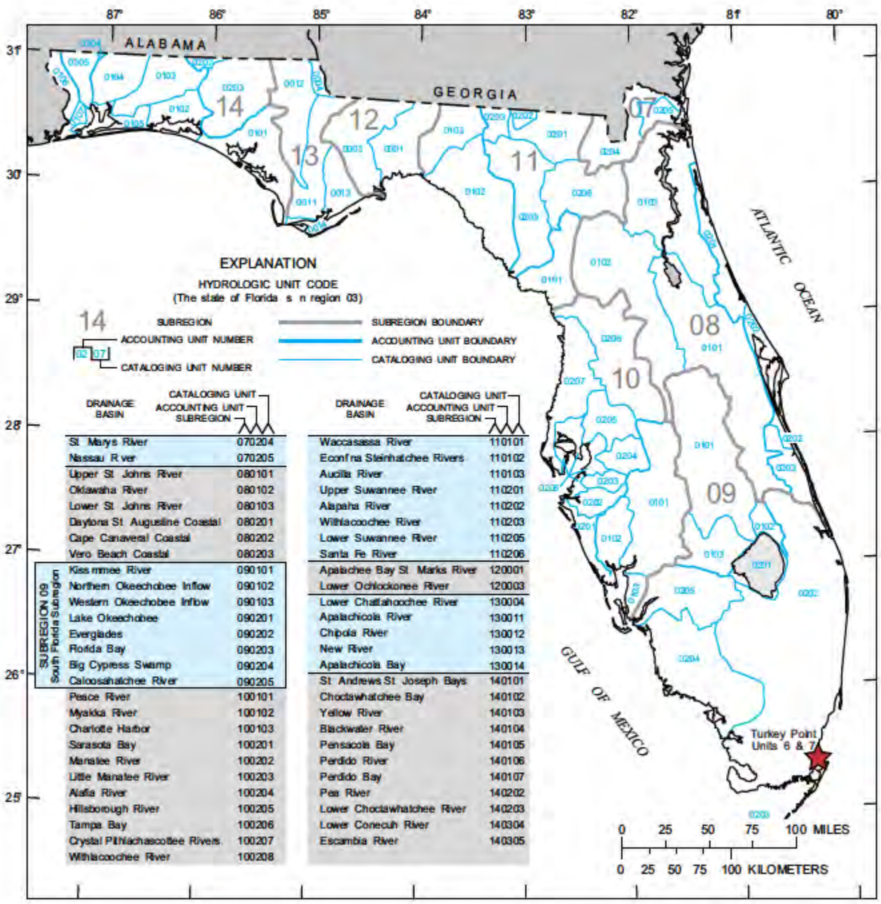
PTN COL 2.4-1

Figure 2.4.1-204 General Arrangement of Units 6 & 7



PTN COL 2.4-1

Figure 2.4.1-205 Map of South Florida Watershed Subregions



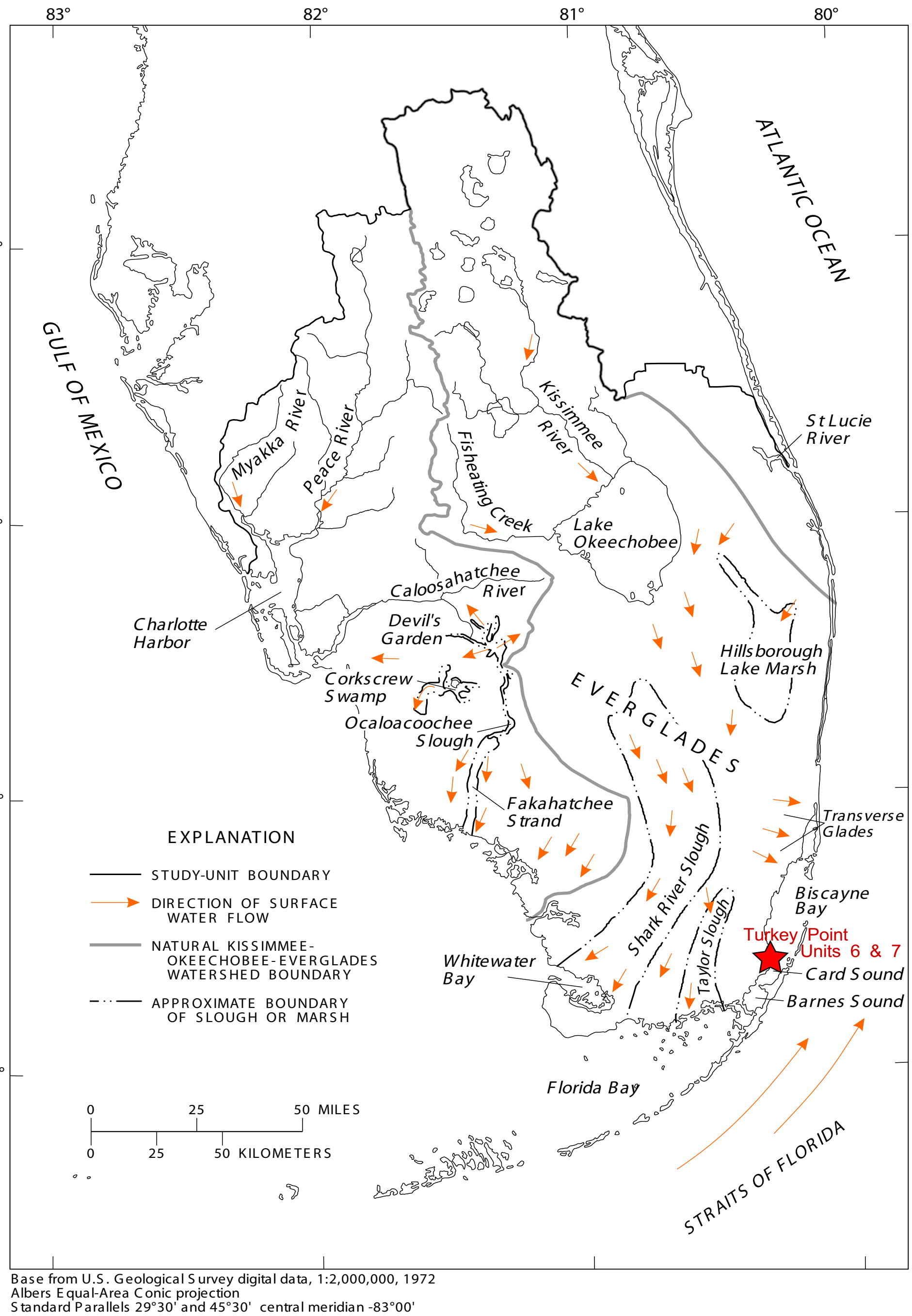
DRAINAGE BASIN	SUBREGION / ACCOUNTING UNIT / CATALOGING UNIT
St Marys River	070204
Nassau R ver	070205
Upper St Johns River	080101
Oklawaha River	080102
Lower St Johns River	080103
Daytona St Augustine Coastal	080201
Cape Canaveral Coastal	080202
Vero Beach Coastal	080203
Kiss mmee River	090101
Northern Okeechobee Inflow	090102
Western Okeechobee Inflow	090103
Lake Okeechobee	090201
Everglades	090202
Florida Bay	090203
Big Cypress Swamp	090204
Caloosahatchee River	090205
Peace River	100101
Myakka River	100102
Charlotte Harbor	100103
Sarasota Bay	100201
Manatee River	100202
Little Manatee River	100203
Alafia River	100204
Hillsborough River	100205
Tampa Bay	100206
Crystal Pithlachascotee Rivers	100207
Withlacoochee River	100208

DRAINAGE BASIN	SUBREGION / ACCOUNTING UNIT / CATALOGING UNIT
Waccasassa River	110101
Econf na Steinhatchee Rivers	110102
Aucilla River	110103
Upper Suwannee River	110201
Alapaha River	110202
Withlacoochee River	110203
Lower Suwannee River	110205
Santa Fe River	110206
Apalachee Bay St Marks River	120001
Lower Ochlockonee River	120003
Lower Chattahoochee River	130004
Apalachicola River	130011
Chipola River	130012
New River	130013
Apalachicola Bay	130014
St Andrews St Joseph Bays	140101
Choctawhatchee Bay	140102
Yellow River	140103
Blackwater River	140104
Pensacola Bay	140105
Perdido River	140106
Perdido Bay	140107
Pea River	140202
Lower Choctawhatchee River	140203
Lower Conecuh River	140304
Escambia River	140305

Modified from Reference 229

PTN COL 2.4-1

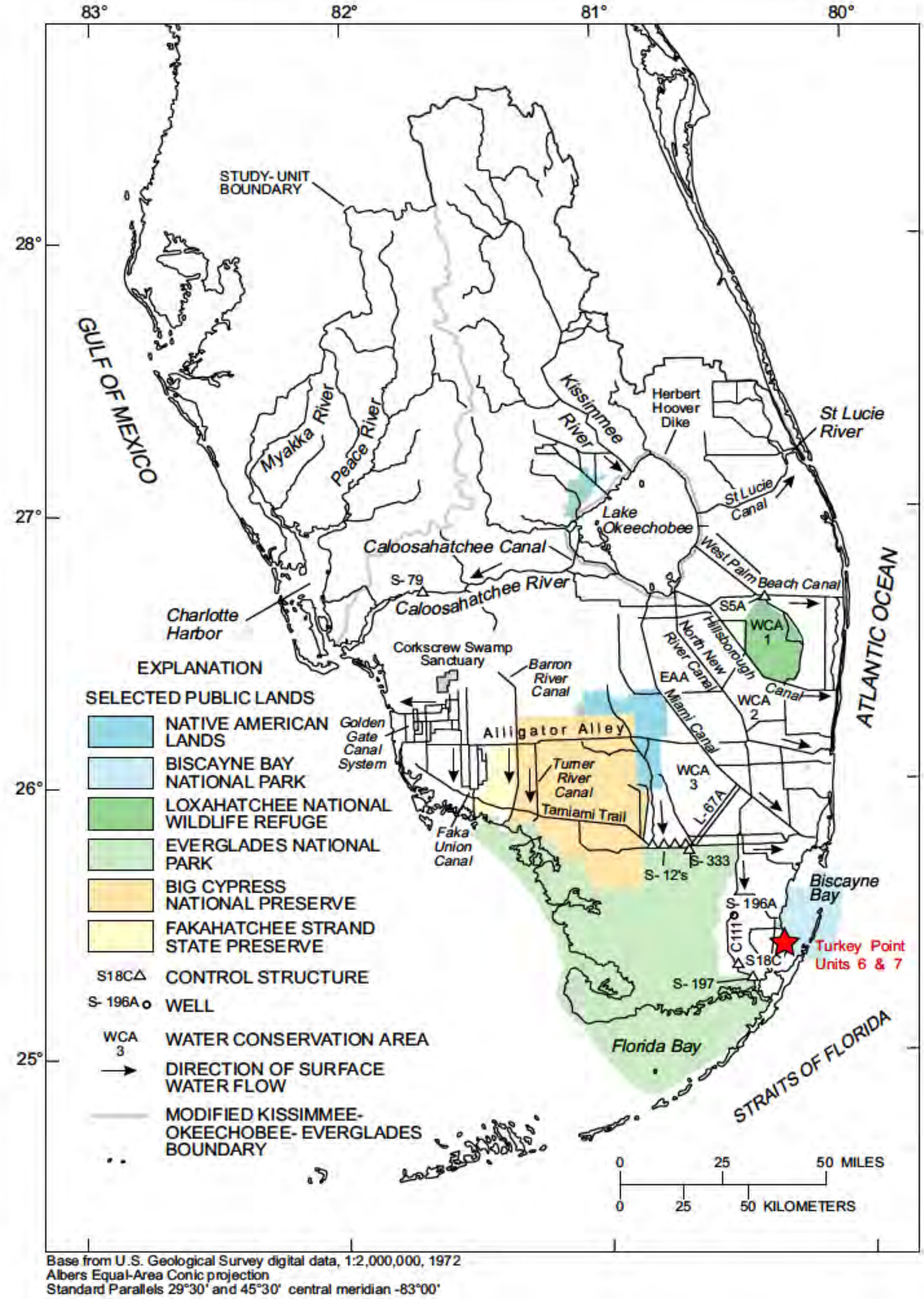
Figure 2.4.1-206 Hydrologic Features and Flow Patterns Within the South Florida Watershed Before the Construction of Drainage Canals



Modified from Reference 202

PTN COL 2.4-1

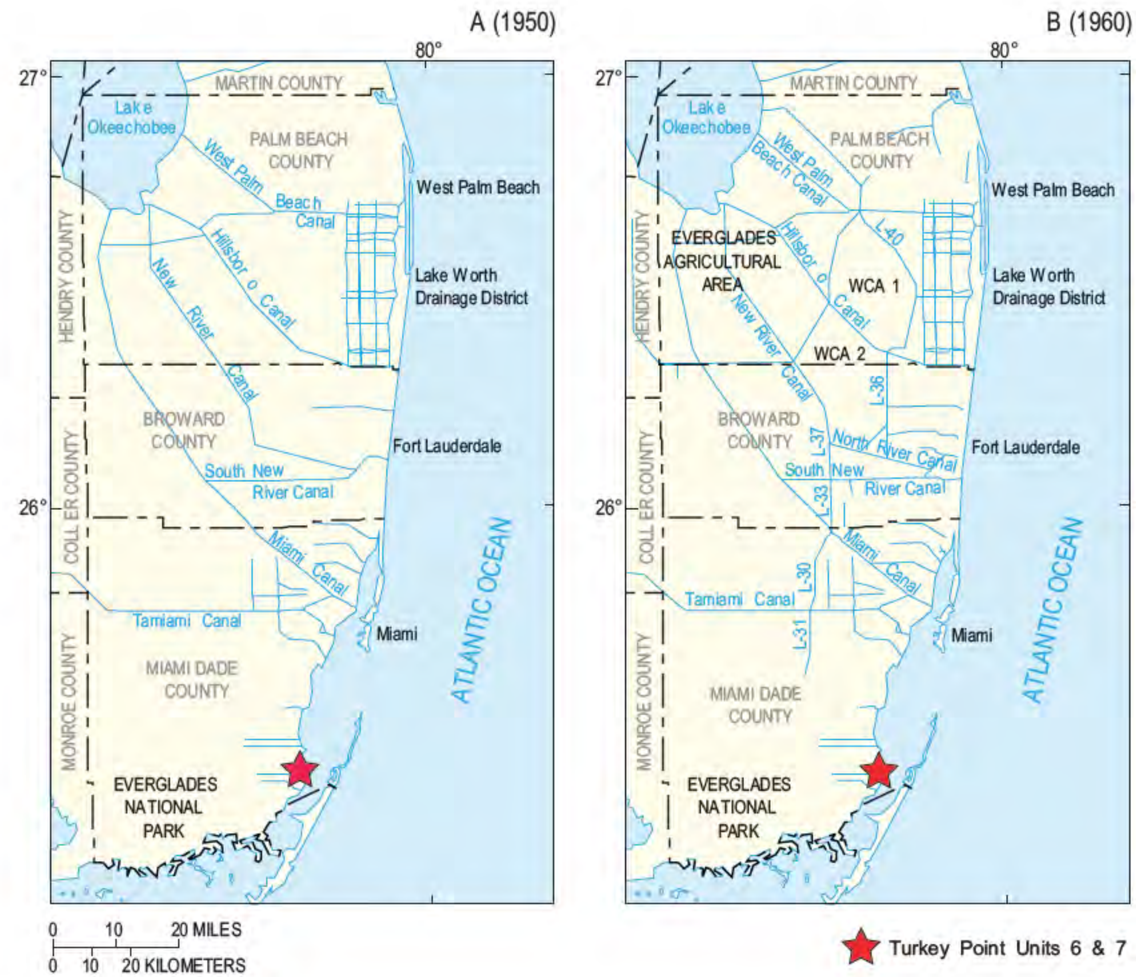
Figure 2.4.1-207 Selected Public Lands and Flow Alteration Within the South Florida Watershed after the Construction of the Drainage Canals



Modified from Reference 202

PTN COL 2.4-1

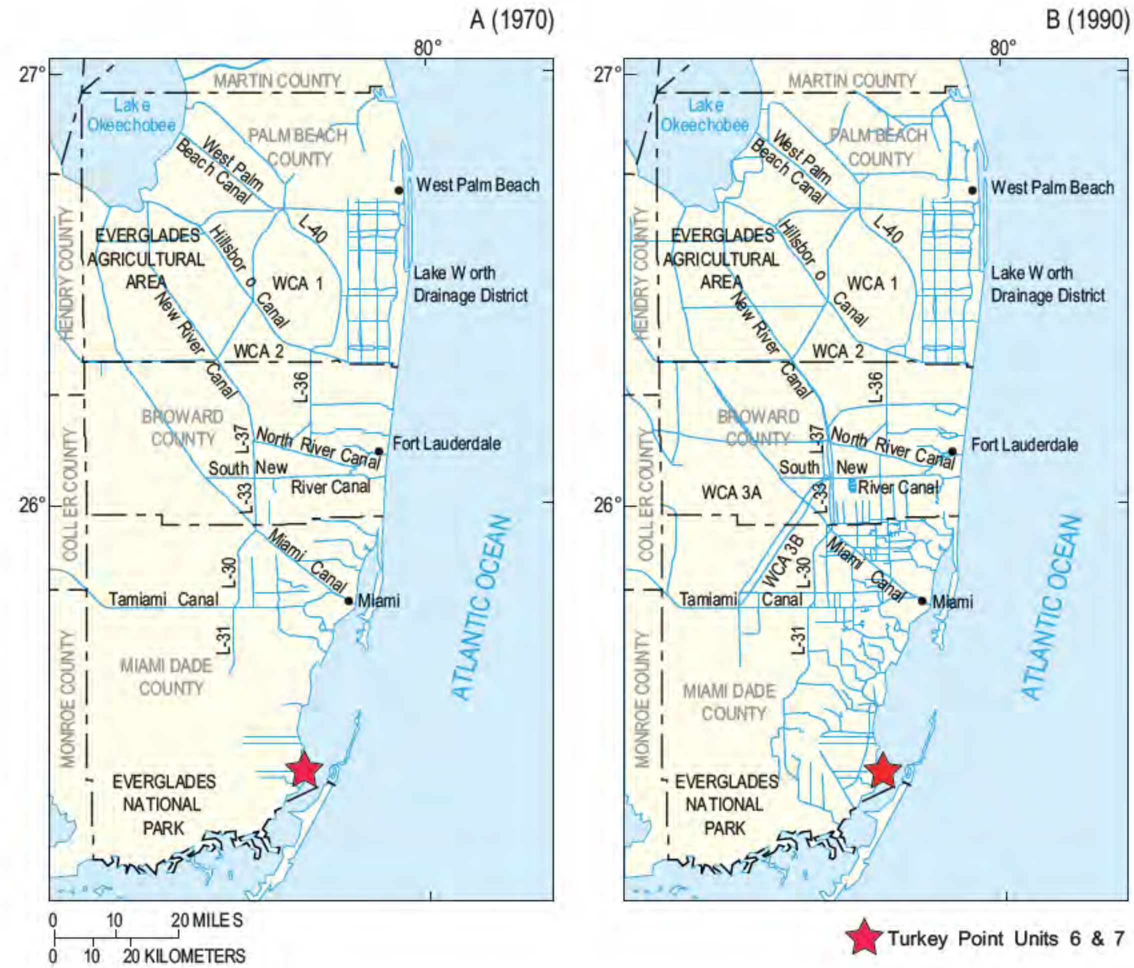
Figure 2.4.1-208 Surface Water Conveyance System in the South Florida Region in (A) 1950 and (B) 1960



Modified from Reference 207

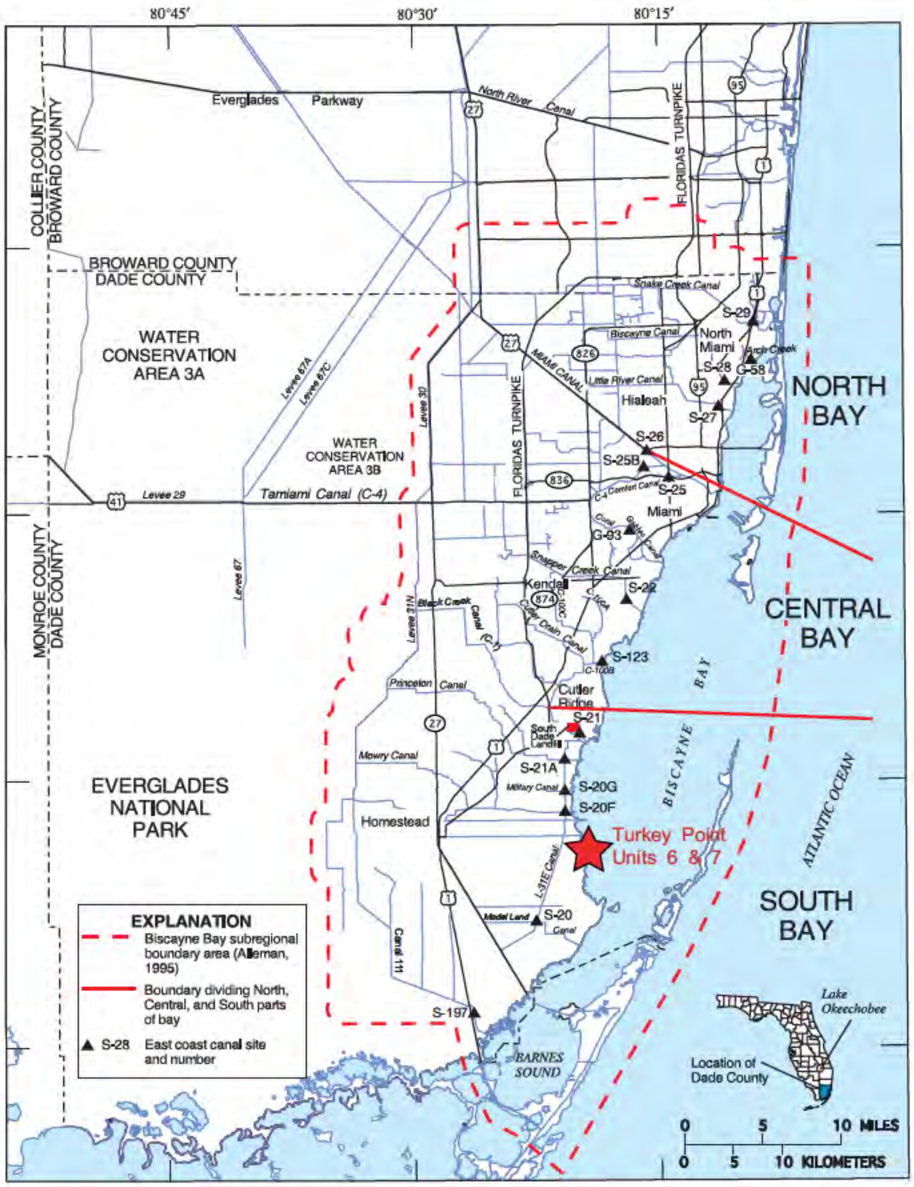
PTN COL 2.4-1

Figure 2.4.1-209 Surface Water Conveyances System in the South Florida Region in (A) 1970 and (B) 1990



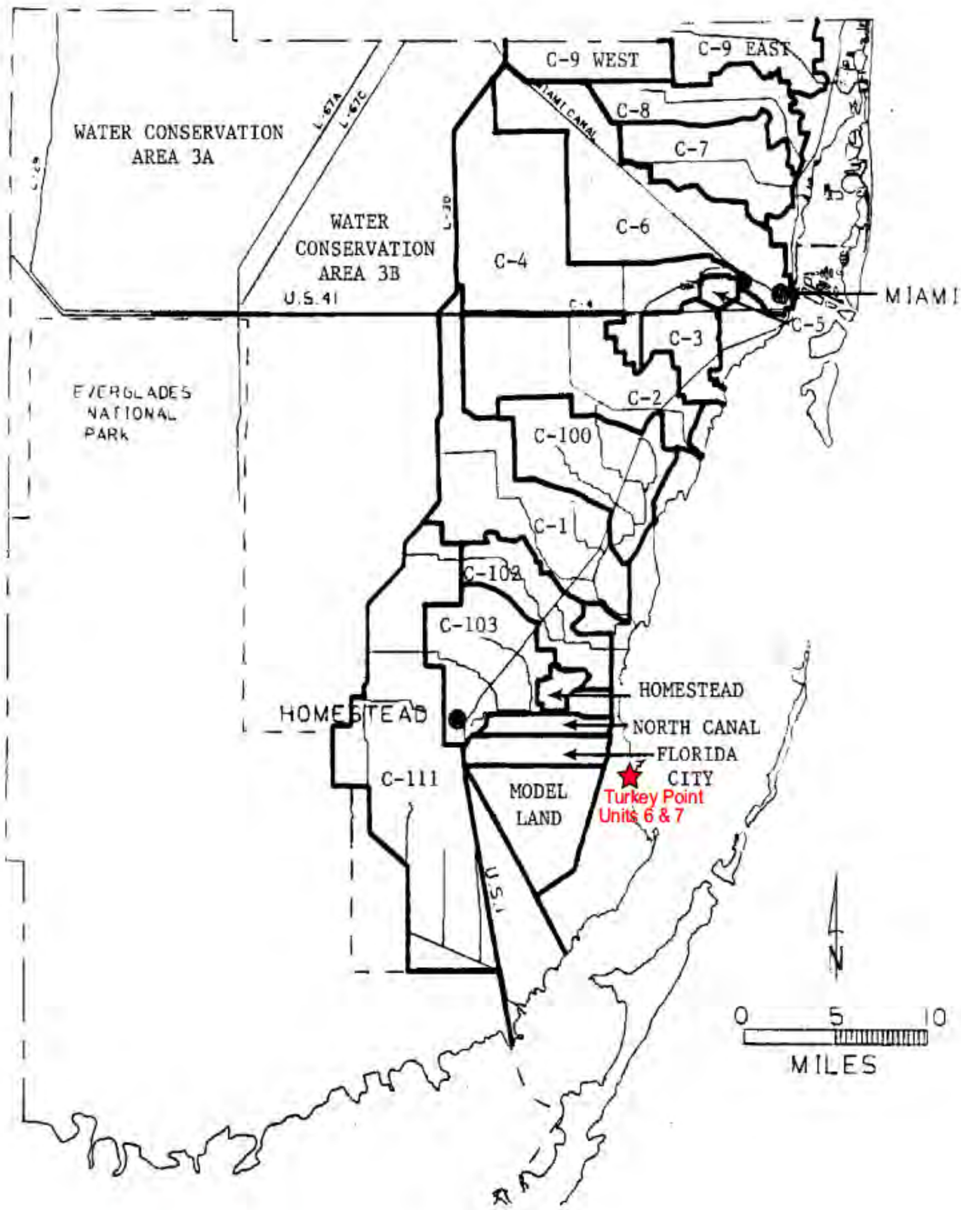
Modified from Reference 207

PTN COL 2.4-1 **Figure 2.4.1-210 Locations of ENP-SDCS Canals, Flow Control Structures on Canal Outlets, and Biscayne Bay Planning Regions**



Modified from Reference 230

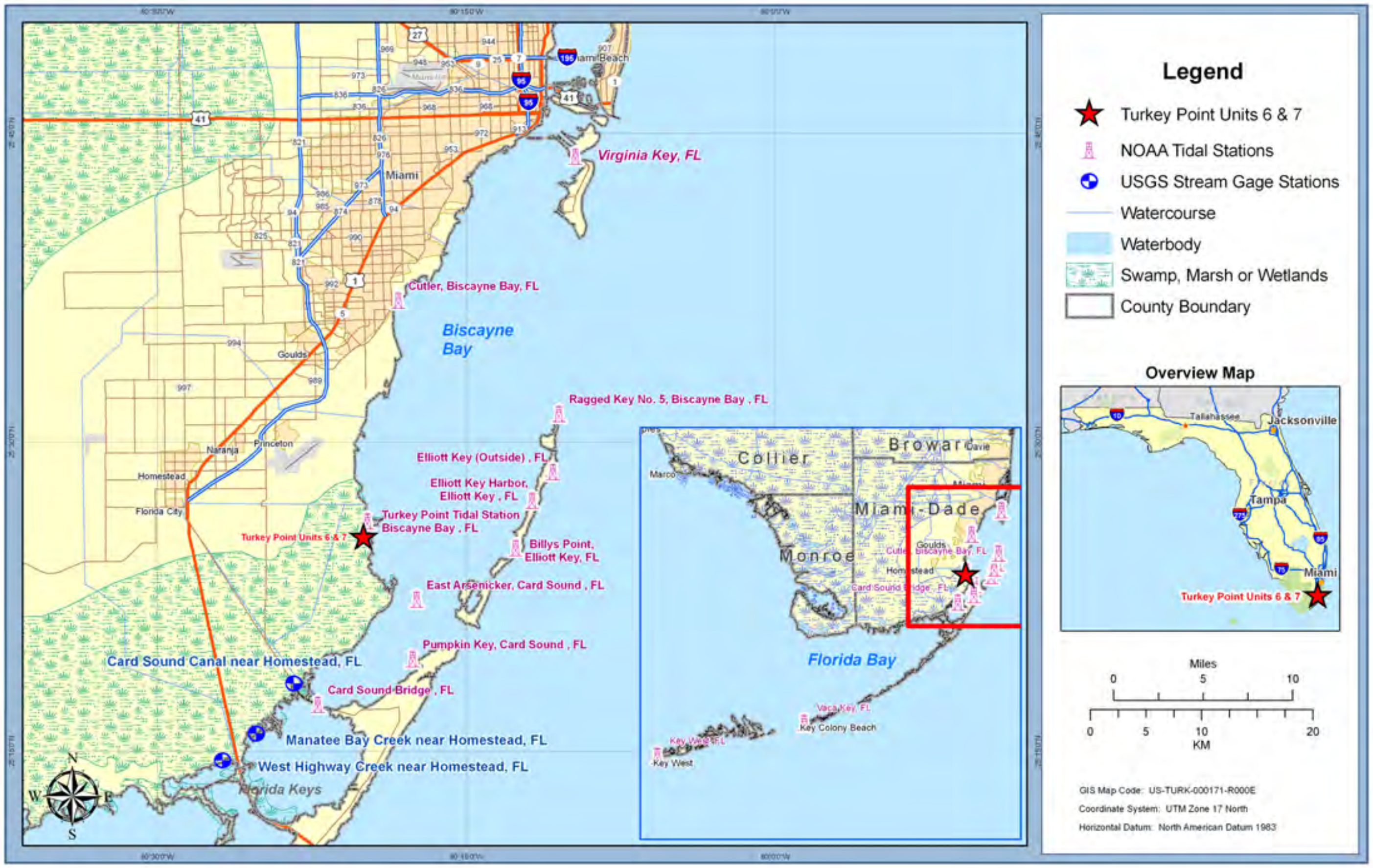
PTN COL 2.4-1 **Figure 2.4.1-211 Locations of Eastern Miami-Dade County Surface Water Management Basins**



Modified from Reference 210

PTN COL 2.4-1

Figure 2.4.1-212 Locations of NOAA Tide and USGS Streamflow Gages Near Units 6 & 7



SUBSECTION 2.4.2: FLOODS

SUBSECTION 2.4.2 LIST OF TABLES

SUBSECTION 2.4.2 LIST OF FIGURES

SUBSECTION 2.4.2 LIST OF FIGURES (CONT.)

2.4.2 FLOODS

PTN COL 2.4-2 This subsection examines the historical flooding at the vicinity of Units 6 & 7, including Card Sound Canal, Manatee Bay Creek, West Highway Creek, Virginia Key, Vaca Key, Miami-Dade County and Miami areas, Miami Palm Beach areas, Biscayne Bay, and the Atlantic Ocean, and summarizes the individual types and combinations of flood-producing phenomena considered in establishing the flood design basis for safety-related facilities. The potential impacts of local intense precipitation are also described in this subsection.

2.4.2.1 Flood History

As described in Subsection 2.4.1, there are no major streams or rivers near Units 6 & 7. There is, however, an extensive network of man-made canals that traverses portions of the Miami-Dade County, Florida, where Units 6 & 7 are located. Located along the Atlantic Ocean, Florida Bay, and Biscayne Bay, the area is susceptible to flooding from storm surge associated with tropical storms and hurricanes. In addition, Miami-Dade County experiences ponding in the very flat, poorly drained areas and drainage canals (Reference 201). The most severe flooding events (up to 1992) in Miami-Dade County, as reported by the Federal Emergency Management Agency (FEMA) in the 1994 flood insurance study for Miami-Dade County, Florida and incorporated areas (Reference 201), are summarized in Table 2.4.2-201. As shown in the table, the maximum recorded storm tide level is at 11.7 feet NAVD 88, occurred between September 6 and 22, 1926. The design grade elevation at 26 feet NAVD 88 for all safety-related buildings of Units 6 & 7 is above this maximum recorded storm tide level.

The effects of Hurricane Andrew and other hurricane events on flooding at Units 6 & 7 are described in detail in Subsection 2.4.5. Hurricane Andrew caused the worst flooding on record for the area near Units 6 & 7. During Hurricane Andrew, rainfall totals of more than 7 inches were recorded in southeastern Florida (Reference 202). On the southeast Florida coast, the peak storm surge occurred near the time of high astronomical tide. The height of the storm tide ranged from 4 to 6 feet in northern Biscayne Bay and increased to a maximum value of 16.9 feet NGVD 29 (15.37 feet NAVD 88) in southeastern Biscayne Bay, approximately 13 miles north of Units 6 & 7. However, the height of the storm tide was 4 to 5 feet in southern Biscayne Bay (Reference 203).

The gage height measurements at three USGS gages are examined for high water levels that occurred in more recent years: Card Sound Canal (USGS Gage 251816080232200), Manatee Bay Creek (USGS Gage 251549080251200), and West Highway Creek (USGS Gage 251433080265000). These USGS stations are located along the southeastern Florida shoreline south of Units 6 & 7 as shown in Figure 2.4.1-212. Data from the Card Sound Canal gage are available from October 2003 through September 2007, data from the Manatee Bay Creek gage are available from October 2003 through September 2007, and data from the West Highway Creek gage are available from October 1995 through September 2007. Gage height data at all three stations are recorded in 15-minute intervals. Tables 2.4.2-202 through 2.4.2-204 present the four highest gage heights recorded at these gages (Reference 204). The majority of the recorded peak water levels are associated with tropical storm or hurricane events. The maximum gage heights recorded are 1.11 feet NAVD 88 on November 12, 2003, at the Card Sound Canal gage; 2.27 feet NAVD 88 on September 20, 2005, at the Manatee Bay Creek gage; and 2.59 feet NAVD 88 on October 24, 2005, at the West Highway Creek gage (Reference 204).

Tide level measurements are also examined at two tide gage stations: the Virginia Key tide gage (Station ID: 8723214), which is 25 miles north of Units 6 & 7, and the Vaca Key tide gage (Station ID: 8723970), which is 70 miles south of Units 6 & 7. The Virginia Key tide gage was installed in January 1994 and has been collecting water levels continuously. Verified data are available from February 1994 through August 2008. The maximum water level recorded in the Virginia Key station is 2.8 feet NAVD 88 on October 24, 2005 (Reference 205). The Vaca Key tide gage was established in 1970. Verified data are available from January 1971 through August 2008. The maximum water level recorded in Vaca Key station was 5.4 feet NAVD 88 on October 24, 2005 (Reference 206). The five highest tide levels recorded at the two tide gage stations are presented in Tables 2.4.2-205 and 2.4.2-206 (References 205 and 206). As shown in the tables, all the peak tide levels at the two tide gage stations are associated with tropical storm or hurricane events.

From Tables 2.4.2-202 through 2.4.2-206, it is evident that the design grade elevation at 26 feet NAVD 88 for all safety-related buildings of Units 6 & 7 is above the maximum water levels recorded at the USGS gages and the tide gages as described above.

There are no records of dam break flooding or tsunami-induced flooding events near the Units 6 & 7 site, as described in Subsections 2.4.4 and 2.4.6, respectively. There are no records of any ice sheet formations, wind-driven ice

ridges, or ice jams on any of the rivers, creeks, or estuaries near Units 6 & 7 as presented in Subsection 2.4.7.

2.4.2.2 Flood Design Considerations

The design basis flooding (DBF) elevation for Units 6 & 7 is determined by considering a number of different flooding scenarios. The potential flooding scenarios applicable and investigated for Units 6 & 7 include the following: probable maximum flood (PMF) on streams and rivers, potential dam failures, probable maximum surge and seiche flooding, probable maximum tsunami, flooding due to ice effects, and potential flooding caused by channel diversions. The flooding scenarios were investigated in conjunction with other flooding and meteorological events, such as wind-generated waves and tidal levels, as recommended in the guidelines presented in ANSI/ANS-2.8-1992 (Reference 207). Detailed descriptions on each of these flooding events and the analysis are described in Subsections 2.4.3 through 2.4.7, and Subsection 2.4.9.

Flooding due to the PMF on streams and rivers is assessed and described in Subsection 2.4.3. The PMF on streams and rivers is defined by the probable maximum precipitation (PMP) storm event over the stream or river watershed. As addressed in Subsection 2.4.3, flood levels at Units 6 & 7 during severe storms, such as the PMP event, would be controlled by storm tides in the Biscayne Bay because Units 6 & 7 are located on the Biscayne Bay shoreline and there are no major streams or rivers nearby. As a result, a detailed modeling analysis to determine the flood levels from PMF on streams and rivers was not performed for the Units 6 & 7.

The impacts of potential dam failures on the Units 6 & 7 safety-related structures, systems, and components (SSC) are addressed in Subsection 2.4.4. There are no dams located upstream or downstream of Units 6 & 7. Thus, a detailed modeling analysis to determine the flood levels as a result of dam breach was not performed. The makeup water reservoir (MWR), located south of the power block, is constructed of a concrete basin with a top of basin wall at 24 feet NAVD 88, which is 2 feet below the design grade of 26 feet NAVD 88 for the safety-related structures. It is concluded in Subsection 2.4.4 that a postulated breach of the reservoir wall would not pose a flooding risk to the safety-related facilities of the plant.

Probable maximum surge and seiche flooding as a result of the probable maximum hurricane (PMH) is presented in Subsection 2.4.5. The maximum water surface elevation including wave run-up at the plant area during the postulated

passage of the PMH is estimated to be 24.8 feet NAVD 88. This flood level also constitutes the DBF elevation for the site, and is below the design grade including the elevation of floor entrances and openings of all safety-related facilities at 26 feet (7.9 meters) NAVD 88. Thus, the safety functions of the plant are not impacted by the PMH-induced flooding.

Subsection 2.4.6 describes the estimation of flood levels associated with the probable maximum tsunami (PMT). The maximum water level associated with the PMT at Units 6 & 7 is conservatively estimated to be 14.0 feet NAVD 88. Therefore, the PMT does not pose a flood risk to the safety-related facilities for Units 6 & 7.

Based on the historical data assessed in Subsections 2.4.7, it is unlikely that ice effects would pose any flood risk to Units 6 & 7.

Subsection 2.4.9 describes the effects of channel diversions, and it is determined that channel diversion would not pose any flood risk to Units 6 & 7.

The maximum water level at Units 6 & 7 due to a local probable maximum precipitation (PMP) storm event is estimated and described in Subsection 2.4.2.3 below. The maximum water level in the power block area due to a local PMP storm event is estimated to be at 24.5 feet NAVD 88, which is lower than the design grade of 26.0 feet NAVD 88 of the safety-related facilities by 1.5 feet. Thus, no safety-related facilities are affected due to flooding as a result of the local PMP storm.

2.4.2.3 Effects of Local Intense Precipitation

The effects of local intense precipitation or local PMP on Units 6 & 7 are presented in this subsection. The drainage system for the plant area is analyzed for the local PMP event to determine the flood levels.

2.4.2.3.1 Probable Maximum Precipitation Depth

The design basis for the local intense precipitation is the all-season, 1-square-mile or point PMP as obtained from the NWS Hydro-meteorological Reports No. 51 and 52 (HMR 51 and HMR 52) (Reference 208 and 209). Section 5 of HMR 51 (Reference 208) indicates that the PMP values of the southernmost isoline can be used to determine the PMP values for basins located further south, such as a basin in southern Florida where Units 6 & 7 are located. Rainfall records near the site also indicate that no large rainfall events have occurred since the publication

of HMR 51 and HMR 52 that would potentially influence the information presented in these publications (References 215 and 216).

The PMP depths given in HMR 51 are for durations ranging from 6 to 72 hours and for drainage areas ranging from 10 to 20,000 square miles. Using these depths, HMR 52 provides procedures for estimating short duration point (or 1 square mile) PMP depths for durations up to 1 hour. Table 2.4.2-207 presents the 1 square-mile PMP depths and intensities for various durations at Units 6 & 7. Figure 2.4.2-201 shows the PMP intensities for storm durations up to 1 hour for Units 6 & 7.

2.4.2.3.2 Local Drainage Components and Subbasins

The Units 6 & 7 power block layout and the finish grades are shown in Figure 2.4.2-202.

As addressed in Subsection 2.4.1, the plant area for Units 6 & 7 is built up from the existing ground with backfill and is surrounded by a retaining wall structure. The design grade for all safety-related facilities, which consist of the containment/ shields building and auxiliary building, is at 26 feet NAVD 88. The grade elevation adjacent to the retaining wall is 19 feet NAVD 88. The top of the retaining wall is at 21.5 feet NAVD 88 along the eastern perimeter and the western perimeter and 20 feet NAVD 88 along the northern perimeter. The southern portion of the plant area is occupied by the makeup water reservoir with the top of the reservoir wall at 24 feet NAVD 88. The safety-related facilities are located in the center portion of the power block and the finish grade slopes away from the safety-related facilities at a minimum slope of 0.5 percent towards the retaining wall in the east and west and to the swales to the north and south of the power block. The swales located south of the power block also collect overflow from the makeup water reservoir during extreme rainfall events, and the swales to the north of the power block collect stormwater runoff from the switchyard (Clear Sky substation) and parking lot areas. The stormwater runoff flow paths, principally along the swales, in the plant area are shown in Figure 2.4.2-203. Water levels in the swales during the local PMP are determined along their flow paths using the step-backwater methodology in the computer program HEC-RAS (Reference 210).

For typical design storm events, runoff from the power block area is conveyed via catch basins and storm drains to a system of piping and swales that release to the industrial wastewater facility/cooling canal system (cooling canals).

For the local PMP flooding analysis, all storm drains, culverts, and catch basins are assumed clogged and not functioning. All flow during PMP condition is assumed to be either overland or directed through the swales.

The local PMP analysis considered the combined event of a preceding large precipitation event such as a 40% PMP by considering saturated ground cover conditions and no available storage area in the makeup water reservoir at the beginning of the PMP event. Additionally, high water levels in the industrial wastewater facility as a result of flooding events in the Atlantic Ocean and Biscayne Bay were also considered. As indicated in Subsection 2.4.3, the 500-year flood level in the Biscayne Bay is elevation 10.8 feet NAVD 88, which is more than 10 feet below the eastern and western edges of the site perimeter retaining wall at elevation 21.5 feet NAVD 88, where local PMP flows are discharged over the retaining wall.

Even if the highly unlikely combined event of the probable maximum storm surge (PMSS) associated with the probable maximum hurricane (PMH) in the Atlantic Ocean and Biscayne Bay is considered coincident with the peak discharge from the local PMP there would be no impact to the safety functions of the plant. As indicated in FSAR Subsection 2.4.5, the PMSS water level at the site is elevation 21.1 feet NAVD 88, which is below the top of the eastern and western edges of the perimeter retaining wall. Thus, precipitation runoff flowing over the retaining wall and the resulting flood elevations in the power block area are not influenced by the PMSS elevation in Biscayne Bay and industrial wastewater facility.

In the PMP flood analysis, the swales south of the power block are referred to as flow paths Cooling Tower East (CT-E) and West (CT-W). The swales north of the power block are referred to as flow paths Parking Lot East (PL-E) and Switchyard West (SY-W). The flow path SY-W consists of two parallel swales located in the switchyard and access road area north of the power block. These two parallel swales are modeled as one channel because during a PMP event the road is postulated to be overtopped.

As shown on Figures 2.4.2-203 and 2.4.2-204, the plant area has been delineated into 22 drainage subbasins, with 19 subbasins for the power block area and 3 subbasins for the makeup water reservoir. The overflow from the makeup water reservoir during the PMP contributes to the flood flow discharges along flow paths CT-E and CT-W. Table 2.4.2-208 lists the individual subbasin drainage areas of the 19 subbasins for the power block of Units 6 & 7.

The northern half of the switchyard and the parking lot is graded down from the high-point elevations of 21.0 feet and 23.0 feet NAVD 88, respectively, toward the retaining wall along the northern perimeter of the plant site where grade elevation is at 19.0 feet NAVD 88. Runoff from these areas would generally behave as sheet flows during the PMP condition. The runoff would flow along and over the swales on the northern perimeters of the plant area into the industrial wastewater facility. Therefore, the runoffs from these areas do not contribute flood flow to the major flow paths defined in the PMP analysis.

2.4.2.3.3 Peak Discharges

The steady-state backwater routing option of the U.S. Army Corps of Engineers computer program HEC-RAS (Reference 210) is used to estimate the maximum local PMP water levels along the flow paths as defined above. Cross section locations along the flow paths, i.e., the modeled channels, are shown on Figure 2.4.2-204.

For the runoff analysis, the PMP peak discharge at each subbasin outlet (referred to as the point of interest or POI) is determined using the Rational Method. To estimate the total discharge at each subbasin outlet, the drainage area of all subbasins upstream is included as summarized in Table 2.4.2-209 and shown on Figure 2.4.2-203. The PMP peak discharge for each subbasin is determined using the runoff coefficient, PMP intensity, and the subbasin POI drainage area.

Runoff coefficients were selected to represent the ground cover conditions of the subbasins. Conservative coefficients are selected to represent saturated ground conditions and as a result of the intense rainfall that would occur during a PMP event. Thus, a runoff coefficient of 1.0, representing 100 percent impervious surfaces, is conservatively selected for all subbasins.

The time of concentration for each subbasin is estimated using the National Resources Conservation Service (NRCS) methodologies (Reference 211). The flow paths for the time of concentration estimation are illustrated in Figure 2.4.2-203. It is postulated that in the first 100 feet of each flow path, the runoff is in the sheet flow regime. Beyond the sheet flow area, the runoff behaves as shallow concentrated flow until it reaches the swales. According to the guidance of the U.S. Army Corps of Engineers, to account for the nonlinear response during the PMP event, the estimated time of concentration for each subbasin should be reduced (Reference 212). Hence, the estimated time of concentration for each subbasins is reduced by 25 percent. The adjusted times of concentration at the subbasin POIs are in the range of 5 minutes to 19.9 minutes, as summarized in

Table 2.4.2-211. The corresponding PMP intensities are determined from Figure 2.4.2-201. Accordingly, the Rational Method, based on runoff coefficients, rainfall intensities, and subbasin drainage areas as determined above, is used to compute the peak discharges at each of the subbasin POIs. The PMP peak discharges for the POIs are listed in Table 2.4.2-211.

The top of wall of the makeup water reservoir is at 24 feet NAVD 88. It is conservatively assumed that the makeup water reservoir is full at the beginning of the PMP event. In order to estimate the peak discharge contribution from the reservoir, the overflow discharge on all sides of the reservoir is also calculated using the Rational Method. The PMP peak runoff is computed based on the area of the reservoir, a runoff coefficient of 1.0, and the 5-minute PMP intensity of 74.5 inches per hour for the 5-minute storm duration, as presented in Table 2.4.2-212. The depth of the contributing overflow discharges from the makeup water reservoir to flow paths CT-E and CT-W is determined using the broad-crested weir equation and the length of reservoir wall, as presented in Table 2.4.2-213. The peak discharges for subbasin POIs 1S3, 1S4, and 2S2, as presented in Table 2.4.2-211, include the overflow contributions from the makeup water reservoir.

The invert elevations of the swales and the modeled cross sections are determined from the finish grade elevation, as shown in Figure 2.4.2-202. The invert elevations and dimensions of the swales are presented in Table 2.4.2-210. The peak discharges of subbasins determined in Table 2.4.2-211 are distributed to the channel cross sections, as shown in Table 2.4.2-214.

Road crossings and retaining walls are modeled as inline structures with broad-crested weirs with a discharge coefficient of 2.6 (Reference 213). Using this fairly low weir coefficient produces higher and, therefore, more conservative water levels over the structures. Figure 2.4.2-234 is a schematic of a typical cross section at the East and West retaining walls and shows the overflow condition during the local PMP event.

The Manning's roughness coefficients (*n* values) for the channel and over bank areas are assigned based on guidance provided by Chow (Reference 214). A Manning's *n* of 0.033, the maximum value for dredged straight channel with short grass and few weeds, is used for the swales. The power block area is primarily paved with impervious surface. The area between the power block and the makeup water reservoir and the area between the power block and the parking lot/switchyard consist of grassy surfaces. These areas are represented by a

Manning's *n* of 0.05, which is the maximum value for over bank areas with high grass.

2.4.2.3.4 Flood Elevations

The results of the HEC-RAS model analysis and the estimated local PMP water levels at each model cross section are shown in Table 2.4.2-215. Plots of representative cross sections along the model flow paths are shown on Figures 2.4.2-205 through 2.4.2-233. In the figures, blue color indicates water and gray color indicates no-flow area such as obstruction or blockage associated with the wall and road crossings. There are no abrupt changes in the channel cross sections in the HEC-RAS model flow paths near the safety-related facilities, and the simulated water surface profile has a mild slope.

As shown in Table 2.4.2-215, the maximum local PMP water level in the power block area is approximately 24.5 feet NAVD 88, which is approximately 1.5 feet below the design grade of 26 feet NAVD 88 for safety-related structures. A sensitivity analysis was performed by adding interpolated cross sections to the HEC-RAS model (Reference 217). The results of the sensitivity analysis indicate that the maximum water level in the power block area due to the local PMP is not sensitive to additional interpolated cross sections.

In addition to the HEC-RAS analysis, the maximum water depth where runoff will be sheet flowing toward the east and west away from the safety-related structures in the power block is estimated. Grading in the power block is designed to provide positive drainage such that the local PMP ground and roof runoff will sheet flow toward the swales and the perimeters of the plant area, away from the buildings, to prevent flooding at the safety-related facilities. The peak water levels over the retaining wall are estimated as shown in Table 2.4.2-216 using the broad-crested weir equation where the retaining walls are treated as weirs. Some ponding may occur near the catch basins and other depressed areas. The ponding will be temporary and localized to the depressed areas.

The PMP-generated sheet flow depths near the safety-related structures are calculated. Peak discharges from the roofs of the safety-related structures are estimated using the Rational Method. The flow depth is estimated using Manning's Equation by postulating that the runoff will flow over the sides of the safety-related buildings and then sheet flow away from the buildings. Figure 2.4.2-235 shows a schematic cross section that illustrates the sheet flow condition away from a safety-related building. A conservatively high Manning's *n* value of 0.05 is used to represent a rough surface and to account for an increased roughness

influence on shallow flows over the surface. The estimated sheet flow depths in the yard area next to the safety-related structures are presented in Table 2.4.2-217. As shown in the table, the sheet flow depth near the safety-related facilities during a PMP is estimated to be in the range of 1.4 inches to 3.8 inches. The highest finish grade elevation in the power block is at 25.5 feet NAVD 88, which is 6 inches below the design grade of 26 feet NAVD 88 for safety-related facilities. Therefore, safety-related facilities are not impacted by PMP flooding.

The site drainage facilities and grading in the power block area are designed to provide positive drainage to evacuate runoff from the local PMP storm event. The finished floor slab elevations for all safety-related buildings are located above the estimated local PMP flood levels. No flood protection measures are considered necessary for the safety-related facilities of Units 6 & 7.

2.4.2.4 References

201. Federal Emergency *Management Agency, Flood Insurance Study*, Dade County, Florida and Incorporated Areas, Revised March 1994.

202. Lovelace, J., and B. McPherson, *Effects of Hurricane Andrew (1992) on Wetlands in Southern Florida and Louisiana*, U.S. Geological Survey, Water Supply Paper 2425, 1996.

203. Rappaport, E., *Preliminary Report: Hurricane Andrew*, 16–28 August, 1992, National Hurricane Center, National Oceanic and Atmosphere Administration. Available at http://www.nhc.noaa.gov/1992 andrew.html, accessed October 2, 2008.

204. U.S. Geological Survey, *South Florida Information Access-Data Exchange*, Hydrology Data. Available at http://sofia.usgs. gov/exchange/zucker_woods_patino/index.html#card, accessed October 15, 2008.

205. National Oceanic and Atmospheric Administration, *Tide and Current Record,* Gage 8723214, Virginia Key, Florida. Available at http:// tidesandcurrents.noaa.gov/geo.shtml?location=8723214, accessed October 3, 2008.

206. National Oceanic and Atmospheric Administration, *Tide and Current Record,* Gage 8723970, Vaca Key, Florida. Available at http:// tidesandcurrents.noaa.gov/geo.shtml?location=8723970, accessed October 15, 2008.

207. American National Standards Institute/American Nuclear Society, *American National Standard for Determining Design Basis Flooding at Nuclear Reactor Sites*, ANSI/ANS-2.8-1992, 1992 (withdrawn 2002).

208. National Oceanic and Atmospheric Administration, NWS, *Probable Maximum Precipitation Estimates*, United States East of the 105th Meridian, Hydrometeorological Report 51, June 1978.

209. National Oceanic and Atmospheric Administration, U.S. National Weather Service, *Application of Probable Maximum Precipitation Estimates — United States East of the 105th Meridian*, Hydrometeorological Report 52, August 1992.

210. U.S. Army Corps of Engineers, *Hydrologic Engineering Center,* River Analysis System, Ver. 3.1.3, May 2005.

211. U.S. Department of Agriculture, Natural Resources Conservation Service, *Urban Hydrology for Small Watersheds,* Technical Release 55, June 1986.

212. U.S. Army Corps of Engineers, *Flood-Runoff Analysis*, EM 1110-2-1417, August 1994.

213. Brater, E., and H. King, *Handbook of Hydraulics,* 6th ed., 1982.

214. Chow, V., Open Channel Hydraulics, 1959.

215. Southeast Regional Climate Center, *Climate Data*, Station 084091, Homestead Exp STN, Florida, Station 087760, Royal Palm Ranger Station, Florida, Station 087020, Perrine 4W, Florida. Available at http://www.sercc.com/climateinfo/historical/historical_fl.html, accessed April 7, 2010.

216. Southeast Regional Climate Center, *Climate Data*, Station 081716 Miami 12 SSW, Florida 1931–1958, Station 085678 Miami 12 SSW, Florida 1958–1988, Station 085663 Miami WSCMO Airport, Florida, Station 085658 Miami Beach, Florida, Station 083909 Hialeah, Florida and Station 088780 Tamiami Trail 40 MI BEN, Florida. Available at http://www.sercc.com/climateinfo/historical/historical_fl.html, accessed July 2, 2010.

217. U.S. Army Corps of Engineers, *Hydrologic Engineering Center, River Analysis System*, Ver. 4.0, March 2008.

PTN COL 2.4-2

Table 2.4.2-201
List of Major Flooding Events in Miami-Dade County, Florida

Flood Date	Flooding Event Description
September 6–22, 1926	The most severe storm recorded to hit the Miami area. Storm tides of 13.2 and 10.9 feet NGVD (11.7 and 9.4 feet NAVD 88) were recorded at Coconut Grove and mouth of Miami River, respectively.
October 30–November 8, 1935	Tide of 8 feet NGVD (6.5 feet NAVD 88) was recorded at Dinner Key, south of Miami.
September 11–19, 1947	Tides at Miami Beach reached 4.2 feet NGVD (2.7 feet NAVD 88).
October 9–15, 1947	This hurricane resulted in minor flooding on the bay side of Miami Beach.
October 15–19, 1950	Hurricane King: Tides of over 5 feet NGVD (3.5 feet NAVD 88) were recorded in Biscayne Bay.
August 20–September 5, 1964	Hurricane Cleo: Tides of 3.6 feet NGVD (2.1 feet NAVD 88) were recorded at the Florida Keys.
August 27–September 12, 1965	Hurricane Betsy: Considerable flooding between the greater Miami and Palm Beach area occurred. Miami Beach reported at 6.1 feet mean low water tide.
August 24, 1992	Hurricane Andrew: This hurricane caused considerable damage in South Dade County near Homestead.

Reference 201

PTN COL 2.4-2

Table 2.4.2-202
Peak Water Levels at Card Sound Canal Gage

Card Sound Canal (USGS Gage 251816080232200)			
Date	**Time**	**Water Level (feet, NAVD 88)**	**Tropical Storm/Hurricane Event**
11/12/2003	2:15	1.11	N/A
10/24/2005	8:00	1.01	Hurricane Wilma (10/15–10/26)
11/5/2006	0:15	0.69	N/A
10/8/2004	7:30	0.15	Tropical Storm Matthew (10/8–10/11)

Note: N/A = No association found
Reference 204

PTN COL 2.4-2

Table 2.4.2-203
Peak Water Levels at Manatee Bay Creek Gage

Manatee Bay Creek (USGS Gage 251549080251200)			
Date	**Time**	**Water Level (feet, NAVD 88)**	**Tropical Storm/Hurricane Event**
9/20/2005	16:00	2.27	Hurricane Rita (9/18–9/26)
11/11/2003	14:45	0.97	N/A
10/16/2005	14:00	0.9	Hurricane Wilma (10/15–10/26)
5/22/2007	19:00	0.83	N/A

Note: N/A = No association found
Reference 204

PTN COL 2.4-2

Table 2.4.2-204
Peak Water Levels at West Highway Creek Gage

West Highway Creek (USGS Gage 251433080265000)			
Date	**Time**	**Water Level (feet, NAVD 88)**	**Tropical Storm/Hurricane Event**
10/24/2005	19:45	2.59	Hurricane Wilma (10/15–10/26)
10/16/1999	3:30	1.86	Hurricane Irene (10/12–10/19)
9/5/2004	17:30	1.38	Hurricane Ivan (9/2–9/24)
9/21/1999	15:00	1.05	Tropical Storm Harvey (9/19–9/22)

Reference 204

PTN COL 2.4-2

Table 2.4.2-205
Peak Tide Level at Virginia Key Tide Gage Station

Virginia Key (Station ID: 8723214) Station Extreme Tide Level Report				
Peak Tide Level (feet STND[(a)])	**Peak Tide Level (feet NAVD 88)**	**Date of Peak Level**	**Time of Peak level**	**Tropical Storm/Hurricane Event**
14.92	2.79	10/24/2005	12:30	Hurricane Wilma (10/15–10/26)
14.30	2.17	9/20/2005	16:00	Hurricane Rita (9/18–9/26)
14.28	2.15	11/15/1994	11:12	Hurricane Gordon (11/8–11/21)
14.25	2.12	10/15/1999	19:42	Hurricane Irene (10/12–10/19)
14.05	1.92	9/26/2008	11:12	Hurricane Ike (9/1–9/14)

(a) STND = Station Datum
Reference 205

PTN COL 2.4-2

Table 2.4.2-206
Peak Tide Level at Vaca Key Tide Gage Station

Vaca Key (Station ID: 8723970) Station Extreme Tide Level Report				
Peak Tide Level (feet STND[a])	**Peak Tide Level (feet NAVD 88)**	**Date of Peak Level**	**Time of Peak Level**	**Tropical Storm/Hurricane Event**
9.31	5.43	10/24/2005	15:42	Hurricane Wilma (10/15–10/26)
5.07	1.19	8/26/2005	8:48	Hurricane Katrina (8/23–9/3)
4.94	1.06	10/07/1974	3:18	Subtropical Storm Unnamed Subtropical Storm 4 (10/4–10/9)
4.89	1.01	10/16/1999	1:12	Hurricane Irene (10/12–10/19)
4.86	0.98	11/06/2001	6:42	Hurricane Michelle (10/29–11/6)

(a) STND = Station Datum
Reference 205

PTN COL 2.4-2

Table 2.4.2-207
Units 6 & 7 Site Short Duration Local PMP Depths

PMP Duration & Area	1-hr, Point Location Ratio	Source	PMP Depth (in)	Intensity (in/hr)
6 hr, 10 mi^2	—	HMR 51 — Figure 18	32.0	5.3
1 hr, point location	—	HMR 52 — Figure 24	19.4	19.4
30 min, point	0.73	HMR 52 — Figure 38	14.2	28.3
15 min, point	0.50	HMR 52 — Figure 37	9.7	38.8
5 min, point	0.32	HMR 52 — Figure 36	6.2	74.5

PTN COL 2.4-2

Table 2.4.2-208
Subbasin Drainage Area

Subbasin	Drainage Area (ft^2)	Drainage Area (acres)
1S1	130,000	2.98
1S2	34,375	0.79
1S3	428,750	9.84
1S4	297,500	6.83
1N1	150,000	3.44
1N2	30,625	0.70
1N3	150,000	3.44
1N4	135,563	3.11
1N5	572,600	13.15
1N6	1,052,800	24.17
1W1	285,156	6.55
1W2	194,688	4.47
2S1	60,625	1.39
2S2	610,156	14.01
2N1	102,813	2.36
2N2	102,813	2.36
2N3	883,722	20.29
2N4	67,500	1.55
2E1	766,875	17.61

PTN COL 2.4-2

Table 2.4.2-209
Subbasin Point of Interest (POI) Drainage Areas

Subbasin POI	Contributing Upstream Subbasin	Total Drainage Area (acres)
1S1	1S1	2.98
1S3	1S1, 1S3	12.83
1S4	1S1–1S4	20.45
2S1	2S1	1.39
2S2	2S1, 2S2	15.40
1N1	1N1	3.44
1N3	1N1, 1N3	6.89
1N5	1N1, 1N3, 1N5	20.03
1N6	1N1–1N6	48.02
2N1	2N1	2.36
2N3	2N1–2N4	26.56
1W1	1W1	6.55
1W2	1W2	4.47
2E1	2E1	17.61

PTN COL 2.4-2

Table 2.4.2-210 (Sheet 1 of 2)
Swale Dimensions[a]

	Cross Section	Swale Invert NAVD 88 (ft)
Cooling Tower EAST	1100	20.3
	900	19.9
	700	19.5
	400	18.9
	300	18.6
	200	18.4
	150	18.3
	100	18.2
	50	18.1
	20	18.1
	Cross Section	**Swale Invert NAVD 88 (ft)**
Cooling Tower WEST	1100	20.3
	900	19.9
	700	19.5
	500	19.1
	350	18.8
	300	18.6
	200	18.4
	150	18.3
	100	18.2
	20	18.1
	Cross Section	**Swale Invert NAVD 88 (ft)**
Parking Lot - East	900	19.5
	800	19.3
	600	19.0
	400	18.6
	300	18.5
	240	18.4
	200	18.3
	50	18.1
	20	18.0

PTN COL 2.4-2

Table 2.4.2-210 (Sheet 2 of 2) Swale Dimensions[a]

	Cross Section	North of Power Block Area Swale Invert NAVD 88 (ft)	Clear Sky Substation Swale Invert NAVD 88 (ft)
Switch Yard - West	1290	19.5	N/A
	1190	19.3	21.0
	1000	19.1	20.5
	800	18.9	20.0
	600	18.7	19.5
	500	18.5	19.2
	300	18.3	18.8
	200	18.2	18.5
	150	18.2	18.4
	50	18.0	18.1
	20	18.0	18.1

(a) Side-slope of all swales is 2 (horizontal) to 1 (vertical)

PTN COL 2.4-2

Table 2.4.2-211
Units 6 & 7 Subbasin Local PMP Peak Discharges

Subbasin POI	Drainage Area (acres)	Composite Runoff Coefficient	Time of Concentration (min)	Rainfall Intensity (in/hr)	PMP Peak Discharge without MWR Overflow (cfs)	MWR Overflow (cfs)	Combined PMP Peak Discharge (cfs)
1S1	2.98	1	5.0	74.5	222.3	—	222.3
1S3	12.83	1	8.1	63.0	808.1	275.1	1083.2
1S4	20.45	1	10.0	56.0	1145.0	235.8	1655.9
2S1	1.39	1	5.0	74.5	103.7	—	103.7
2S2	15.40	1	10.3	56.0	862.3	534.5	1396.8
1N1	3.44	1	5.0	74.5	256.5	—	256.5
1N3	6.89	1	5.5	73.0	502.8	—	502.8
1N5	20.03	1	13.0	47.0	941.5	—	941.5
1N6	48.02	1	19.9	36.0	1728.6	—	1728.6
2N1	2.36	1	5.2	74.0	174.7	—	174.7
2N3	26.56	1	13.6	45.0	1195.1	—	1195.1
1W1	6.55	1	5.0	74.5	487.7	—	487.7
1W2	4.47	1	5.0	74.5	333.0	—	333.0
2E1	17.61	1	5.5	73.0	1285.2	—	1285.2

PTN COL 2.4-2

Table 2.4.2-212
Flow Depth Over the Crest of Makeup Water Reservoir Walls

Reservoir	Storage Reservoir Wall Length (feet)	Drainage Area (acres)	PMP Peak Discharge (cfs)	Flow Depth over MWR Wall (feet)	Flow Depth over MWR Wall (inches)
CT	5717	36.19	2696.1	0.32	3.8

PTN COL 2.4-2

Table 2.4.2-213
Total Discharge Over the Northern Wall of the Makeup Water Reservoir

Subbasin	MWR Wall Length (feet)	Flow Depth over MWR Wall (feet)	PMP Peak Discharge From MWR Overflow (cfs)
CT-1N1	583	0.32	275.1
CT-1N2	500	0.32	235.8
CT-2N1	1133	0.32	534.5
sum=	2217	sum=	1045.4

PTN COL 2.4-2

Table 2.4.2-214 (Sheet 1 of 2)
Units 6 & 7 Flow Path Cross Section PMP Peak Discharge

	Cross Section Channel Station	Contributing Subbasin	Subbasin POI Cumulative Peak Discharge (cfs)	Subbasin POI Incremental Peak Discharge (cfs)	Peak Discharge Allocation Percentage	Upstream Contributing Subbasins	Cross Section Peak Discharge (cfs)
Cooling Tower West	1100	1S3	1083.2	1083.2	5%	1S1, 1S3, CT-1N1	54.2
	900	1S3	1083.2	1083.2	50%	1S1, 1S3, CT-1N1	541.6
	700	1S3	1083.2	1083.2	100%	1S1, 1S3, CT-1N1	1083.2
	500	1S4	1655.9	572.7	10%	1S1-1S4,CT-1N1, CT-1N2	1140.5
	350	1S4	1655.9	572.7	30%	1S1-1S4,CT-1N1, CT-1N2	1255.0
	300	1S4	1655.9	572.7	40%	1S1-1S4,CT-1N1, CT-1N2	1312.3
	200	1S4	1655.9	572.7	70%	1S1-1S4,CT-1N1, CT-1N2	1484.1
	150	1S4	1655.9	572.7	80%	1S1-1S4,CT-1N1, CT-1N2	1541.4
	100	1S4	1655.9	572.7	90%	1S1-1S4,CT-1N1, CT-1N2	1598.6
	20	1S4	1655.9	572.7	100%	1S1-1S4,CT-1N1, CT-1N3	1655.9
	0	1S4	1655.9	572.7	100%	1S1-1S4,CT-1N1, CT-1N2	1655.9
Cooling Tower East	1100	2S2	1396.8	1396.8	5%	2S1, 2S2, CT-2N1	69.8
	900	2S2	1396.8	1396.8	20%	2S1, 2S2, CT-2N1	279.4
	700	2S2	1396.8	1396.8	40%	2S1, 2S2, CT-2N1	558.7
	400	2S2	1396.8	1396.8	60%	2S1, 2S2, CT-2N1	838.1
	300	2S2	1396.8	1396.8	70%	2S1, 2S2, CT-2N1	977.8
	200	2S2	1396.8	1396.8	80%	2S1, 2S2, CT-2N1	1117.5
	150	2S2	1396.8	1396.8	85%	2S1, 2S2, CT-2N1	1187.3
	100	2S2	1396.8	1396.8	90%	2S1, 2S2, CT-2N1	1257.2
	50	2S2	1396.8	1396.8	95%	2S1, 2S2, CT-2N1	1327.0
	20	2S2	1396.8	1396.8	100%	2S1, 2S2, CT-2N2	1396.8
	0	2S2	1396.8	1396.8	100%	2S1, 2S2, CT-2N1	1396.8
Parking Lot — East	900	2N3	1195.1	1195.1	5%	2N1, 2N2, 2N4	59.8
	800	2N3	1195.1	1195.1	15%	2N1, 2N2, 2N4	179.3
	600	2N3	1195.1	1195.1	35%	2N1, 2N2, 2N4	418.3
	400	2N3	1195.1	1195.1	55%	2N1, 2N2, 2N4	657.3
	300	2N3	1195.1	1195.1	60%	2N1, 2N2, 2N4	717.1
	240	2N3	1195.1	1195.1	75%	2N1, 2N2, 2N4	896.3
	200	2N3	1195.1	1195.1	80%	2N1, 2N2, 2N4	956.1
	50	2N3	1195.1	1195.1	95%	2N1, 2N2, 2N4	1135.3
	20	2N3	1195.1	1195.1	100%	2N1, 2N2, 2N5	1195.1
	0	2N3	1195.1	1195.1	100%	2N1, 2N2, 2N4	1195.1

PTN COL 2.4-2

Table 2.4.2-214 (Sheet 2 of 2)
Units 6 & 7 Flow Path Cross Section PMP Peak Discharge

	Cross Section Channel Station	Contributing Subbasin	Subbasin POI Cumulative Peak Discharge (cfs)	Subbasin POI Incremental Peak Discharge (cfs)	Peak Discharge Allocation Percentage	Upstream Contributing Subbasins	Cross Section Peak Discharge (cfs)
Switch Yard — West	1290	1N5	941.5	941.5	20%	1N1, 1N53, 1N5	188.3
	1190	1N5	941.5	941.5	45%	1N1, 1N53, 1N5	423.7
	1000	1N5	941.5	941.5	100%	1N1, 1N53, 1N5	941.5
	800	1N6	1728.6	787.1	10%	1N1-1N6	1020.2
	600	1N6	1728.6	787.1	35%	1N1-1N6	1217.0
	500	1N6	1728.6	787.1	50%	1N1-1N6	1335.0
	300	1N6	1728.6	787.1	70%	1N1-1N6	1492.5
	200	1N6	1728.6	787.1	80%	1N1-1N6	1571.2
	150	1N6	1728.6	787.1	85%	1N1-1N6	1610.5
	50	1N6	1728.6	787.1	95%	1N1-1N6	1689.2
	20	1N6	1728.6	787.1	100%	1N1-1N7	1728.6
	0	1N6	1728.6	787.1	100%	1N1-1N6	1728.6

PTN COL 2.4-2

Table 2.4.2-215 (Sheet 1 of 3)
HEC-RAS Model Result for Units 6 & 7

Flow Path	Reach	Channel Station (cross section)	Profile	PMP Peak Discharge (cfs)	Minimum Channel Elevation NAVD 88 (ft)	Water Surface Elevation NAVD 88 (ft)	Channel Velocity (ft/s)	Froude Number
Cooling Tower W	PMP CT-W	1100	PMP	54.2	20.3	24.5	0.1	0.01
Cooling Tower W	PMP CT-W	1000[(a)]	PMP	54.2	20.1	24.5	0.1	0.01
Cooling Tower W	PMP CT-W	900	PMP	541.6	19.9	24.5	1.5	0.13
Cooling Tower W	PMP CT-W	800[(a)]	PMP	541.6	19.7	24.4	1.5	0.13
Cooling Tower W	PMP CT-W	700	PMP	1083.2	19.5	24.4	3.3	0.27
Cooling Tower W	PMP CT-W	600[(a)]	PMP	1083.2	19.3	24.3	2.9	0.23
Cooling Tower W	PMP CT-W	500	PMP	1140.5	19.1	24.2	3.2	0.25
Cooling Tower W	PMP CT-W	425[(a)]	PMP	1140.5	18.9	24.2	3.3	0.26
Cooling Tower W	PMP CT-W	350	PMP	1255.0	18.8	24.1	3.9	0.30
Cooling Tower W	PMP CT-W	300	PMP	1312.3	18.6	24.1	4.2	0.32
Cooling Tower W	PMP CT-W	200	PMP	1484.1	18.4	23.9	5.5	0.42
Cooling Tower W	PMP CT-W	150	PMP	1541.4	18.3	23.7	6.3	0.49
Cooling Tower W	PMP CT-W	100	PMP	1598.6	18.2	23.2	10.2	0.82
Cooling Tower W	PMP CT-W	80	Inline Structure	1598.6	N/A	23.2	N/A	N/A
Cooling Tower W	PMP CT-W	20	PMP	1655.9	18.1	22.8	3.3	0.28
Cooling Tower W	PMP CT-W	10	Inline Structure	1655.9	N/A	22.8	N/A	N/A
Cooling Tower W	PMP CT-W	0	PMP	1655.9	0.0	1.3	6.5	1.01
Cooling Tower E	PMP CT-E	1100	PMP	69.8	20.3	23.9	0.2	0.02
Cooling Tower E	PMP CT-E	1000[(a)]	PMP	69.8	20.1	23.9	0.2	0.02
Cooling Tower E	PMP CT-E	900	PMP	279.4	19.9	23.9	1.0	0.09
Cooling Tower E	PMP CT-E	800[(a)]	PMP	279.4	19.7	23.8	1.0	0.09
Cooling Tower E	PMP CT-E	700	PMP	558.7	19.5	23.8	2.1	0.19
Cooling Tower E	PMP CT-E	600[(a)]	PMP	558.7	19.3	23.8	2.2	0.19
Cooling Tower E	PMP CT-E	500[(a)]	PMP	558.7	19.1	23.7	2.3	0.19
Cooling Tower E	PMP CT-E	400	PMP	838.1	18.9	23.6	4.5	0.37
Cooling Tower E	PMP CT-E	300	PMP	977.8	18.6	23.1	7.3[(b)]	0.63

PTN COL 2.4-2

Table 2.4.2-215 (Sheet 2 of 3)
HEC-RAS Model Result for Units 6 & 7

Flow Path	Reach	Channel Station (cross section)	Profile	PMP Peak Discharge (cfs)	Minimum Channel Elevation NAVD 88 (ft)	Water Surface Elevation NAVD 88 (ft)	Channel Velocity (ft/s)	Froude Number
Cooling Tower E	PMP CT-E	250	Inline Structure	977.8	N/A	23.1	N/A	N/A
Cooling Tower E	PMP CT-E	200	PMP	1117.5	18.4	23.1	5.9[(b)]	0.50
Cooling Tower E	PMP CT-E	150	PMP	1187.3	18.3	22.9	6.6[(b)]	0.56
Cooling Tower E	PMP CT-E	100	PMP	1257.2	18.2	22.7	6.9[(b)]	0.59
Cooling Tower E	PMP CT-E	50	PMP	1327.0	18.1	22.6	5.4[(b)]	0.46
Cooling Tower E	PMP CT-E	20	PMP	1396.8	18.1	22.7	2.7	0.23
Cooling Tower E	PMP CT-E	10	Inline Structure	1396.8	N/A	22.7	N/A	N/A
Cooling Tower E	PMP CT-E	0	PMP	1396.8	0.0	0.6	4.6	1.00
Switch Yard	PMP SY-W	1290	PMP	188.3	19.5	22.9	0.5	0.05
Switch Yard	PMP SY-W	1190	PMP	423.7	19.3	22.9	0.5	0.08
Switch Yard	PMP SY-W	1095[(a)]	PMP	423.7	19.2	22.9	0.4	0.06
Switch Yard	PMP SY-W	1000	PMP	941.5	19.1	22.9	0.8	0.12
Switch Yard	PMP SY-W	900[(a)]	PMP	941.5	19.0	22.8	0.8	0.11
Switch Yard	PMP SY-W	800	PMP	1020.2	18.9	22.8	0.9	0.12
Switch Yard	PMP SY-W	700[(a)]	PMP	1020.2	18.8	22.8	0.8	0.12
Switch Yard	PMP SY-W	600	PMP	1217	18.6	22.8	1.1	0.14
Switch Yard	PMP SY-W	500	PMP	1335	18.5	22.7	1.1	0.15
Switch Yard	PMP SY-W	400[(a)]	PMP	1335	18.4	22.7	1.1	0.15
Switch Yard	PMP SY-W	300	PMP	1492.5	18.3	22.7	1.2	0.17
Switch Yard	PMP SY-W	200	PMP	1571.2	18.2	22.6	1.3	0.18
Switch Yard	PMP SY-W	150	PMP	1610.5	18.2	22.6	1.6	0.21
Switch Yard	PMP SY-W	125	Inline Structure	1610.5	N/A	22.6	N/A	N/A
Switch Yard	PMP SY-W	50	PMP	1689.2	18.0	22.6	1.5	0.2
Switch Yard	PMP SY-W	20	PMP	1728.6	18.0	22.6	1.1	0.14
Switch Yard	PMP SY-W	10	Inline Structure	1728.6	N/A	22.6	N/A	N/A
Switch Yard	PMP SY-W	0	PMP	1728.6	0.0	1.3	6.6	1.01
Parking Lot	PMP PL E	900	PMP	59.8	19.4	22.8	0.2	0.02

PTN COL 2.4-2

Table 2.4.2-215 (Sheet 3 of 3)
HEC-RAS Model Result for Units 6 & 7

Flow Path	Reach	Channel Station (cross section)	Profile	PMP Peak Discharge (cfs)	Minimum Channel Elevation NAVD 88 (ft)	Water Surface Elevation NAVD 88 (ft)	Channel Velocity (ft/s)	Froude Number
Parking Lot	PMP PL E	800	PMP	179.3	19.3	22.8	0.5	0.05
Parking Lot	PMP PL E	700[(a)]	PMP	179.3	19.1	22.8	0.5	0.04
Parking Lot	PMP PL E	600	PMP	418.3	19.0	22.8	1.1	0.1
Parking Lot	PMP PL E	500[(a)]	PMP	418.3	18.8	22.8	1.1	0.1
Parking Lot	PMP PL E	400	PMP	657.3	18.6	22.8	1.8	0.16
Parking Lot	PMP PL E	300	PMP	717.1	18.5	22.7	2.0	0.17
Parking Lot	PMP PL E	240	PMP	896.3	18.4	22.7	2.5	0.22
Parking Lot	PMP PL E	200	PMP	956.1	18.3	22.7	2.8	0.24
Parking Lot	PMP PL E	88	Inline Structure	956.1	N/A	22.7	N/A	N/A
Parking Lot	PMP PL E	50	PMP	1135.3	18.1	22.6	2.7	0.23
Parking Lot	PMP PL E	20	PMP	1195.1	18.0	22.6	3.8	0.32
Parking Lot	PMP PL E	10	Inline Structure	1195.1	N/A	22.6	N/A	N/A
Parking Lot	PMP PL E	0	PMP	1195.1	0.0	1	8.6	1.48

(a) Interpolated Cross Section
(b) Segments of the drainage swale experiencing high velocity are protected with rip rap or concrete lining
N/A Not applicable for Inline Structure

PTN COL 2.4-2

Table 2.4.2-216
Sheet Flow Depth Over the Retaining Wall

Subbasin	PMP Peak Discharge for Subbasin (cfs)	Weir Coefficient for Broad Crested Weir	Retaining Wall Length (ft)	Flow Depth over the Retaining Wall NAVD 88 (ft)	Maximum Water Level over Retaining wall (ft NAVD 88)
1W1	487.7	2.6	733.0	0.4	21.9
1W2	333.0	2.6	666.0	0.3	21.8
2E1	1232.4	2.6	1133.0	0.6	22.1

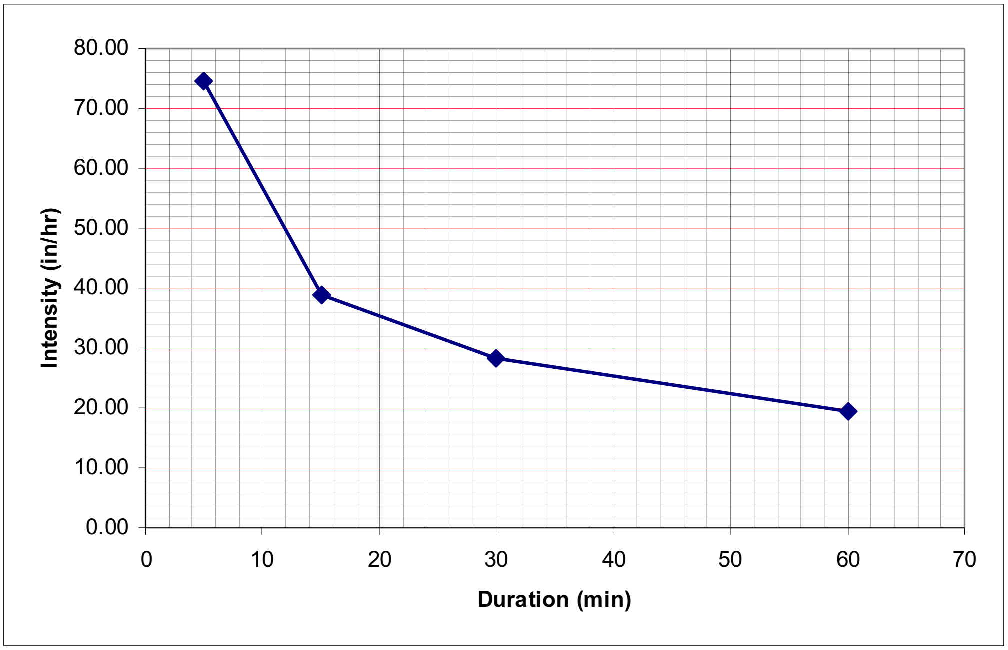
PTN COL 2.4-2

Table 2.4.2-217
Sheet Flow Depth Near Safety-Related Buildings

Subbasin	Proportion of Safety Buildings Contributing to Sheet Flow Depth	Safety Building (acre)	PMP Peak Discharge Generated Near Safety Building (cfs)	Manning's *n*	Width, b (ft)	Slope, S	Flow Depth (ft)	Flow Depth (in)	Maximum Water Level Near Safety-Related Structures (ft NAVD 88)
1W1	1/4 of Containment Building, 1/20 of Auxiliary Building	0.13	9.7	0.1	100.0	0.005	0.2	1.9	25.7
1W2	1/4 of Containment Building	0.10	7.5	0.1	125.0	0.005	0.1	1.4	25.6
2E1	1/3 of Containment Building, 2/3 of Auxiliary Building	1.24	92.4	0.1	300.0	0.005	0.3	3.8	25.8

PTN COL 2.4-2

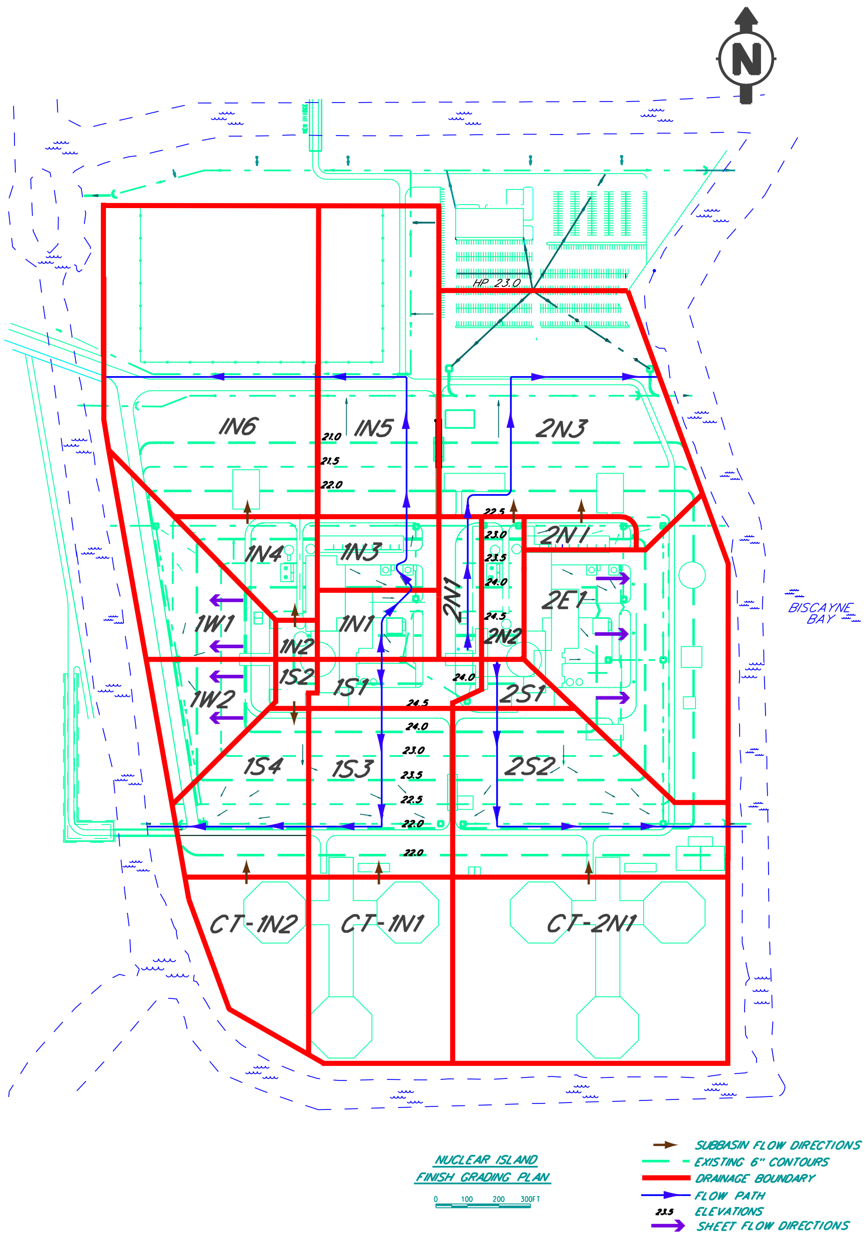
Figure 2.4.2-201 Units 6 & 7 Site Local PMP Intensity-Duration Curve



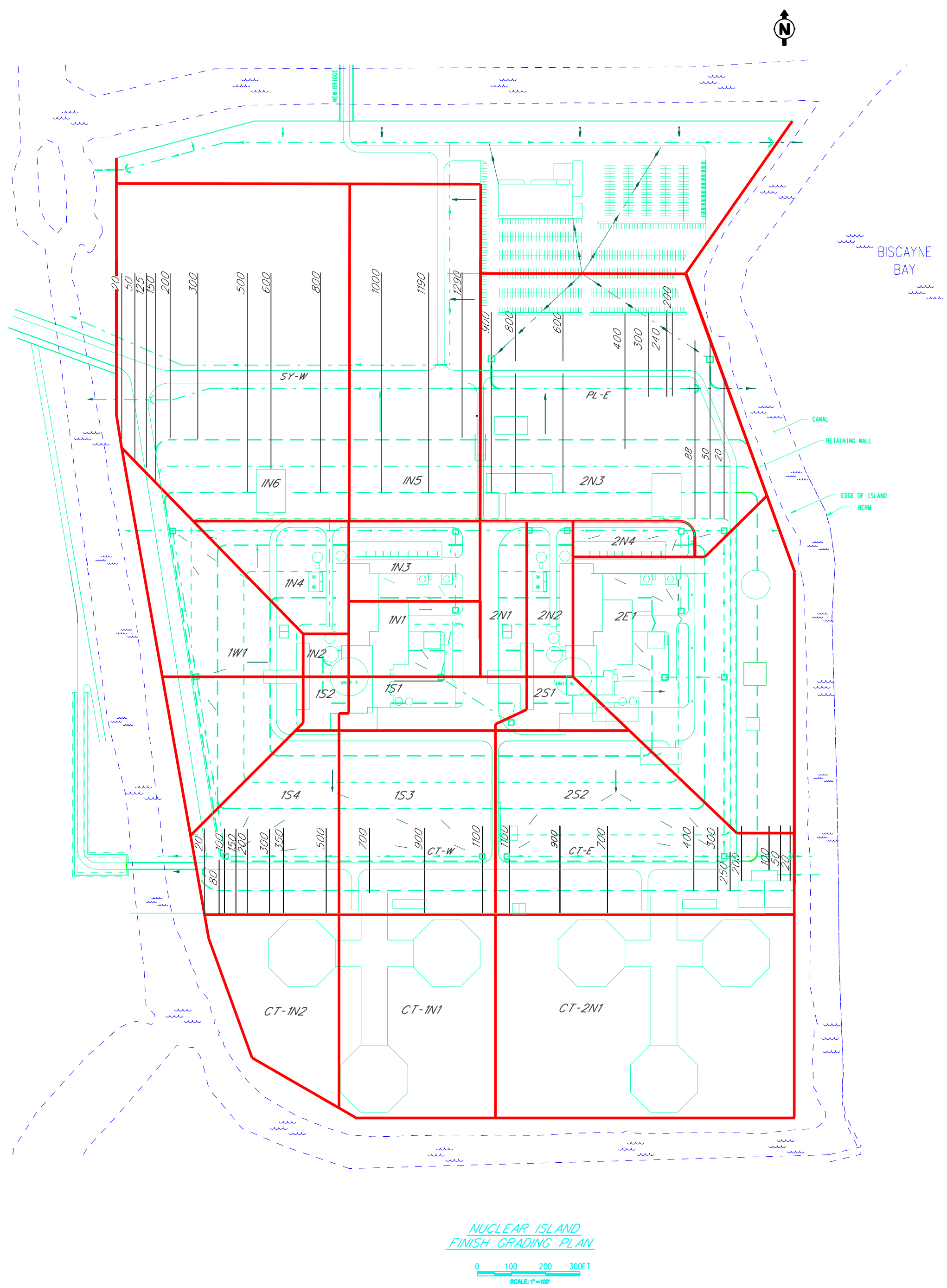
PTN COL 2.4-2

Figure 2.4.2-202 Units 6 & 7 Power Block Finish Grading Plan

PTN COL 2.4-2 **Figure 2.4.2-203 Units 6 & 7 Local PMP Analysis Subbasin Drainage Areas**



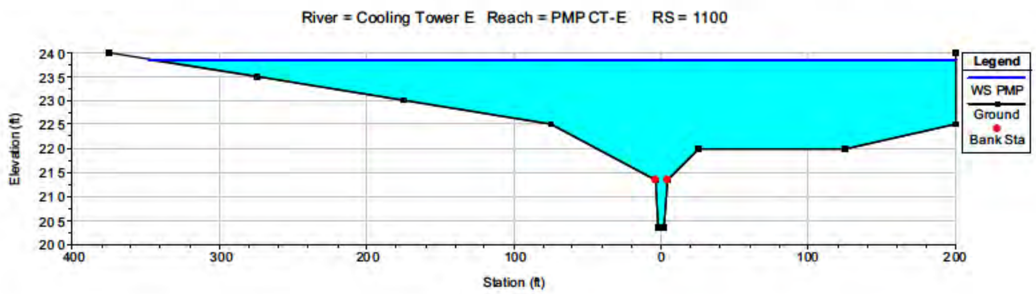
PTN COL 2.4-2 **Figure 2.4.2-204 Units 6 & 7 Local PMP Analysis HEC-RAS Cross Section Locations**



Note: River Station 0 of each of the HEC-RAS model flow paths is located 20 to 30 feet downstream of River Station 20 and does not represent any physical feature.

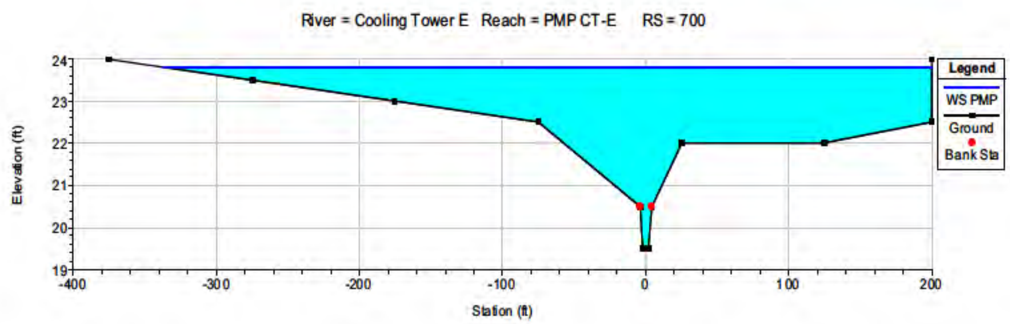
PTN COL 2.4-2

Figure 2.4.2-205 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Cooling Tower East Cross Section 1100



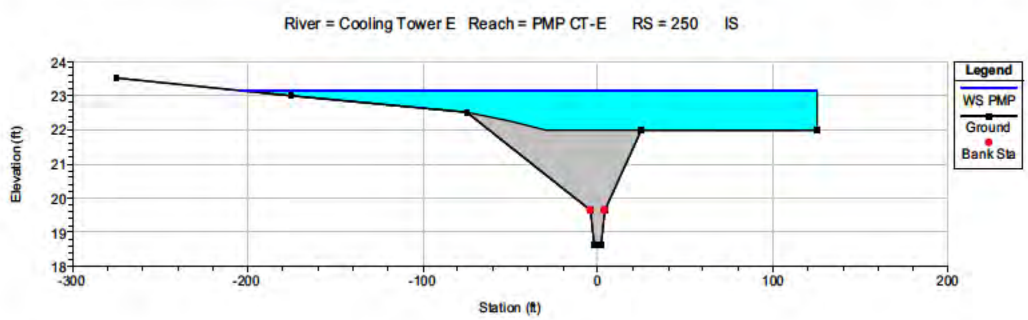
PTN COL 2.4-2

Figure 2.4.2-206 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Cooling Tower East Cross Section 700

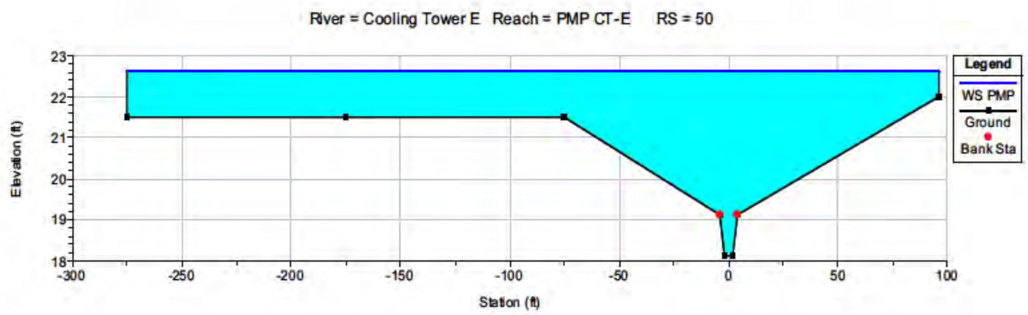


PTN COL 2.4-2

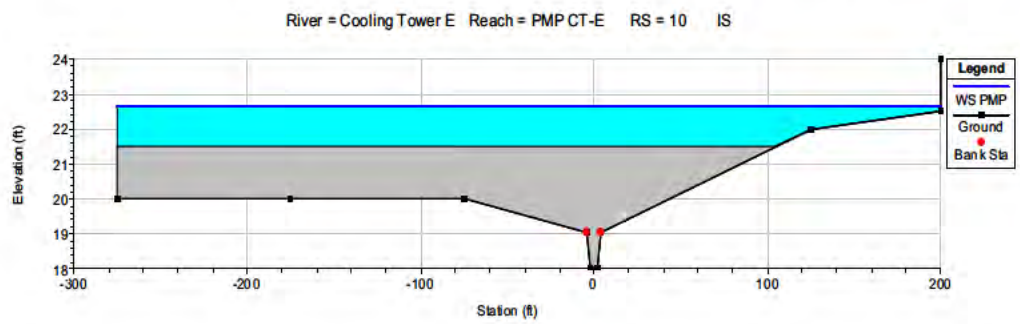
Figure 2.4.2-207 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Cooling Tower East Cross Section 250 Inline Structure (IS)



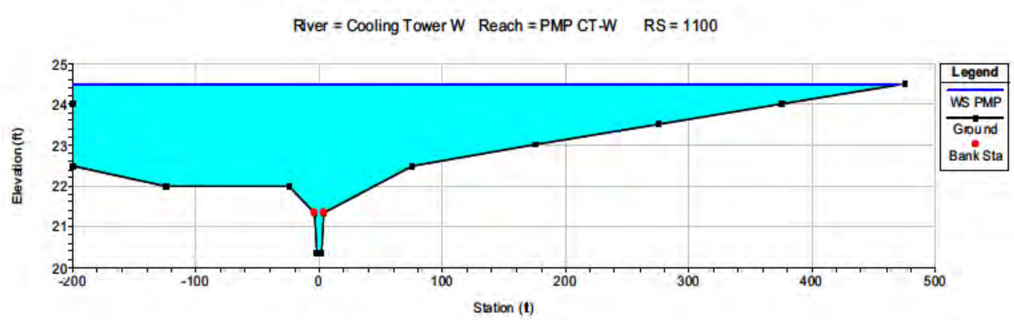
PTN COL 2.4-2 **Figure 2.4.2-208 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Cooling Tower East Cross Section 50**



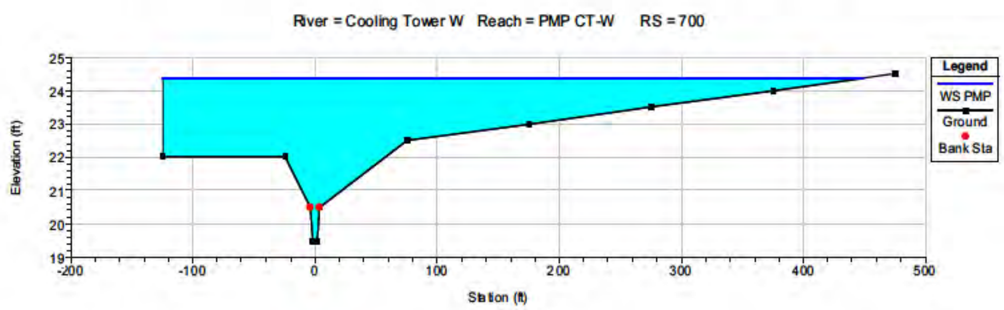
PTN COL 2.4-2 **Figure 2.4.2-209 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Cooling Tower East Cross Section 10 IS**



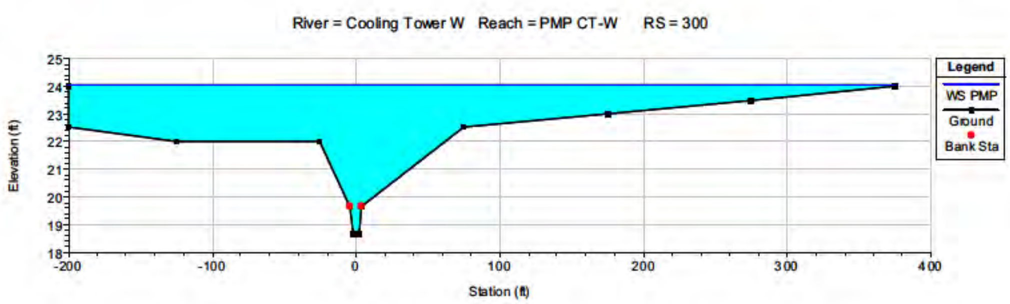
PTN COL 2.4-2 **Figure 2.4.2-210 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Cooling Tower West Cross Section 1100**



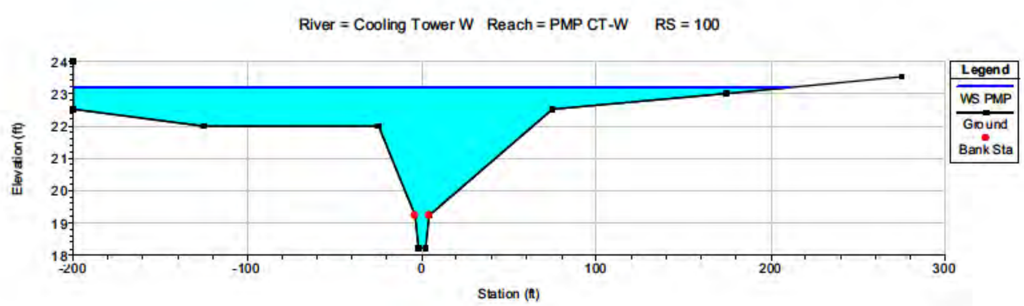
PTN COL 2.4-2 **Figure 2.4.2-211 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Cooling Tower West Cross Section 700**



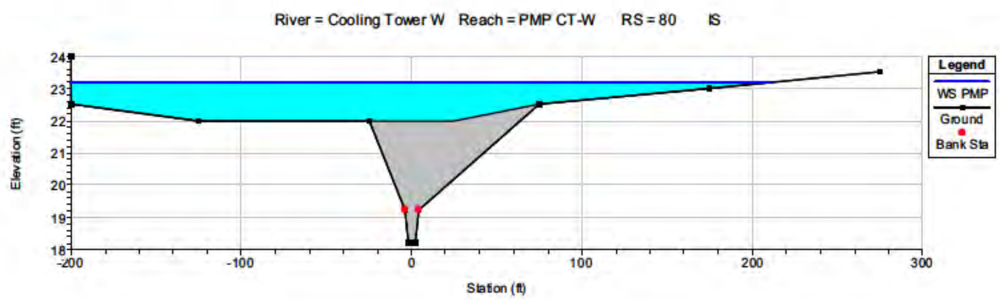
PTN COL 2.4-2 **Figure 2.4.2-212 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Cooling Tower West Cross Section 300**



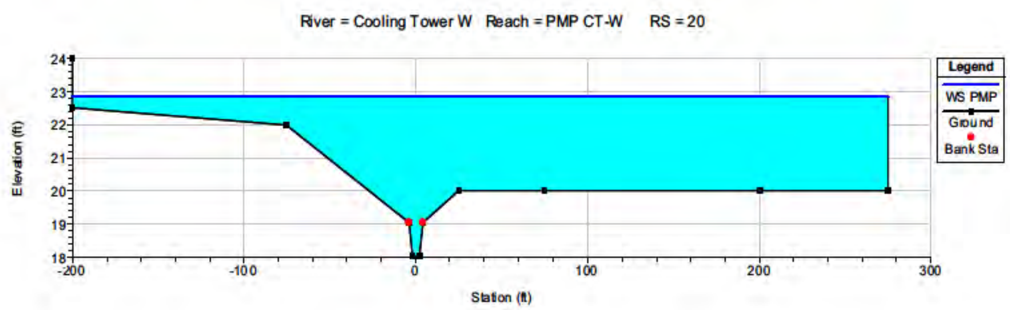
PTN COL 2.4-2 **Figure 2.4.2-213 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Cooling Tower West Cross Section 100**



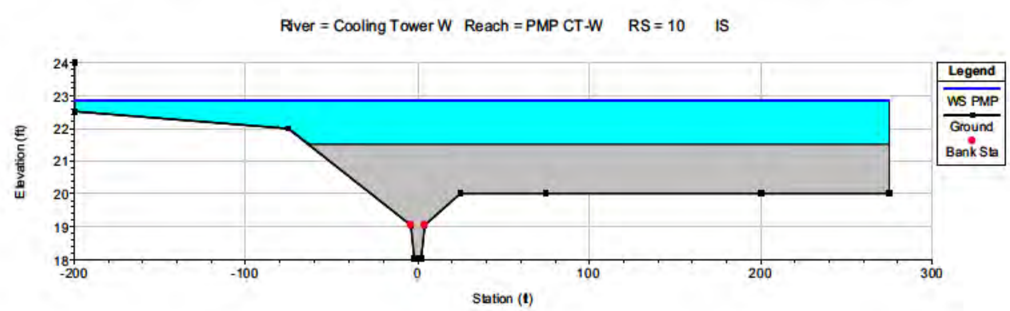
PTN COL 2.4-2 **Figure 2.4.2-214 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Cooling Tower West Cross Section 80 IS**



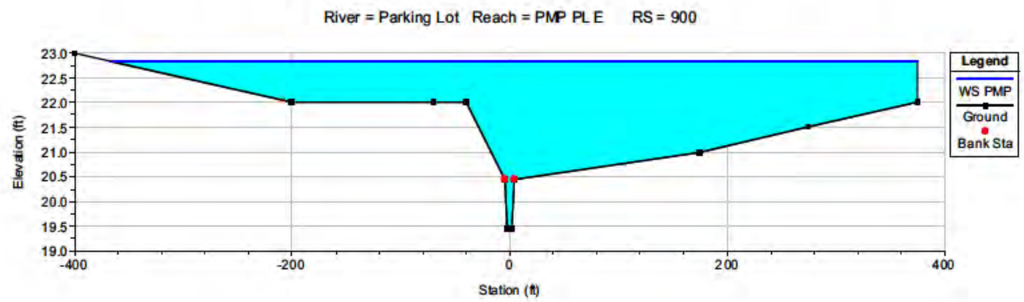
PTN COL 2.4-2 **Figure 2.4.2-215 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Cooling Tower West Cross Section 20**



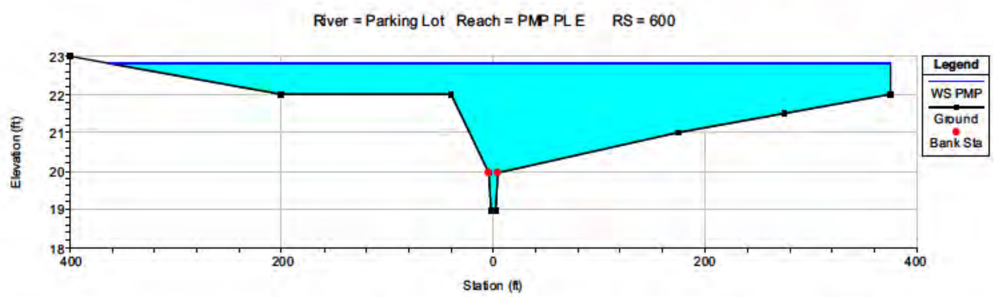
PTN COL 2.4-2 **Figure 2.4.2-216 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Cooling Tower West Cross Section 10 IS**



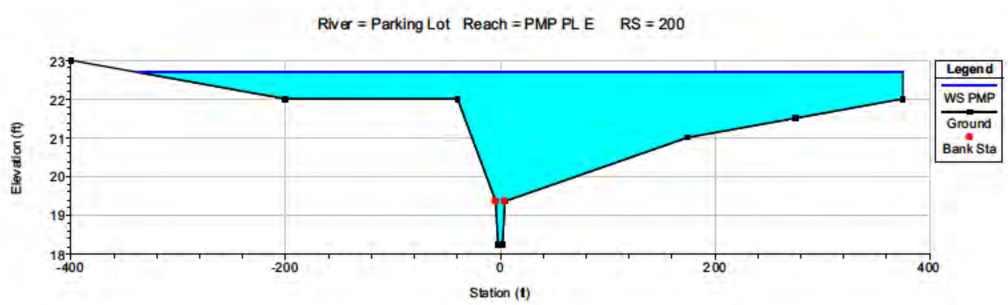
PTN COL 2.4-2 **Figure 2.4.2-217 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Parking Lot East Cross Section 900**



PTN COL 2.4-2 **Figure 2.4.2-218 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Parking Lot East Cross Section 600**

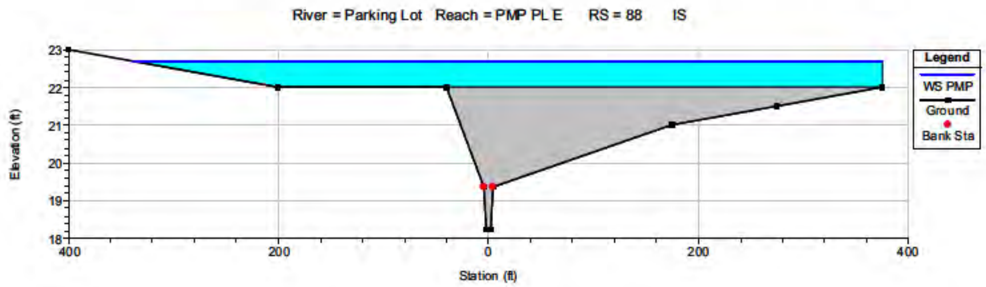


PTN COL 2.4-2 **Figure 2.4.2-219 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Parking Lot East Cross Section 200**



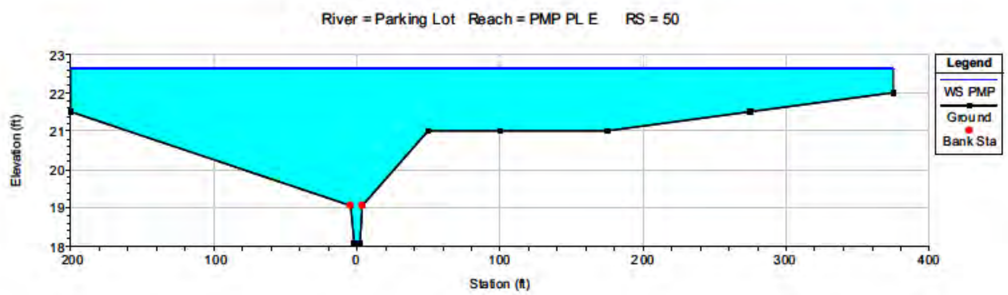
PTN COL 2.4-2

Figure 2.4.2-220 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Parking Lot East Cross Section 88 IS



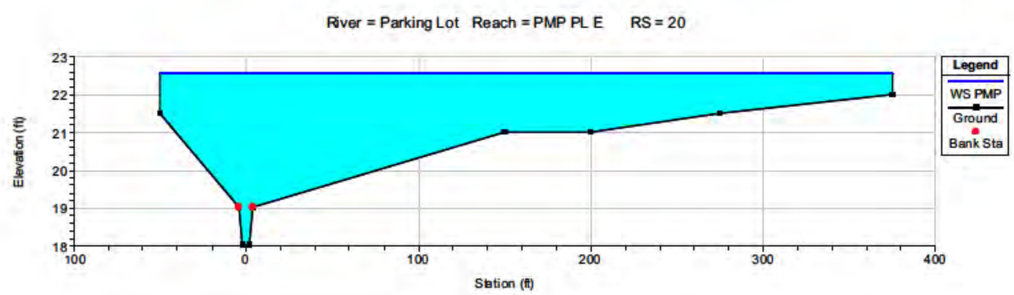
PTN COL 2.4-2

Figure 2.4.2-221 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Parking Lot East Cross Section 50

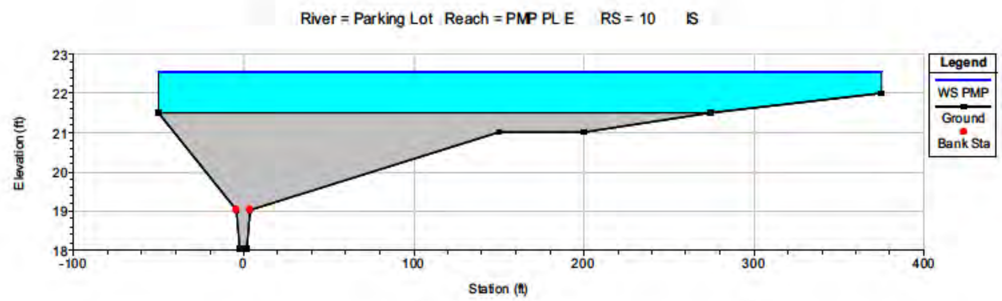


PTN COL 2.4-2

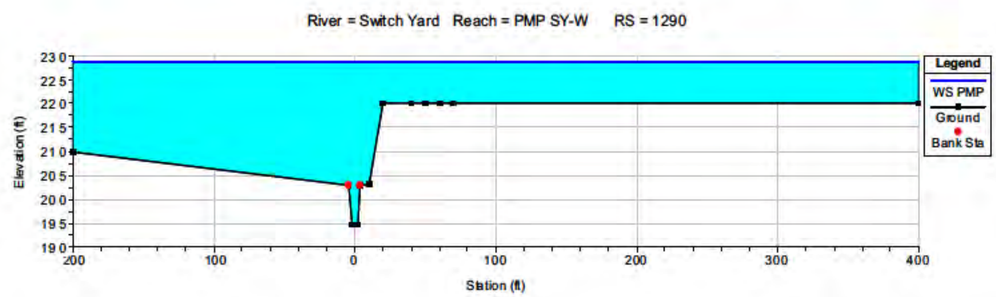
Figure 2.4.2-222 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Parking Lot East Cross Section 20



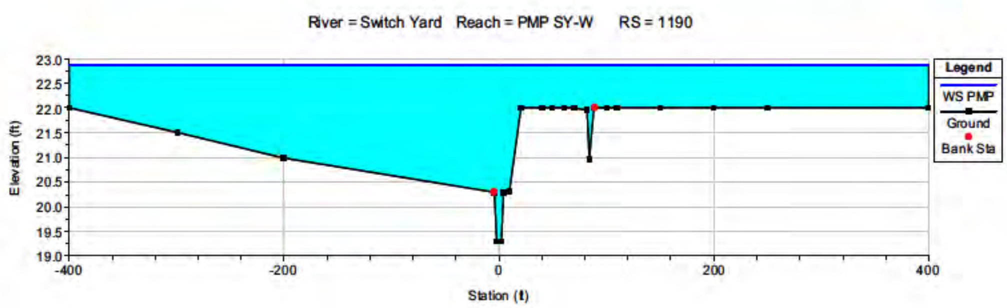
PTN COL 2.4-2 **Figure 2.4.2-223 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Parking Lot East Cross Section 10 IS**



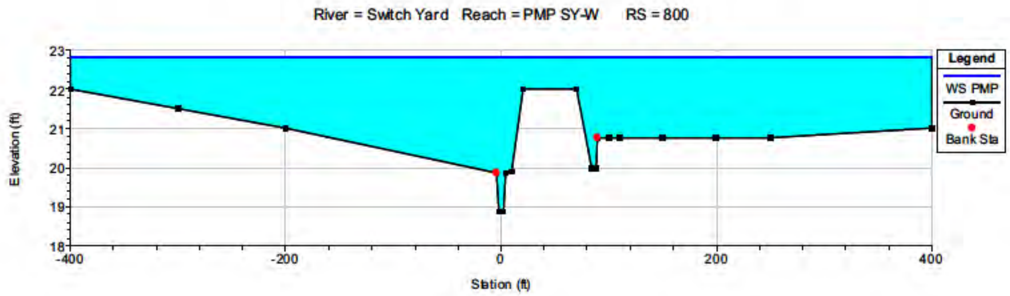
PTN COL 2.4-2 **Figure 2.4.2-224 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Parking Lot East Cross Section 1290**



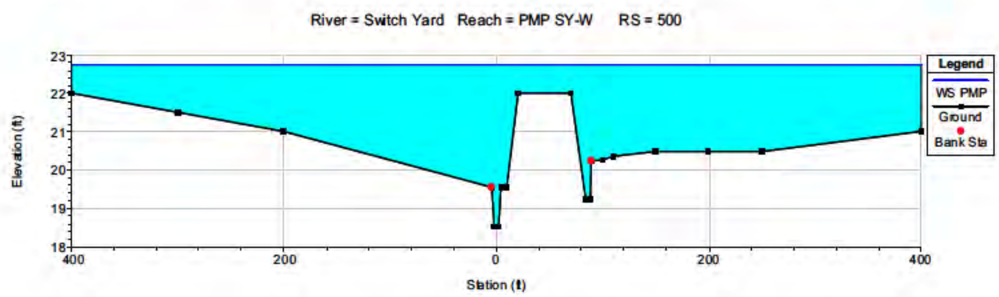
PTN COL 2.4-2 **Figure 2.4.2-225 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Parking Lot East Cross Section 1190**



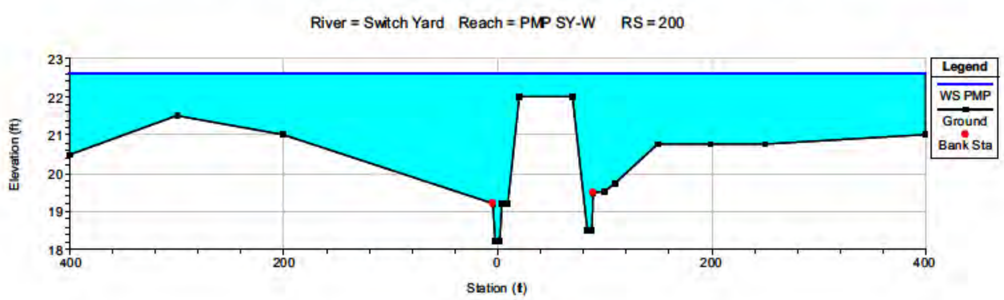
PTN COL 2.4-2 **Figure 2.4.2-226 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Switchyard West Cross Section 800**



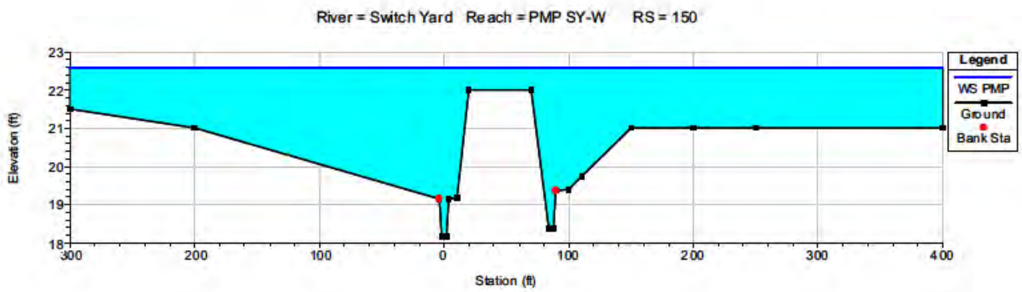
PTN COL 2.4-2 **Figure 2.4.2-227 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Switchyard West Cross Section 500**



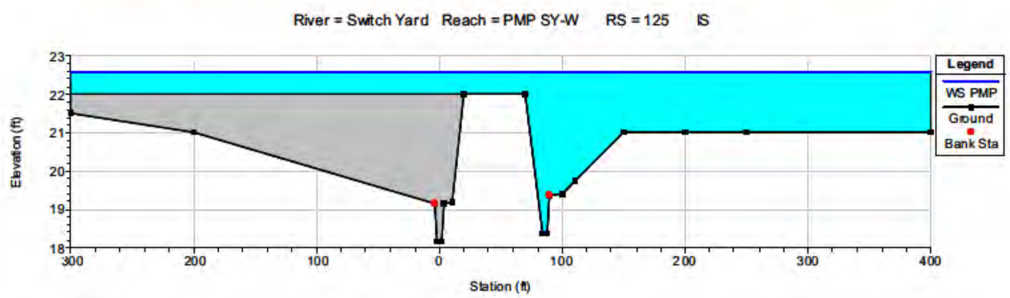
PTN COL 2.4-2 **Figure 2.4.2-228 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Switchyard West Cross Section 200**



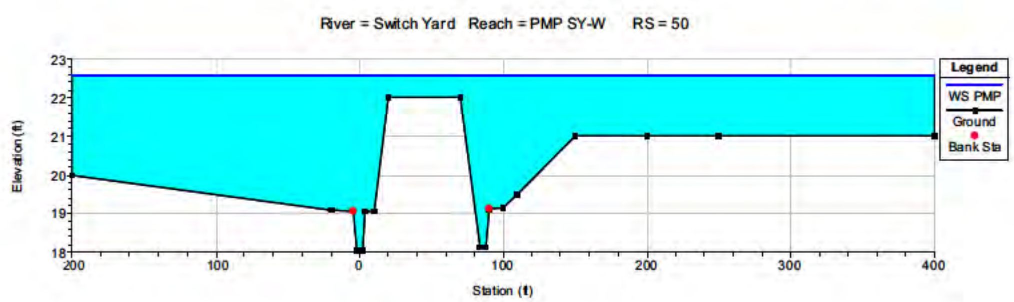
PTN COL 2.4-2 **Figure 2.4.2-229 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Switchyard West Cross Section 150**



PTN COL 2.4-2 **Figure 2.4.2-230 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Switchyard West Cross Section 125 IS**

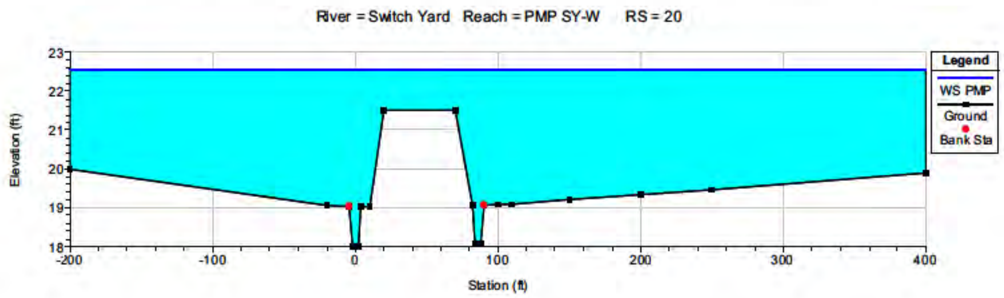


PTN COL 2.4-2 **Figure 2.4.2-231 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Switchyard West Cross Section 50**



PTN COL 2.4-2

Figure 2.4.2-232 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Switchyard West Cross Section 20



PTN COL 2.4-2

Figure 2.4.2-233 Units 6 & 7 Local PMP HEC-RAS Cross Section and PMP Flood Level: Switchyard West Cross Section 10 IS

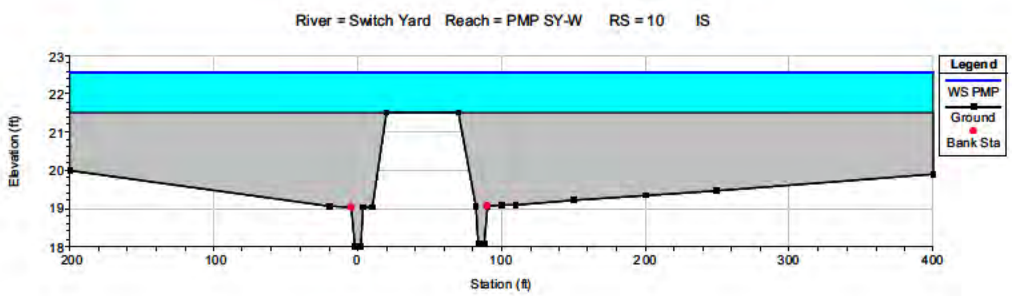
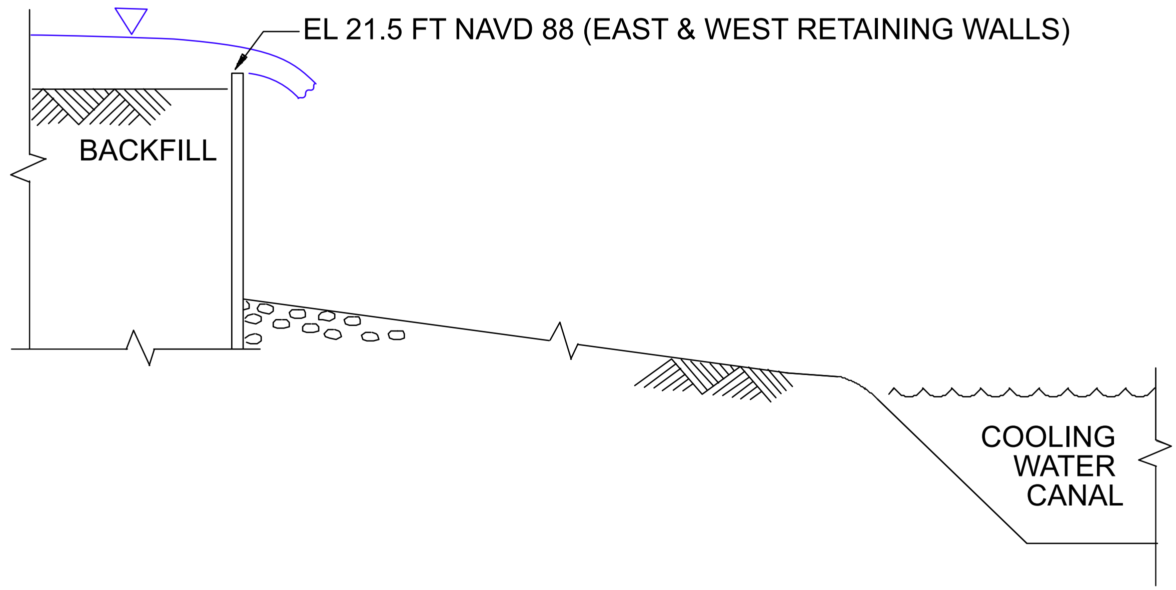
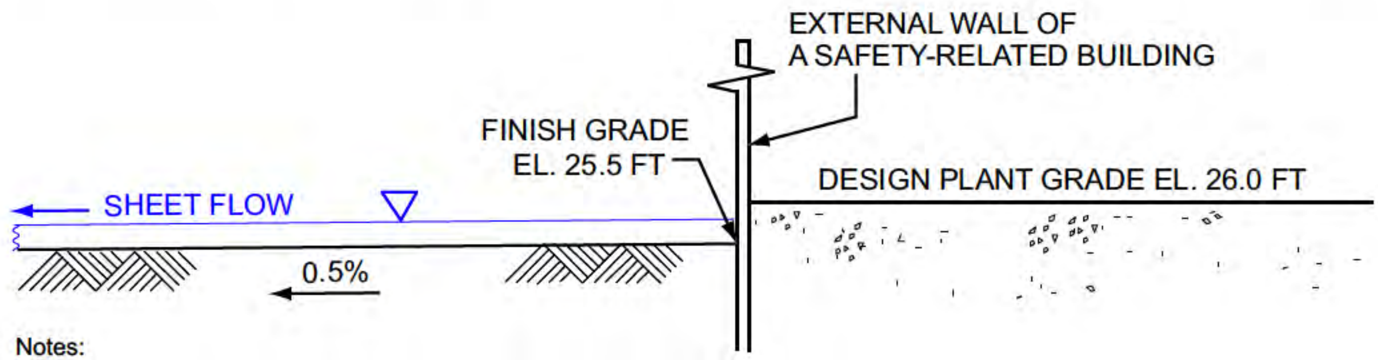


Figure 2.4.2-234 Schematic of Overflow Condition at the Retaining Wall Boundary



Note: Not to scale.

Figure 2.4.2-235 Schematic of a Typical Sheet Flow Condition Adjacent to a Safety-related Building



Notes:
-Elevation in NAVD 88.
-Not to scale.

SUBSECTION 2.4.3:
PROBABLE MAXIMUM FLOOD ON STREAMS AND RIVERS

PTN COL 2.4-2 2.4.3 PROBABLE MAXIMUM FLOOD ON STREAMS AND RIVERS

Units 6 & 7 are located adjacent to the Biscayne Bay shoreline. There are no major natural streams or rivers nearby. The topography of the area is extremely flat with natural elevations ranging from 2 to 5 feet NAVD 88 (Reference 201). Although there are no major natural streams or rivers nearby, there are several man-made canals located west of Units 6 & 7 extending from Florida City and Homestead to Biscayne Bay as described in Subsection 2.4.1.

A storm event with the magnitude of the probable maximum precipitation (PMP) would likely be associated with a tropical storm event and accompanied by a strong low-pressure system and a storm surge in the Biscayne Bay. The NOAA Hydrometeorological Report No. 51, Subsection 3.2.5 indicates that PMP estimates in Florida were developed by adjusting rainfall events associated with tropical storms for a looping track, a known occurrence with tropical storms along the Atlantic Ocean and Gulf of Mexico coasts where rainfall is concentrated over a specific area (Reference 202). Near the shoreline, where Units 6 & 7 are located, the seawater level in Biscayne Bay would control the floodwater level in these canals. The Federal Emergency Management Agency Flood Insurance Study, Dade County, Florida and Incorporated Areas (Reference 203), provides still water elevations in Biscayne Bay at the Turkey Point plants and near the mouths for these canals for various return period frequencies. These still water levels range between elevation 8.5 feet NGVD 29 (6.9 feet NAVD 88) (Reference 204) for the 10-year return period still water elevation (Reference 203, Table 2, Transect 31) to 12.4 feet NGVD 29 (10.8 feet NAVD 88) (Reference 204) for the 500-year return period still water elevation (Reference 203, Table 2, Transect 30). All historical flooding events listed in the Dade County Flood Insurance Study are a result of tropical storms, which indicates that flooding in the county is primarily a result of tropical storm events (Reference 203).

The still water elevation as a result of the probable maximum hurricane is at elevation 21.1 feet NAVD 88 with a wave run-up water level at elevation 24.8 feet NAVD 88 as presented in Subsection 2.4.5. As described in Subsection 2.4.2, the design grade elevation for Units 6 & 7 safety-related buildings is elevation 26.0 feet NAVD 88, which is above the Biscayne Bay flood elevations listed above.

Additionally, the flood elevations listed above are higher than the ground elevations surrounding Units 6 & 7 as well as the canal locations. Therefore,

floodwater levels from Biscayne Bay will extend landward a significant distance even during a 10-year flooding event on the bay. Water levels in Biscayne Bay will control the water levels in the canals. Because the topography near the site and the canals is flat for many miles in all directions, it provides a large amount of storage volume for canal flooding with very little increase in water level.

For instance, the floodplain width for the Florida City Canal, located north of the site, is more than 45,000 feet wide upstream of the site as measured from the Florida City Canal to the Little Card Sound shoreline south of the site (Reference 201). As indicated above, the elevations in the vicinity of the site range from 2 to 5 feet NAVD 88. Using this information, every 1000 foot reach of the Florida City Canal floodplain contains approximately 1030 acre-ft of storage for every foot of vertical rise above elevation 5 feet NAVD 88. FSAR Subsection 2.4.2 indicates that the 6 hour, 10 square mile PMP depth is 32.0 inches. With the flat topography and wide floodplains described above, there would be no concentration of the flood discharge as the runoff and canal overflows would spread out laterally in the floodplain areas near the site. Consequently, the flood level from 32 inches of precipitation would not reach levels above those estimated for the probable maximum hurricane level indicated in Subsection 2.4.5, or that would impact the site, which have the safety-related buildings design grade elevation at 26.0 feet NAVD 88.

In accordance with American National Standards/American Nuclear Society 2.8-1992 (Reference 205), nuclear power reactor sites located on shorelines only need to consider flooding as a result of the probable maximum hurricane. There is no additional need to consider the impacts of flooding as a result of the PMP on adjacent streams or rivers as a result of the controlling nature of coastal water levels along a shoreline. Based on the estimation that storm surge elevations in Biscayne Bay control flood levels in the canals and that there are no other nearby major streams or rivers, a PMP runoff analysis on streams and rivers for Units 6 & 7 was not performed. Subsection 2.4.2 includes a description on the local PMP runoff analysis performed for the power block area to assess the impacts of the PMP on the Units 6 & 7 drainage system.

2.4.3.1 References

201. U.S. Geological Survey, *Arsenicker Keys and Card Sound Quadrangles*, Florida-Dade County, 7.5 Minute Series Topographic Maps, 1997 and 1994.

202. National Oceanic and Atmospheric Administration, NWS, *Probable Maximum Precipitation Estimates*, United States East of the 105th Meridian, Hydrometeorological Report No. 51, June 1978.

203. Federal Emergency Management Agency, *Flood Insurance Study*, Dade County, Florida and Incorporated Areas, Revised March 1994.

204. U.S. National Geodetic Survey, *National Vertical Datum Conversion Utility*. Available at http://www.ngs.noaa.gov/TOOLS/Vertcon/vertcon.html, accessed August 2008.

205. American National Standards Institute/American Nuclear Society, *American National Standard for Determining Design Basis Flooding at Power Reactor Sites*, ANSI/ANS-2.8-1992, 1992 (withdrawn 2002).

SUBSECTION 2.4.4: POTENTIAL DAM FAILURES
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2.4.4 POTENTIAL DAM FAILURES

PTN COL 2.4-2 As stated in Subsection 2.4.3, there are no major natural streams or rivers near Units 6 & 7, and, therefore, there are no dams located upstream or downstream of the site. The nearest embankment dam is the Herbert Hoover Dike that surrounds Lake Okeechobee. The dike and lake are located more than 90 miles northwest of Units 6 & 7 (Reference 201). There is no direct channel or stream path from Lake Okeechobee to Units 6 & 7 (Reference 201). Any breach of the Herbert Hoover Dike would result in floodwaters from the breach quickly spreading out laterally from the breaching location, as the topography between the lake and Units 6 & 7 is relatively flat. Herbert Hoover Dike Breach Inundation Area maps published in the Unified Local Mitigation Strategy for Palm Beach County, Florida and produced by the U.S. Army Corps of Engineers (Reference 203) indicate that flooding, as a result of a Herbert Hoover Dike breach, does not extend beyond the drainage canals located along the Palm Beach–Broward County line between Lake Okeechobee and the site. Thus, flood water from a Herbert Hoover Dike breach has no impact on the Units 6 & 7 site.

The Units 6 & 7 concrete water storage reservoir, referred to as the makeup water reservoir, is located in the cooling tower area south of the power block. The top of the reservoir wall is at elevation 24.0 feet NAVD 88, which is 2 feet below the design grade elevation of the safety-related structures. The existing cooling water return canals for Units 1, 2, 3 & 4 surround the reservoir walls on the east, south, and west sides. Any breach that were to occur along these three sides of the reservoir would result in water flowing away from the power block and into the canals, to the Biscayne Bay, or to the low-lying natural topography south and west of Units 6 & 7. Therefore, breaches along these three sides would not pose a flooding risk to the safety-related facilities.

A breach in the makeup water reservoir northern wall results in water flowing toward the power block area. The design grade elevation adjacent to the north wall of the makeup water reservoir is at approximately elevation 22.0 feet NAVD 88. Thus, the reservoir wall extends only 2 feet above grade. The maximum operating water level in the reservoir is approximately elevation 22.5 feet NAVD 88, 1.5 feet below the top of the reservoir. When considering a breach of the northern reservoir wall, the combined events criteria in American National Standards/American Nuclear Society 2.8-1992 (Reference 202) indicate that a one-half probable maximum flood shall be considered coincidental with a dam breach event. The one-half probable maximum flood for the makeup water reservoir is a result of the one-half probable maximum precipitation (PMP) directly over the reservoir. During a one-half PMP storm event of 27.9 inches over a 72-

hour period, the makeup water reservoir overflows along all four sides. As presented in Subsection 2.4.2 the full PMP event maximum discharge over the reservoir walls is estimated to be approximately 2696 cubic feet per second (cfs). During a one-half PMP storm event, the peak discharge over the reservoir wall is then estimated to be approximately 1348 cfs. Using the broad crest weir equation with a total wall length of 5717 feet around the four sides of the reservoir and a weir coefficient of 2.6, the maximum water level is 2.4 inches (0.2 foot) above the top of the reservoir wall at elevation 24.0 feet NAVD 88. Thus, the maximum one-half PMP water level in the reservoir is approximately elevation 24.2 feet NAVD 88.

If a breach were to occur in the north wall of the makeup water reservoir during a one-half PMP event, the maximum head during the peak outflow from the reservoir would be approximately 2.2 feet above the finished grade adjacent to north wall of the reservoir at elevation 22.0 feet NAVD 88. With a water level in the reservoir at the time of the breach at elevation 24.2 feet NAVD 88 (i.e., 1.8 feet below the elevation of the safety-related design grade elevation at 26.0 feet NAVD 88), the flood wave from a breach in the north wall of the reservoir does not pose a flooding risk to the safety-related facilities. It should also be noted that there are more than 700 feet between the makeup water reservoir wall and the nearest safety-related building (i.e., the auxiliary building for either Unit 6 or 7).

A detailed dam breach flooding analysis was not performed for Units 6 & 7 because there are no upstream or downstream dams that would pose a flooding potential to Units 6 & 7 and the makeup water reservoir top of wall elevation is lower than the design grade elevation of the safety-related facilities.

2.4.4.1 References

201. U.S. Geological Survey, *Florida Topographic 2 Sided Map*, Florida South Section, Scale 1:500,000, 1989.

202. American National StandardsInstitute/American Nuclear Society, *American National Standard for Determining Design Basis Flooding at Power Reactor Sites*, ANSI/ANS-2.8-1992, 1992 (withdrawn 2002).

203. Palm Beach County, Florida, *Unified Local Mitigation Strategy*, 2009.

SUBSECTION 2.4.5: PROBABLE MAXIMUM SURGE AND SEICHE FLOODING
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2.4.5 PROBABLE MAXIMUM SURGE AND SEICHE FLOODING

PTN COL 2.4-2 This subsection describes the probable maximum wind and associated meteorological parameters that could produce the probable maximum storm surge (PMSS) at Units 6 & 7. A summary of historical storm surge events and the effects of probable maximum surge and seiche flooding on the safety-related facilities at Units 6 & 7 are also presented in this subsection.

2.4.5.1 Probable Maximum Winds and Associated Meteorological Parameters

Subsection 2.4.5 of NUREG-0800 defines the PMSS as the surge that results from a combination of meteorological parameters of a probable maximum hurricane (PMH), a probable maximum wind storm (PMWS), or a moving squall line that has virtually no probability of being exceeded in the region involved.

The NOAA Technical Report NWS 23 defines the PMH as a hypothetical steady-state hurricane with a combination of meteorological parameters that will give the highest sustained wind speed that can probably occur at a specified coastal location (Reference 201). The meteorological parameters that define the PMH wind field include the hurricane peripheral pressure (p_n), central pressure (p_o), radius of maximum winds (R), forward speed (T), track direction (θ), and inflow angles of the hurricane winds (φ). NUREG-0800 (Subsection 2.4.5) indicates that the PMH, as defined by the NOAA Technical Report NWS 23 (Reference 201), should be estimated for coastal locations that may be exposed to these events.

The PMH parameters at the Atlantic coast near Units 6 & 7 are obtained from the NOAA Technical Report NWS 23 (Reference 201). The PMH parameter values were established based on data from historical hurricanes from 1851 to 1977 and were presented for multiple locations along the Gulf of Mexico and Atlantic Ocean coastlines corresponding to their milepost distances from the U.S.-Mexico border. The milepost distance to the shoreline location nearest to Units 6 & 7 is estimated to be 1450 nautical miles (1669 miles) (Reference 201).

The pressure difference between the hurricane peripheral and central pressures, Δp, is identified as the most important meteorological parameter in defining the hurricane wind field (Reference 201). NOAA Technical Report NWS 23 provides single values of PMH peripheral and central pressures along the mileposts, thereby giving single values for Δp. However, a range of values (i.e., lower and upper bounds) is provided for other PMH parameters. The PMH parameters, as estimated from the NOAA Technical Report NWS 23 for a location on the Atlantic Ocean shoreline at milepost 1450 nautical miles, are summarized in

Table 2.4.5-201. As can be seen in Table 2.4.5-201, the Δp at this location is 4.0 inches of mercury or 135.5 millibars.

The effect of long-term climate variability on hurricane intensity is an area of active research. Since 1977, several intense hurricanes had made landfall on the Gulf of Mexico and Atlantic coasts. Research on the effects of El Niño/Southern Oscillation indicated that while El Niño conditions tend to suppress hurricane formation in the Atlantic basin, La Niña conditions tend to favor hurricane development (Reference 202). Additionally, research has been performed into the relationship between the Atlantic Multi-decadal Oscillation (AMO), which is the variation of long-duration sea surface temperature in the northern Atlantic Ocean with cool and warm phases that may last for 20 to 40 years, and hurricane intensity (Reference 202). It shows that hurricane activities increase during the warm phases of the AMO compared to hurricane activities during the AMO cool phases. Recent hurricane data indicates that Atlantic hurricane seasons have been significantly more active since 1995. However, hurricane activities during the earlier years, such as from 1945 to 1970, were apparently as active as in the recent decade (References 202 and 203).

Blake et al. indicated that during the past 35 years, the conterminous U.S. was affected by the landfall of three Category 4 or stronger hurricanes: Hurricane Charley of 2004, Hurricane Andrew of 1992, and Hurricane Hugo of 1989 (Reference 203). Based on the analysis of hurricane data from 1851 to 2006, they summarized that, on the average, the U.S. is affected by a Category 4 or stronger hurricane approximately once every 7 years, thereby suggesting that there have been fewer exceptionally strong hurricane landfalls during the past 35 years than an expected 35-year average of approximately five (Reference 203).

Because NOAA Technical Report NWS 23 includes the last active hurricane period from 1945 to 1970 (and any such earlier periods from 1851) in the analysis, it is reasonable to assume that the PMH parameters derived are sufficiently conservative even in the considerations of future climate variability.

2.4.5.2 Surge and Seiche Water Level

Units 6 & 7 are located adjacent to the Biscayne Bay shoreline, approximately 8 miles west of the Elliott Key Barrier Island, as shown on Figure 2.4.5-201. The finished grade elevation at the plant area where safety-related facilities are located is at 25.5 feet NAVD 88. The elevation of floor entrances and openings of all safety-related structures (also referred to as the design plant grade elevation in the DCD, which is 100 feet or 30.48 meters in the DCD reference datum) is 26

feet NAVD 88. Following the guidance from NUREG-0800, the PMSS is postulated to be generated by the PMH approaching from the Atlantic Ocean. Because storm surges near Units 6 & 7 would inundate the barrier islands, seiche oscillations within the bay are not expected to coincide with large storm surge events like the PMSS, as addressed in Subsection 2.4.5.4.

2.4.5.2.1 Historical Hurricane Events and Storm Surges

A list of hurricanes that caused sustained hurricane wind damage to the Florida coast (including hurricanes that did not make landfall) between 1851 and 2006 is presented in Table 2.4.5-202 (Reference 203). Figure 2.4.5-202 shows the tracks of all hurricanes in the Atlantic basin during the same period with intensities equal to or greater than Hurricane Category 3 in the Saffir-Simpson Hurricane Scale. Unless specified otherwise, the Saffir-Simpson Hurricane Scale as shown in Table 2.4.5-203 (Reference 203), is used throughout this subsection to describe hurricane intensities. Blake et al. analyzed the frequencies of hurricanes of different categories that had landfall on the U.S. coast (Reference 203). They reported that approximately 40 percent of all hurricanes, Category 3 and above, that had landfall in the U.S. affected Florida, while 83 percent of hurricanes of Category 4 or higher struck the Florida and Texas coasts (Reference 203).

As indicated in Table 2.4.5-202, the Category 5 Labor Day hurricane of August/September 1935 was the most intense hurricane since 1851 that affected the Florida coast. The hurricane had made landfall on the islands of Islamorada in the upper Florida Keys, south of Units 6 & 7. The track for the 1935 Labor Day hurricane is shown on Figure 2.4.5-202. The 1935 Labor Day hurricane, with a central pressure of 892 millibars, also had the lowest central pressure at landfall for any hurricane on the U.S. coast since 1851 (Table 2.4.5-202).

The most severe recent hurricane that made landfall near Units 6 & 7 was Hurricane Andrew. Originating as a tropical depression in August 1992 near the Cape Verde Islands, Hurricane Andrew moved through the northwestern Bahamas, the southern Florida peninsula, and south-central Louisiana, bringing unprecedented devastation (Reference 204). With damage in the U.S. estimated to be near 26.5 billion U.S. dollars, Hurricane Andrew is ranked as the second most costly hurricane in U.S. history after Hurricane Katrina (Reference 203). This Category 5 hurricane had landfall at Fender Point, Florida in Miami-Dade County, approximately 8 nautical miles (9.2 miles) east-northeast of Homestead, Florida (Reference 204). The landfall location was approximately 8 miles north of the plant area. At landfall, the hurricane had a central pressure of 922 millibars and a maximum sustained wind speed (1-minute average, 33-foot-high) of 145 knots

(167 miles per hour). It is also the fourth most intense hurricane in history to make landfall in the United States (References 203 and 204).

Hurricane Andrew produced significant storm surges within the Biscayne Bay region. The combined storm surge and astronomical tide in the northern Biscayne Bay ranged from 4 to 6 feet NGVD 29 (Reference 204), which is approximately 2.4 to 4.4 feet in NAVD 88 based on the datum relationship given in Subsection 2.4.1. The maximum surge level of 16.9 feet NGVD 29 (15.3 feet NAVD 88) from Hurricane Andrew was observed on the western shoreline near the center of the Biscayne Bay (Reference 204). In the southern part of the Biscayne Bay, the surge elevation ranged from 4 to 5 feet NGVD 29 (2.4 to 3.4 feet NAVD 88) (References 203 and 204). Details of storm surge elevations within the bay due to Hurricane Andrew are shown on Figure 2.4.5-203.

2.4.5.2.2 Storm Surge Analysis

The PMSS elevation from the PMH at Units 6 & 7 is simulated using the NOAA computer model *Sea, Lake, and Overland Surges from Hurricanes* (SLOSH) (Reference 205). The antecedent water level, as defined in RG 1.59, is estimated separately and used to establish the initial water level condition in the SLOSH model simulation. The PMH parameters (Δp, radius of maximum wind, forward speed, track direction), as described in Subsection 2.4.5.1, are used to define the physical attributes of the PMH in the model. Model simulations are performed with numerous combinations of input PMH parameters to obtain the maximum storm surge elevation in the determination of the PMSS elevation. The effect of wind-wave run-up is superimposed on the PMSS elevation to obtain the maximum water level at Units 6 & 7.

The SLOSH computer model is developed by the NWS to forecast real-time hurricane storm surge levels on continental shelves, across inland water bodies and along coastlines, including inland routing of water levels. The SLOSH is a depth-averaged two-dimensional finite difference model on curvilinear polar, elliptical, or hyperbolic grid schemes. Modification of storm surges due to the overtopping of barriers (including levees, dunes, and spoil banks), the flow through channels and floodplains, and barrier cuts/breaches are included in the model. The effects of local bathymetry and hydrography are also included in the SLOSH simulation. Details of model formulation and application can be found in Reference 205.

2.4.5.2.2.1 Antecedent Water Level

According to RG 1.59, the 10 percent exceedance high spring tide including initial rise should be used to represent the PMSS antecedent water level. RG 1.59 defines the 10 percent exceedance high spring tide as the high tide level that is equaled or exceeded by 10 percent of the maximum monthly tides over a continuous 21-year period. For locations where the 10 percent exceedance high spring tide is estimated from observed tide data, RG 1.59 indicates that a separate estimate of initial rise (or sea level anomaly) is not necessary.

RG 1.59 also provides estimates of 10 percent exceedance high spring tide and initial rise at the Miami Harbor Entrance on the Atlantic Ocean, which is located close to the NOAA tide gage station at Virginia Key, Florida, north-northeast of Units 6 & 7. The 10 percent exceedance high spring tide and the initial rise at Miami Harbor Entrance are given as 3.6 feet above mean low water and 0.9 foot, respectively. The water level including the 10 percent exceedance high spring tide and initial rise, therefore, is ([3.6 + 0.9] feet =) 4.5 feet above mean low water. Using the datum conversion relation given in Subsection 2.4.1, the water level at the Miami Harbor Entrance is approximately 2.6 feet NAVD 88.

NOAA maintains tide gage stations along the Atlantic Ocean shoreline near Units 6 & 7. Long-term records of measured tidal levels are available at Virginia Key, Florida (station number 8723214); Vaca Key, Florida (8723970); and Key West, Florida (8724580). The tidal range at these currently active stations is provided in Table 2.4.1-211. However, only the station at Key West has data records longer than a 21-year period that can be used to estimate the 10 percent exceedance high spring tide consistent with the definition in RG 1.59. The combined 10 percent exceedance high spring tide and initial rise at the Miami Harbor Entrance from RG 1.59 of 2.6 feet NAVD 88 is higher than the estimated 10 percent exceedance high spring tides at the Virginia Key, Florida station at 1.43 feet NAVD 88 and Key West, Florida station at 0.97 foot NAVD 88 based on available data records (15 years of record for Virginia Key station and 38 years of record for Key West station). Consequently, the combined 10 percent exceedance high spring tide and initial rise at the Miami Harbor Entrance as obtained from RG 1.59 is conservatively used in the PMSS estimate.

In addition to the 10 percent exceedance high spring tide and initial rise, the long-term trend observed in tide gage measurements is also considered to account for the expected sea level rise for a period consistent with the DCD Tier 2 Section 1.2.1.1.2 plant design objective of 60 years without replacement of the reactor vessel. The NOAA station nearest to Units 6 & 7 where long-term trend in sea

level rise is available is the Miami Beach, Florida (8723170), station. The station is located close to the Virginia Key, Florida, station and is no longer active. The long-term sea level rise trend at Miami Beach, Florida, as estimated based on data from 1931 to 1981, is 0.78 foot per century (Reference 206). Accordingly, a nominal long-term sea level adjustment of 1 foot is applied to the 10 percent high tide level resulting in an antecedent water level of 3.6 feet NAVD 88 (2.6 feet NAVD 88 + 1 foot), which represents the initial water level condition in the SLOSH model simulations.

2.4.5.2.2.2 SLOSH Biscayne Bay Basin Model

The NOAA SLOSH model requires the hurricane pressure difference (Δp), hurricane track description including landfall location, forward speed, and size, given as the radius of maximum wind, as input to define the physical attributes of a hurricane in performing a surge simulation (Reference 207). The SLOSH Biscayne Bay basin model includes Units 6 & 7. The model is setup using a curvilinear hyperbolic-type grid system (Reference 207). The corresponding bathymetry data are obtained from the NOAA NWS. The basin bathymetry and water levels in the model input and output are referenced to NGVD 29. The datum conversion relationship at the NOAA Virginia Key, Florida, station, as given in Subsection 2.4.1, is adopted for converting elevation data from NGVD 29 to NAVD 88 or vice-versa.

The time sequence of the movement of a hurricane or the hurricane track is a required input to the SLOSH model. It is represented in the model by a series of successive locations of the center of hurricane derived as a function of the hurricane direction (angle), forward speed, and landfall location (defined as the location where the hurricane crosses the shoreline). The hurricane direction defined in SLOSH is different from the hurricane direction given in NOAA Technical Report NWS 23 (Table 2.4.5-201). While NWS 23 provides the angle of incoming hurricane from the north as the hurricane direction, SLOSH defines the hurricane direction as the angle between north and the direction of hurricane propagation (References 201 and 207). As a result, SLOSH hurricane directions are 180 degrees ahead of hurricane directions in NWS 23.

Model simulations are performed for different combinations of the PMH parameters to obtain the maximum surge water level at Units 6 & 7. The model results are processed using the NOAA SLOSH Display Program (Reference 208). The centerline of Units 6 & 7 (25.425° N, 80.333° W) is located in the SLOSH model grid cell (63, 40) and the simulated time histories of water levels are extracted from this grid cell for the PMSS evaluation. The model grid for the

Biscayne Bay basin and the location of Units 6 & 7 are shown on Figure 2.4.5-204.

2.4.5.2.2.3 Sensitivity of PMH Parameters on Storm Surge Elevation

A total of 53 SLOSH model runs are performed to investigate the effects of the PMH forward speed, size, direction, and track distance from Units 6 & 7 on the storm surge elevation. The ranges of the parameters used in the simulations include two steady state PMH forward speeds (the lower and upper bounds), three PMH radiuses of maximum wind (the mean, the lower bound and upper bound), five PMH directions and seven track distances. The selected hurricane directions are 225, 247.5, 258.75, 270, and 315 degrees from the north. The range of the hurricane directions modeled corresponds to the sector between 45 and 135 degrees in the convention adopted in the NOAA Technical Report NWS 23. The selected track distances from Units 6 & 7 are 0, 5.75, 11.5, 17.25, 23, 34.5, and 46 miles. The simulations are performed with the PMH Δp (4.0 inches of mercury or 135.5 millibars) as given in Table 2.4.5-201. Two initial water level conditions, with and without adding the long-term sea level rise to the combined 10 percent exceedance high spring tide and initial rise as given in Subsection 2.4.5.2.2.1, are simulated in the model. The initial water level condition excluding the long-term sea level rise is selected to facilitate a comparison of surge elevation from RG 1.59 at Miami Harbor Entrance with SLOSH simulation results. The comparison is described in Subsection 2.4.5.2.2.5.

Figure 2.4.5-205 shows the variation of storm surge elevations at Units 6 & 7 for two PMH forward speeds, three radii of maximum wind, and three hurricane directions, 225, 270, and 315 degrees from the north. Based on the simulation results as presented in Figure 2.4.5-205, the following may be concluded:

- Higher PMH forward speed results in higher surge elevations.
- At the upper bound PMH forward speed, the surge elevation increases with increasing hurricane size for all directions simulated.
- At the lower forward speed, the largest (upper bound) hurricane size does not lead to the highest surge elevation.
- The variation of surge height for the selected PMH directions, between 225 and 315 degrees from the north, is the maximum at the upper bound PMH size, which is 1.3 feet for both forward speeds.

The effect of PMH size beyond the upper bound radius of maximum wind for the upper bound forward speed is described later in this subsection.

The variation of surge elevation for different PMH directions and distances of the PMH track from Units 6 & 7 is presented in Figure 2.4.5-206. The figure shows that the maximum surge elevation is predicted to occur when the PMH direction is 258.75 degrees from the north (78.75 degrees according to NWS 23). Additionally, the surge height is the maximum when the PMH track is located at a distance from Units 6 & 7 equal to approximately 0.75 times the PMH radius of maximum wind.

Based on the results of the SLOSH model sensitivity runs, it is concluded that the PMSS would be generated by a PMH that has the upper bound forward speed (20 knots or 23 miles per hour) and size (radius of maximum wind of 20 nautical miles or 23 miles), approaches Units 6 & 7 with a direction of 258.75 degrees from the north, and passes by with a track distance of approximately 15 nautical miles (17.25 miles) south of Units 6 & 7.

Figure 2.4.5-205 indicates that the surge elevation increases with increasing PMH size at the upper bound forward speed. This behavior is further investigated by varying the PMH size beyond the upper bound specified in NWS 23 for a PMH approaching at a direction of 270 degrees from the north. The hurricane track is assumed at a distance from Units 6 & 7 equal to the PMH radius of maximum wind. The Δp is artificially kept constant for the hurricane sizes beyond the upper bound of 20 nautical miles (23 miles). The resulting surge elevations are presented on Figure 2.4.5-207. For the selected set of parameters, Figure 2.4.5-207 shows that the surge elevation would be the maximum when the PMH size (radius of maximum wind) is 30 nautical miles (34.5 miles). The maximum surge elevation is approximately 2.6 percent higher than the surge elevation from the PMH upper bound radius of maximum wind. Beyond 30 nautical miles (34.5 miles) surge elevation decreases.

As discussed below, for larger hurricanes, the Δp should not be kept constant and it would be smaller and would generate lower surge elevations. Figure 2.5 of NWS 23 shows that PMH radius of maximum wind increases with latitude. The highest PMH radius of maximum wind is 38 nautical miles (44 miles) at Eastport, Maine. However, as shown in NWS 23, Figure 2.3, the PMH Δp decreases with latitude and Eastport, Maine, has the lowest PMH Δp of 2.7 inch mercury lower than the PMH Δp of 4.0 inch mercury near the site. NWS 23 defines the PMH as a fully developed, tightly wound hurricane whose RMW for any particular coastal point is less than the RMW of the standard project hurricane (SPH) which is a less

intense hurricane than the PMH. Near the site, SPH has an upper bound RMW of about 29 nautical miles (33 miles), higher than the PMH upper bound of 20 nautical miles (23 miles). However, the Δp for the SPH is 2.6 inch mercury which is lower than PMH Δp of 4.0 inch mercury. This suggests that, for larger hurricane sizes than the PMH upper bound value given in NWS 23, the Δp would be smaller. The purpose of Figure 2.4.5-207 is to better understand the impact of hurricane sizes on storm surge elevation by artificially keeping the Δp constant. Therefore, surge elevations shown in Figure 2.4.5-207, for the hurricane sizes larger than the NWS 23 upper bound of 20 nautical miles (23 miles), are not taken as bounding.

2.4.5.2.2.4 Maximum Surge Elevation with Selected PMH Parameters

The maximum surge elevation at Units 6 & 7 is obtained from the SLOSH model simulation with the selected set of PMH parameters described in Subsection 2.4.5.2.2.3. The time history of the simulated surge elevation at Units 6 & 7 is presented on Figure 2.4.5-208, which shows a maximum surge elevation of 19.8 feet NGVD 29 (18.2 feet NAVD 88). The envelope of maximum surge elevation over the model domain for the selected set of PMH parameters is shown on Figure 2.4.5-209. Figure 2.4.5-209 shows that the maximum surge elevation would occur at a location northwest of Units 6 & 7.

The time history of the 1-minute average, 33-foot-high wind speed at Units 6 & 7 during the PMH, as obtained from the SLOSH model results, is presented on Figure 2.4.5-210. The maximum wind speed corresponding to the PMH conditions that provide the maximum surge elevation is estimated to be 188.3 miles per hour.

2.4.5.2.2.5 Uncertainties in SLOSH Model Results

Comparison of SLOSH Results with Observations

The SLOSH model predictions have been validated against observed hurricane surge levels at several locations (References 205 and 209). The errors of the SLOSH model predictions, defined by subtracting the observed surge water levels from model predictions, were evaluated for ten storms in eight SLOSH model basins, 90 percent of which were in the Gulf of Mexico (Reference 209). Based on a comparison of the SLOSH simulated surge heights against 523 observations, a mean error of –0.09 meter (–0.3 foot) was reported. The range of errors was from –2.16 meters (–7.1 feet) to 2.68 meters (8.8 feet) with a standard deviation of 0.61 meter (2 feet) (Reference 209).

NOAA Technical Report NWS 48 also provides a comparison of SLOSH model results with observations for well-documented hurricanes. A total of 570 observations from 13 significant hurricanes in nine SLOSH basins were evaluated as shown on Figure 2.4.5-211. NOAA concludes that the model results generally stayed within ± 20 percent for significant surges (Reference 205). The +20 percent margin on the perfect fit line is also shown on Figure 2.4.5-211.

Uncertainties in Computed Surge Height during the PMH

The SLOSH predictions shown in Figure 2.4.5-211 are converted to surge heights without including the effects of antecedent water level. To establish the same basis in addressing the model uncertainty on the predicted surge height at Units 6 & 7, the antecedent water level of 5.2 feet NGVD 29 (3.6 feet NAVD 88) is subtracted from the simulated maximum surge level of 19.8 feet NGVD 29 (18.2 NAVD 88) giving a surge height of 14.6 feet. Applying conservatively the 20 percent margin suggested by NOAA on the simulated maximum surge height to account for the SLOSH model uncertainties, the adjusted maximum surge height would be approximately 17.5 feet.

Comparison with RG 1.59

RG 1.59 provides estimates of the PMSS elevation along the U.S. Gulf and Atlantic Coasts. The only location close to Units 6 & 7 where PMSS water level is available from RG 1.59 is Miami, Florida (25.787° N, 80.13° W). The four components contributing to the PMSS at this location, as given in RG 1.59, include a wind set-up of 2.51 feet, a pressure set-up of 3.9 feet, an initial rise of 0.9 foot, and a 10 percent exceedance high spring tide of 3.6 feet above mean low water. These four components combine to give a total storm surge elevation of 10.91 feet above mean low water (approximately 9 feet NAVD 88 or 10.6 feet NGVD 29) at Miami, Florida. By comparison, the surge elevation predicted by the SLOSH Biscayne Bay basin model at Miami, Florida (25.787° N, 80.13° W), represented by model grid cell (40, 88), is higher at 11.2 feet NGVD 29 (9.6 feet NAVD 88). The predicted surge elevation at Miami, Florida, corresponds to a PMSS elevation at Units 6 & 7, does not include the 20 percent margin, and is based on a SLOSH model simulation without the long-term sea level rise adjustment. Consequently, it is concluded that the PMSS elevation obtained from the SLOSH model is more conservative than that presented in RG 1.59.

2.4.5.2.2.6 The Probable Maximum Storm Surge Elevation

The PMSS elevation (still water level) at Units 6 & 7 is obtained by adjusting the maximum surge elevation for model uncertainties. The adjustment is applied to the surge height after subtracting the antecedent water level from the surge elevation. Subsequently, the PMSS elevation is obtained by adding the antecedent water level to the adjusted surge height. The final PMSS elevation thus obtained is approximately 22.7 feet NGVD 29 or 21.1 feet NAVD 88.

2.4.5.3 Wave Actions

The effect of PMH wind field on the PMSS still water level near Units 6 & 7 is investigated to estimate the PMH-induced waves, set-up, and run-up.

2.4.5.3.1 Hurricane Maximum Wind Speed

The maximum 1-minute average, 33-foot-high wind speed at Units 6 & 7 is obtained from the SLOSH model results. For the combination of PMH parameters that produces the PMSS, the maximum 1-minute average, 33-foot-high wind speed is 188.3 miles per hour. The 1-minute average, 33-foot-high wind speed is converted to the sustained 10-minute average, 33-foot-high wind speed following the procedure given in the Coastal Engineering Manual of the U.S. Army Corps of Engineers (Reference 210). The converted 10-minute average wind speed is approximately 159 miles per hour, which is then used to calculate the coincidental wind wave activities.

2.4.5.3.2 Wave Height, Period and Run-up

The wind setup due to the PMH wind field is included in the surge elevation obtained in the SLOSH model results. However, the hurricane wind field produces wind-induced waves that result in wave run-up at Units 6 & 7. The plant area is built up and surrounded by a retaining wall structure with a top of wall elevation of 21.5 feet NAVD 88 on the eastern side. The PMSS still water level would be located below the top of the retaining wall. Coincident wind-waves would overtop the retaining wall and run up the slopes in the plant area. The grade elevation from the top of the wall to the safety-related buildings acts as a berm and, therefore, reduces the effect of wave run-up at the plant safety-related facilities.

The SLOSH model results indicate that a PMH surge elevation inundates the Elliott Key Barrier Island east of the Biscayne Bay. Because the PMH maximum wind approaches from the Atlantic Ocean side, the fetch length to produce wind-waves is very large. The wave heights at the retaining wall, therefore, are likely

limited by the water depth, with the breaking wave height representing the limiting wave condition. Wave breaking is the process of wave energy dissipation and wave height reduction due to shallow water depths (Reference 210), and the breaking wave height represents the limiting wave condition beyond which waveforms cannot sustain. Consequently, the significant and 1 percent wave heights are bounded by the breaking wave condition and are not presented separately. Following the procedures given in the Coastal Engineering Manual (Reference 210), breaking wave height and corresponding wave period in front of the retaining wall are calculated as approximately 15.4 feet and 5.1 seconds, respectively. The wave run-up at the safety-related facilities of Units 6 & 7 is calculated based on an equivalent slope considering that the grade elevations from the retaining wall to the safety-related facilities would act as a berm. The surf similarity parameter, a parameter that defines wave breaking and run-up and depends on approach bottom slope and wave steepness, hence, is calculated using equivalent deepwater wave parameters corresponding to the breaking waves at the retaining wall and the equivalent slope including the berm. Thus, the maximum wave run-up at the site is estimated to be approximately 3.7 feet.

2.4.5.3.3 Maximum Water Surface Elevation due to the PMH

Combining the PMSS still water level (21.1 feet NAVD 88) and wave run-up (3.7 feet), the maximum water level due to a PMH at Units 6 & 7 is estimated at 24.8 feet NAVD 88.

2.4.5.4 Resonance

Units 6 & 7 are located adjacent to the west shore of the Biscayne Bay approximately 8 miles west of the Elliott Key Barrier Island. There are no records of seismic seiches within the bay. However, because the bay is a semi-enclosed body of water, seiche oscillation may occur due to atmospheric forcing. It is likely that such oscillations would occur along the principal axis of the bay in the north-south direction. Assuming that the bay is approximately 25 miles long, the natural period of oscillation for the bay, during a PMH event, is estimated to be approximately 36.8 minutes (based on PMH still water depth of approximately 27.7 feet). This period is calculated conservatively using the half length of the bay and second mode of oscillation which gives a smaller period closer to the period of wind-waves. During a PMH event, storm surge elevation inundates the Elliott Key Barrier Island. Under such conditions, it is unlikely that seiches occur. In addition, the natural period of oscillation is much greater than the period of wind-waves and shorter than the period of storm surge waves. Therefore, natural

oscillations within the bay do not result in a resonance and flooding of the plant area due to a seiche event in the Biscayne Bay is precluded.

Florida Current is a major influence on the coastal circulation and current dynamics in the southeast Florida shelf. The Florida Current generates internal wave field and coastal ocean current oscillations with a dominant periodicity of about 10 hours (References 212, 213 and 214). Soloviev et al. 2003 (Reference 212) also illustrate that the presence of the Florida Current has no apparent effect on the sea level and its oscillations near the shore, which still follows the tidal constituents with dominant periods near 12 and 24 hours. Therefore, there is no evidence to support a hypothesis that the Florida Current has any impact on the sea level oscillations near the site, despite its influence on the velocity and density fields.

The natural oscillation periods of Biscayne Bay during a normal sea condition are estimated to be approximately 3.4 to 5.3 hours calculated using the methodology from Section II-5-6 of the USACE Coastal Engineering Manual (Reference 210), which are much smaller than the observed oscillation period of 10 hours in the current and density fields. Therefore, the potential for resonance in Biscayne Bay as affected by the Florida Current can further be precluded.

The potential of resonance within the Biscayne Bay from the forcing from sea breeze, which is caused by the diurnal (24-hour period) heating and cooling of the land and sea was also evaluated. This 24-hour period is much greater than the natural oscillation periods of the Biscayne Bay which are estimated to be approximately 3.4 to 5.3 hours. According to Militello and Kraus 2001 (Reference 215), sea breeze can introduce diurnal oscillations and generate higher harmonic motions into water bodies. Through the analytical solution and numerical modeling developed for a simplified one-dimensional idealized basin, their study illustrates that (i) the amplitudes of wind-forced motions at the higher harmonics are orders of magnitude smaller than that at the fundamental period, and (ii) the wind-forced motions near the resonant modes can be almost completely damped by relatively small bottom friction in the water body. Consequently, flooding from resonance within the Biscayne Bay due to sea breeze is not expected.

The potential for resonance within the Makeup Water Reservoir (MWR) during the maximum PMH wind condition is also evaluated. The natural periods of the MWR, which can be approximated as a rectangular basin, are estimated using an approach provided in the USACE Coastal Engineering Manual (Reference 210) for a closed water body. The dimensions along the two principal axes of the MWR

are approximately 2200 feet and 766 feet (a north side dimension of 2260 feet is used for this evaluation). With the top of wall and bottom elevations at 24.0 feet and -2.0 feet NAVD 88, respectively (Subsection 2.4.8), the natural periods of the MWR are approximately 156 and 53 seconds, based on the two principal dimensions and a full reservoir with 26 feet of water to account for precipitation. The corresponding wave periods estimated for a maximum PMH wind condition at the site are 2.4 and 1.7 seconds, respectively, following the procedures in Reference 210. Because the natural periods of the MWR are significantly longer than the periods of waves generated from the PMH, the potential for resonance in the MWR due to any storm-driven wind waves is not expected.

2.4.5.5 Protective Structures

The PMSS still water level at Units 6 & 7, along with coincidental wind-wave run-up, is conservatively estimated to be approximately 24.8 feet NAVD 88. This estimated maximum PMH-induced water level is lower than the design plant grade elevation of 26 feet NAVD 88 for safety-related facilities. Therefore, the postulated PMH event does not affect the safety functions of the plant. Because the maximum PMH-induced water level is lower than the plant grade elevation, debris, waterborne projectiles, and sediment erosion and deposition are not of concern to the safety-related facilities of Units 6 & 7.

2.4.5.6 References

201. Schwerdt, R. et al., *Meteorological Criteria for Standard Project Hurricane and Probable Maximum Hurricane Windfields, Gulf and East Coast of the United States*, Technical Report NWS 23, U.S. Department of Commerce, NOAA, September 1979.

202. National Oceanic and Atmospheric Administration, *FAQ/State of the Science: Atlantic Hurricane & Climate*, U.S. Department of Commerce, December 2006.

203. Blake, E. et al., *The Deadliest, Costliest, and Most Intense United States Tropical Cyclones from 1851 to 2006 (and Other Frequently Requested Hurricane Facts)*, Technical Memorandum NWS TPC-5, National Weather Service, National Hurricane Center, NOAA, April 2007.

204. National Oceanic and Atmospheric Administration, *Hurricane Andrew, Preliminary Report: National Hurricane Center*. Available at http://www.nhc.noaa.gov/1992andrew.html, accessed September 14, 2008.

205. Jelesnianski, C. et al., *SLOSH: Sea, Lake, and Overland Surges from Hurricanes*, Technical Report NWS 48, NOAA, April 1992.

206. National Oceanic and Atmospheric Administration, *Sea Levels Online*, Mean Sea Level Trend, 8723170 Miami Beach, Florida. Available at http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8723170, accessed June 19, 2008.

207. National Oceanic and Atmospheric Administration, *SLOSH: Sea, Lake, and Overland Surges from Hurricanes,* User and Technical Software Documentation, October 2006.

208. National Oceanic and Atmospheric Administration, *SLOSH: Sea, Lake, and Overland Surges from Hurricanes*, Display Program (1.40) for Windows, 2006.

209. Jarvinen, B. et al., *An Evaluation of the SLOSH Storm Surge Model*, Bulletin American Meteorological Society, Vol. 66, No. 11, pp. 1408–1411, November 1985.

210. U.S. Army Corps of Engineers, *Coastal Engineering Manual*. Available at http://chl.erdc.usace.army.mil/cemtoc, accessed January 20, 2009.

211. National Oceanic and Atmospheric Administration, *Historical Hurricane Tracks*, NOAA Coastal Service Center. Available at http://maps.csc.noaa.gov/hurricanes/, accessed April 7, 2008.

212. Soloviev, A. et al., *Energetic Baroclinic Super-Tidal Oscillations on the Southeast Florida Shelf*, Geophysical Research Letters, Vol. 30, No. 9, 1463, May 2003.

213. Peters, H. et al., *Current Variability on a Narrow Shelf with Large Ambient Vorticity*, J. Geophys. Res., 107, C8, 3087, August 2002.

214. Davis, K. et al., *Effects of Western Boundary Current Dynamics on the Internal Wave Field of the Southeast Florida Shelf*, J. Geophys. Res.,Vol. 113, C09010, September 2008.

215. Militello, A., and N. Kraus, *Generation of Harmonics by Sea Breeze in Nontidal Water Bodies*, Journal of Physical Oceanography, Vol. 31(6), 1639, June 2001.

PTN COL 2.4-2

Table 2.4.5-201
Probable Maximum Hurricane Characteristics

Hurricane Parameter	Magnitude
Peripheral Pressure (p_n)	30.12 inch mercury
Central Pressure (p_o)	26.12 inch mercury
Radius of Maximum Winds (R)	4 to 20 nautical miles
Forward Speed (T)	6 to 20 knots
Track Direction (θ)	72 to 185 degrees (clockwise from north)
Inflow angle (φ)	2 to 9 degrees (at a distance R from the hurricane center)

Source: Reference 201

PTN COL 2.4-2

Table 2.4.5-202 (Sheet 1 of 4) Summary of Historical Hurricane Events in the Florida Atlantic and Gulf Coasts

Date[a] (month & year)	Hurricane Name[b]	Saffir-Simpson Hurricane Category at Landfall[c]	Central Pressure at Landfall[d] (millibars)	Maximum Winds[e] (knots)
August 1851	Great Middle Florida	3	960	100
August 1852	Great Mobile	3	960	100
September 1852		1	985	70
October 1852	Middle Florida	2	969	90
September 1854	Great Carolina	3	950	100
August 1856	Southeastern States	2	969	90
September 1859		1	985	70
August 1861	Key West	1	970	70
October 1865		2	969	90
October 1867	Galveston	2	969	90
October 1870	Twin Key West (I)	1	970	70
October 1870	Twin Key West (II)	1	977	80
August 1871		3	955	100
August 1871		2	965	90
September 1871		1	985	70
September 1873		1	985	70
October 1873		3	959	100
September 1874		1	985	70
October 1876		2	973	90
September 1877		1	985	70
October 1877		3	960	100
September 1878		2	970	90
August 1880		2	972	90
October 1880		1	985	70
September 1882		3	949	100
October 1882		1	985	70
August 1885		3	953	100
June 1886		2	973	85
June 1886		2	973	85
July 1886		1	985	70

PTN COL 2.4-2

Table 2.4.5-202 (Sheet 2 of 4) Summary of Historical Hurricane Events in the Florida Atlantic and Gulf Coasts

Date[(a)] (month & year)	Hurricane Name[(b)]	Saffir-Simpson Hurricane Category at Landfall[(c)]	Central Pressure at Landfall[(d)] (millibars)	Maximum Winds[(e)] (knots)
July 1887		1	981	75
August 1888		3	945	110
October 1888		2	970	95
August 1891		1	985	70
August 1893	Sea Islands	3	954	100
September 1894		2	975	90
October 1894		3	955	105
July 1896		2	973	85
September 1896		3	960	110
August 1898		1	985	70
October 1898		4	938	115
August 1899		2	979	85
September 1903		1	976	80
October 1904		1	985	70
June 1906		1	979	75
September 1906		2	958	95
October 1906		3	953	105
October 1909		3	957	100
October 1910		2	955	95
August 1911		1	985	70
September 1912		1	985	95
September 1915		1	988	—
October 1916		2	972	—
November 1916		1	—	—
September 1917		3	958	—
September 1919		4	927	—
October 1921	Tampa Bay	3	952	—
September 1924		1	985	—
October 1924		1	980	—
Nov.-Dec. 1925		1	—	—
July 1926		2	967	—

PTN COL 2.4-2

Table 2.4.5-202 (Sheet 3 of 4)
Summary of Historical Hurricane Events in the Florida Atlantic and Gulf Coasts

Date[(a)] (month & year)	Hurricane Name[(b)]	Saffir-Simpson Hurricane Category at Landfall[(c)]	Central Pressure at Landfall[(d)] (millibars)	Maximum Winds[(e)] (knots)
September 1926	Great Miami	4	935	—
August 1928		2	—	—
September 1928	Lake Okeechobee	4	929	—
September 1929		3	948	—
August 1933		2	975	—
September 1933		3	948	—
September 1935	Labor Day	5	892	—
November 1935		2	973	—
July 1936		3	964	—
August 1939		1	985	—
October 1941		2	975	—
October 1944		3	962	—
June 1945		1	985	—
September 1945		3	951	—
October 1946		1	980	—
September 1947		4	940	—
October 1947		2	974	—
September 1948		3	963	—
October 1948		2	975	—
August 1949		3	954	—
September 1950	Easy	3	958	—
October 1950	King	3	955	—
September 1953	Florence	1	985	—
September 1956	Flossy	2	975	—
September 1960	Donna	4	930	—
August 1964	Cleo	2	968	—
September 1964	Dora	2	966	—
October 1964	Isbell	2	974	—
September 1965	Betsy	3	948	—
June 1966	Alma	2	982	—
October 1966	Inez	1	983	—
October 1968	Gladys	2	977	—

PTN COL 2.4-2

Table 2.4.5-202 (Sheet 4 of 4)
Summary of Historical Hurricane Events in the Florida Atlantic and Gulf Coasts

Date[a] (month & year)	Hurricane Name[b]	Saffir-Simpson Hurricane Category at Landfall[c]	Central Pressure at Landfall[d] (millibars)	Maximum Winds[e] (knots)
June 1972	Agnes	1	980	—
September 1975	Eloise	3	955	—
September 1979	David	2	970	—
September 1985	Elena	3	959	100
November 1985	Kate	2	967	85
October 1987	Floyd	1	993	65
August 1992	Andrew	5	922	145
August 1995	Erin	2	973	85
October 1995	Opal	3	942	100
September 1998	Earl	1	987	70
September 1998	Georges	2	964	90
October 1999	Irene	1	987	70
August 2004	Charley	4	941	130
September 2004	Frances	2	960	90
September 2004	Ivan	3	946	105
September 2004	Jeanne	3	950	105
July 2005	Dennis	3	946	105
August 2005	Katrina	3	920	110
September 2005	Rita	3	937	100
October 2005	Wilma	3	950	105

(a) Only month and year of hurricane landfall are provided.
(b) Hurricane names are formally maintained from 1950.
(c) The highest Saffir-Simpson Hurricane Scale impact in the United States is based on estimated maximum sustained surface winds produced at the coast.
(d) The observed (or analyzed by NOAA from peripheral pressure measurements) central pressure of the hurricane at landfall or at the time closest to the shoreline.
(e) Estimated maximum sustained (1-minute) surface (at 10 meters or 33 feet) winds to occur along the U.S. coast. Winds are estimated to the nearest 10 knots for the period of 1851 to 1885 and to the nearest 5 knots for the period of 1886 to date.

Source: Reference 203

PTN COL 2.4-2

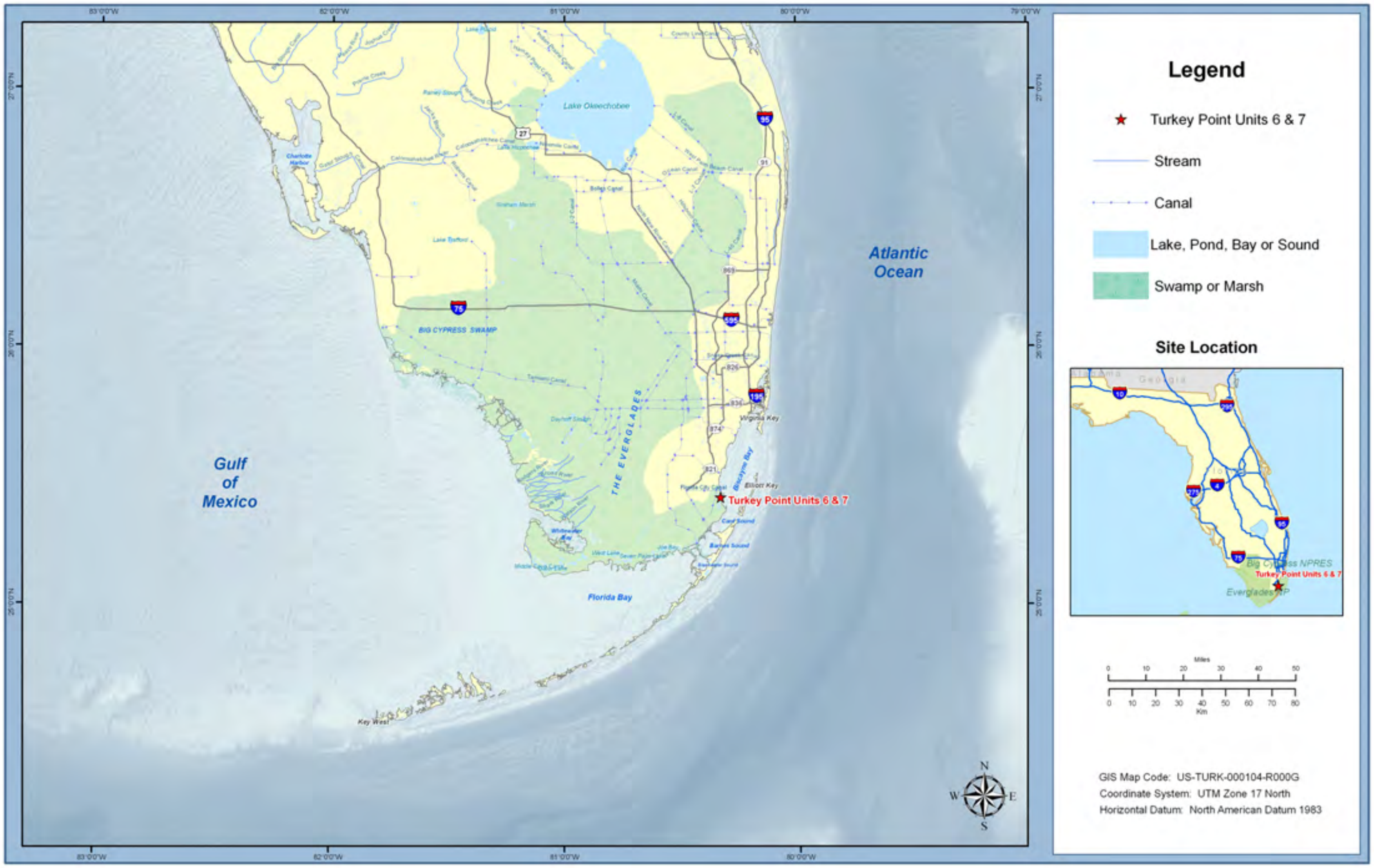
Table 2.4.5-203
The Saffir-Simpson Hurricane Scale

Hurricane	Wind	Hurricane Properties		
Category	Speed (miles per hour)	Central Pressure (millibars)	Surge Height (feet)	Damage
1	74–95	>979	4–5	Minimal
2	96–110	965–979	6–8	Moderate
3	111–130	945–964	9–12	Extensive
4	131–155	920–944	13–18	Extreme
5	>155	<920	>18	Catastrophic

Source: Reference 203

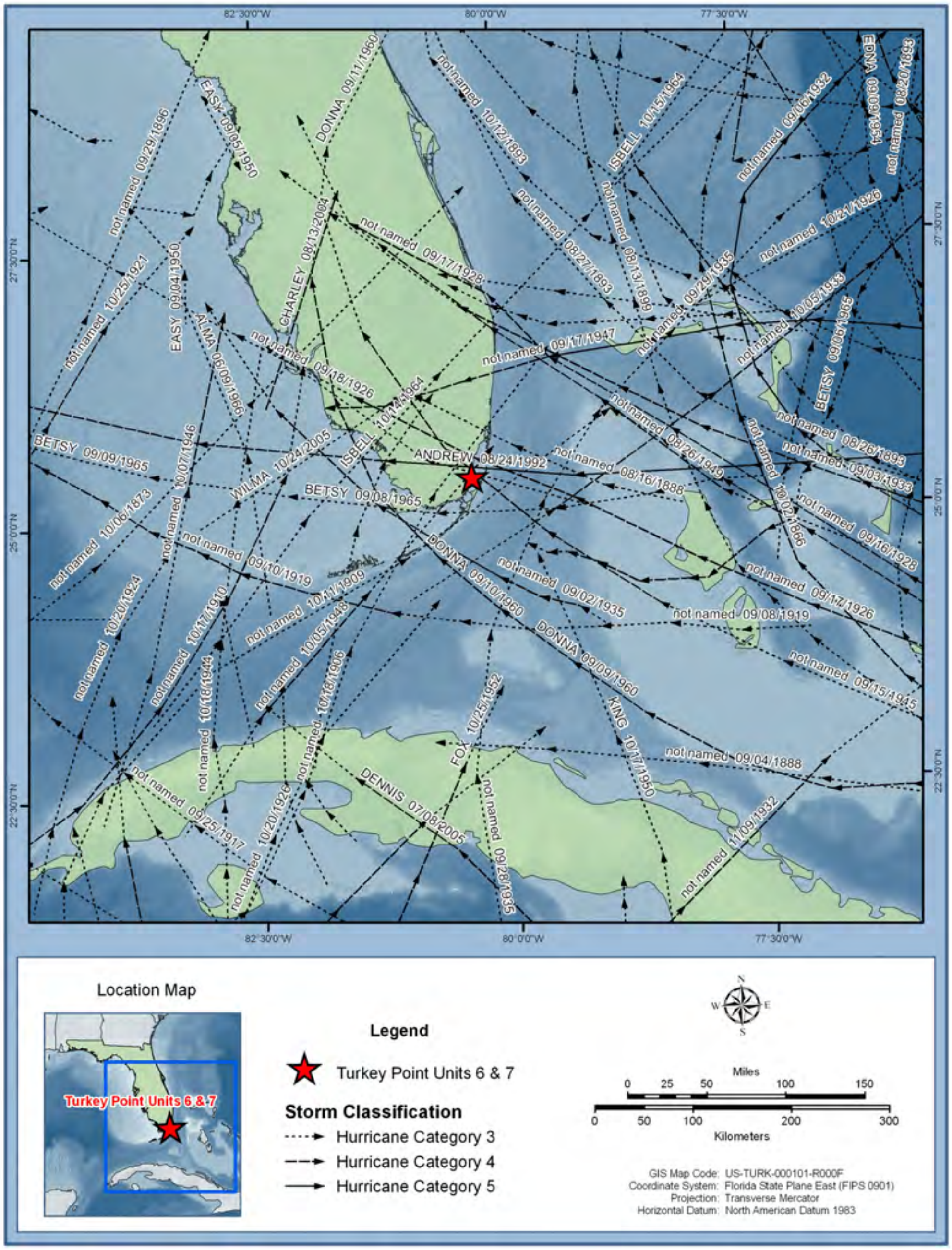
PTN COL 2.4-2

Figure 2.4.5-201 Location Map of Units 6 & 7 and Surrounding Water Bodies



PTN COL 2.4-2

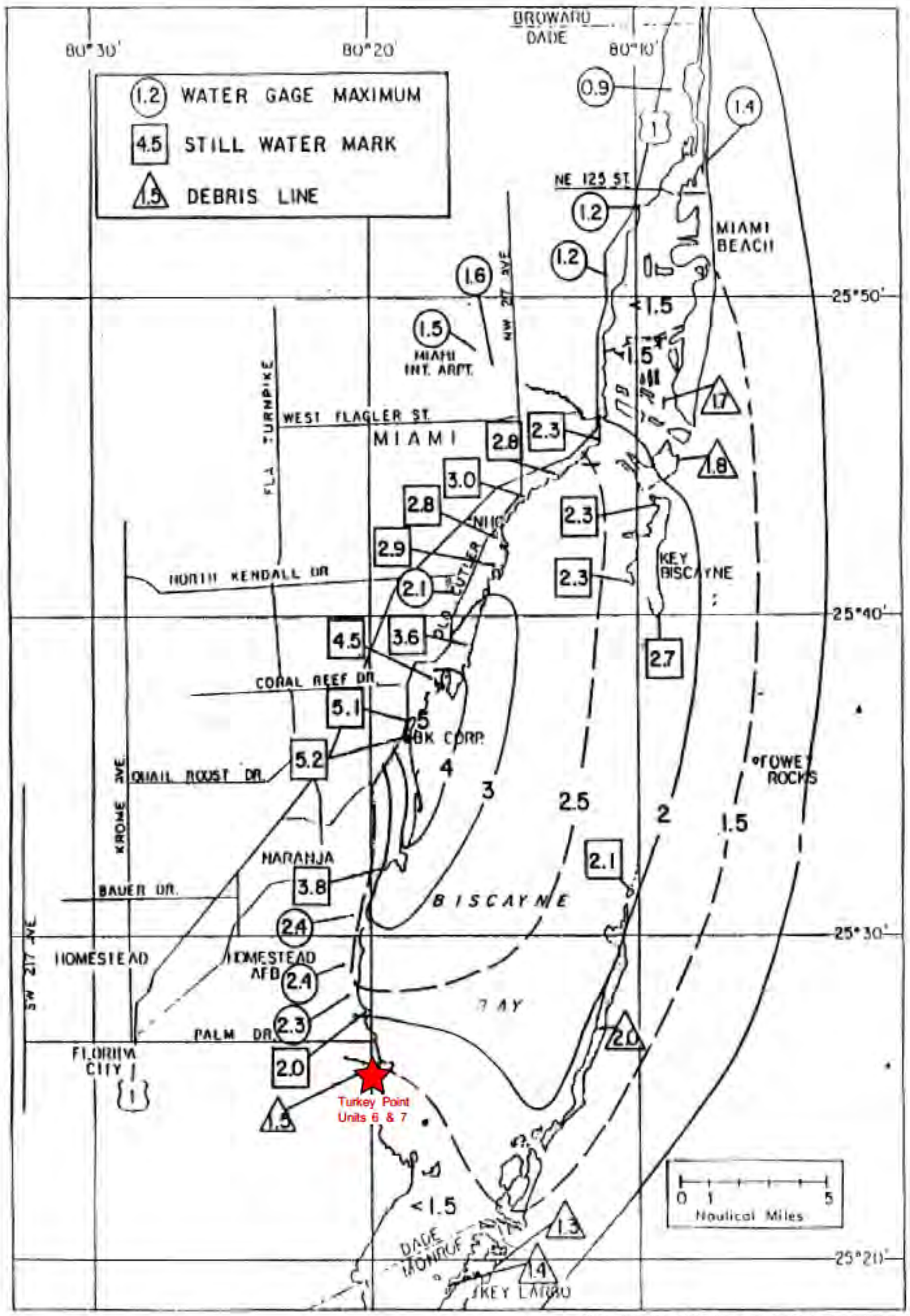
Figure 2.4.5-202 Tracks of Historical Hurricanes with Intensities of Category 3 and Above in Saffir-Simpson Hurricane Scale in the Region of Units 6 & 7



Source: Reference 211

PTN COL 2.4-2

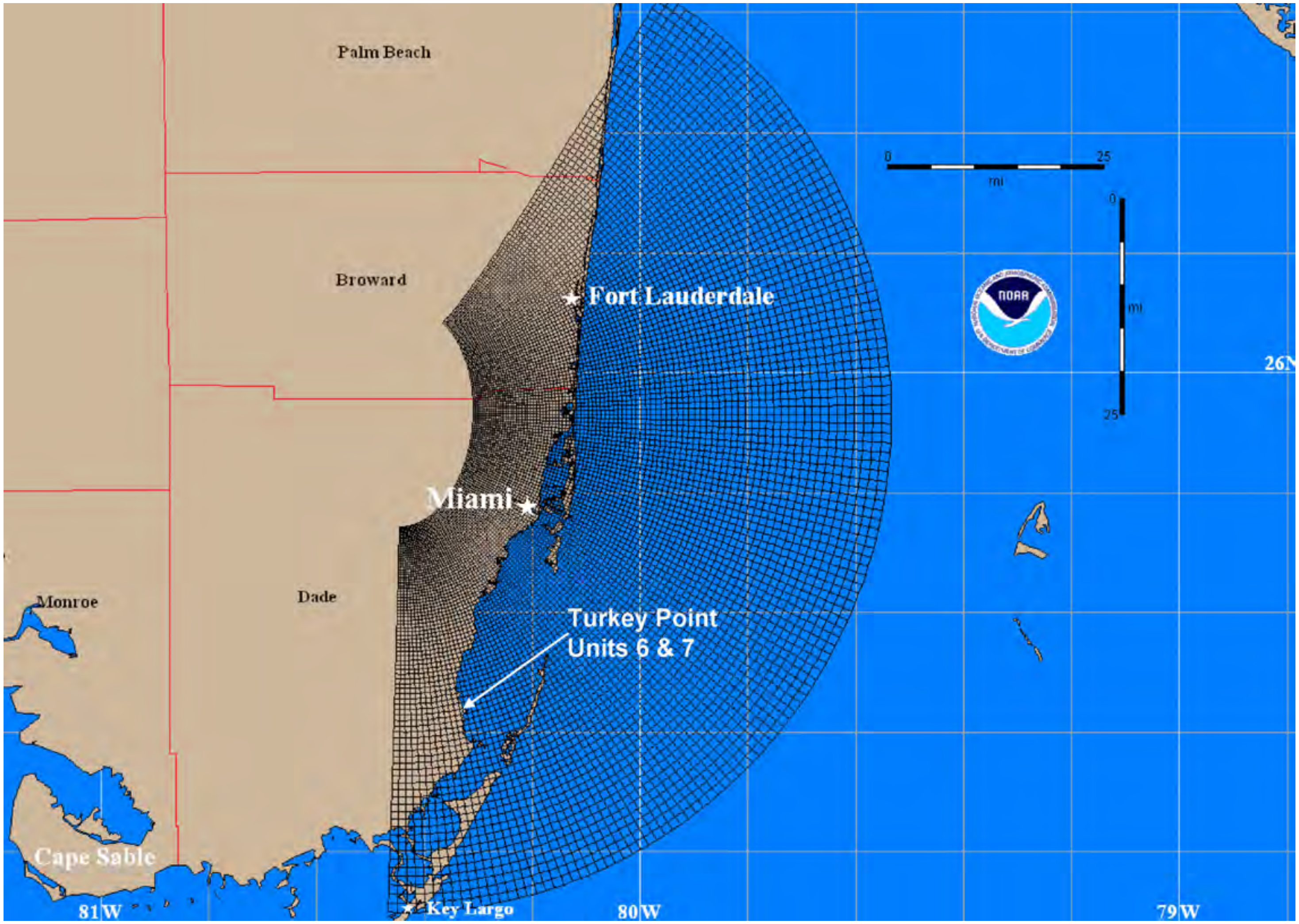
Figure 2.4.5-203 Observed Storm Surge Elevations in and Around the Biscayne Bay During Hurricane Andrew



Note: Surge elevations are in meters and referenced to the NGVD 29.
Source: Reference 204.

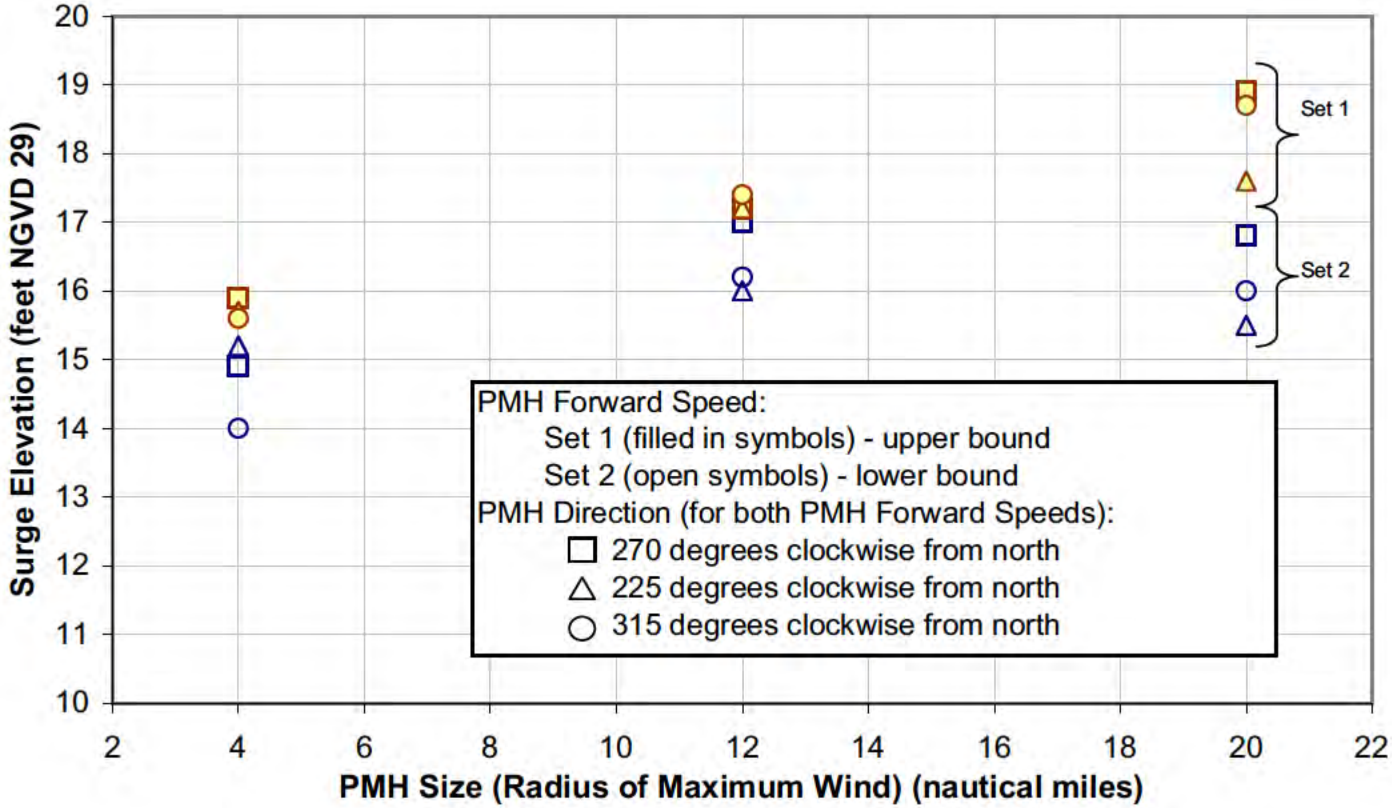
PTN COL 2.4-2

Figure 2.4.5-204 SLOSH Biscayne Bay, Florida Basin Model Grids and Location of Units 6 & 7



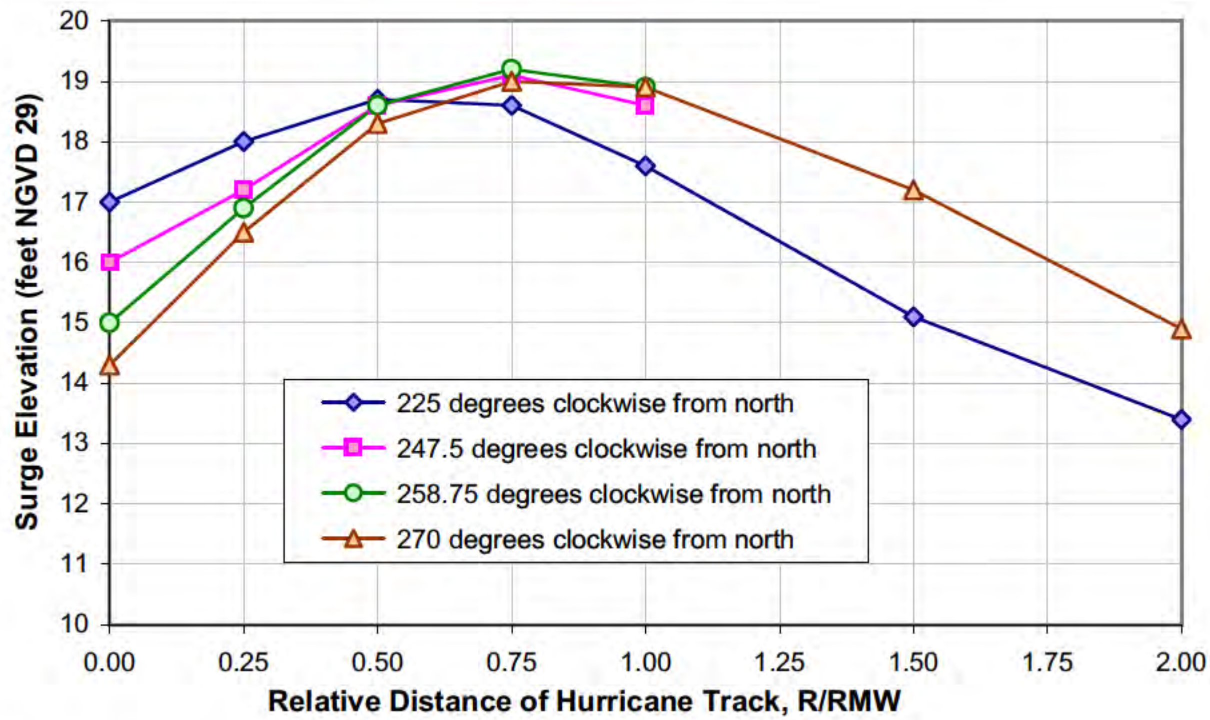
PTN COL 2.4-2

Figure 2.4.5-205 Simulated Surge Elevations For Different Combinations of the PMH Forward Speed, Size, and Direction



PTN COL 2.4-2

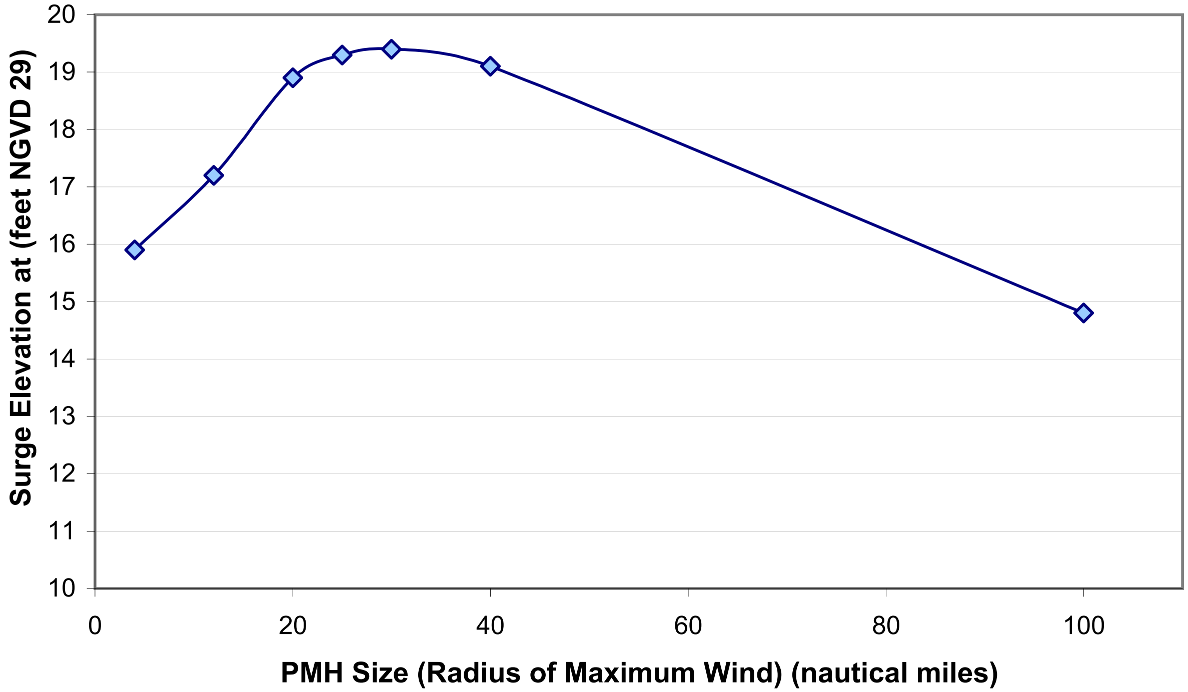
Figure 2.4.5-206 Simulated Surge Elevations for Different PMH Directions and Distances of PMH Track from Units 6 & 7



Note: R is the distance of the PMH track from Units 6 & 7.
RMW is the radius of maximum wind, which is 20 nautical miles or 23 miles.

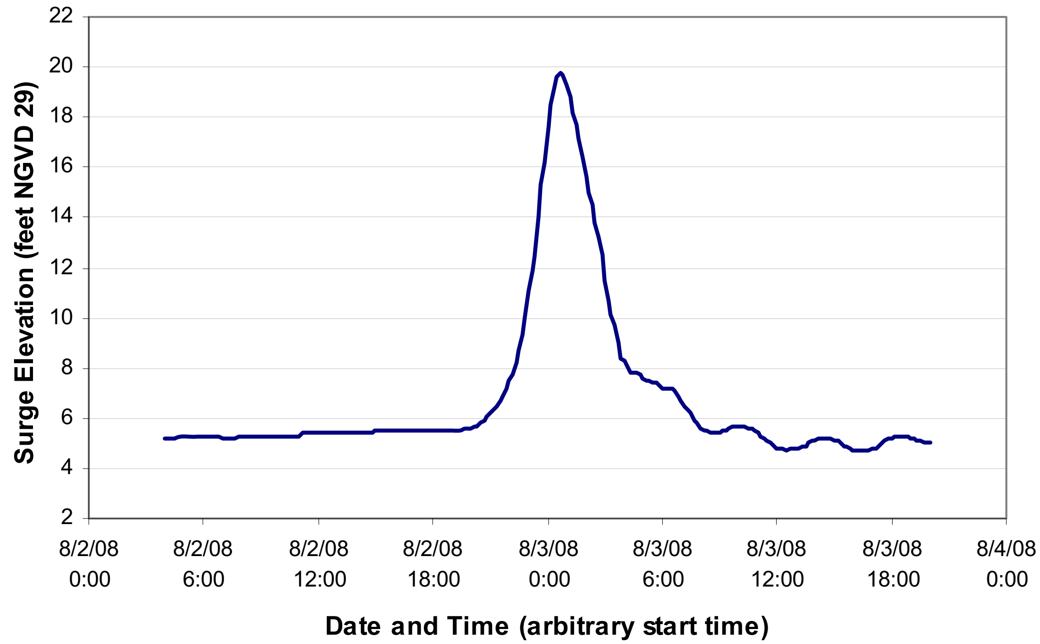
PTN COL 2.4-2

Figure 2.4.5-207 Simulated PMH Surge Elevations at Units 6 & 7 Versus Different PMH Sizes

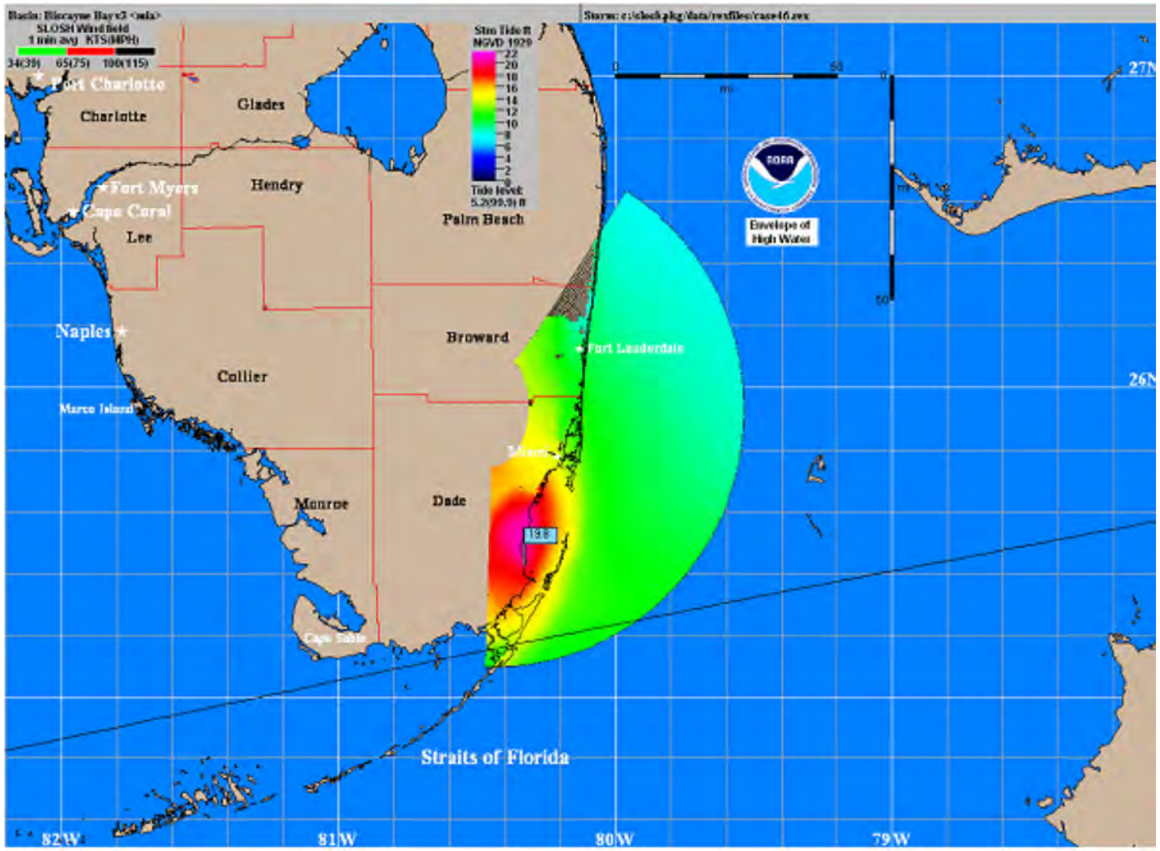


PTN COL 2.4-2

Figure 2.4.5-208 Time History of Simulated Maximum PMH Surge Elevation at Units 6 & 7



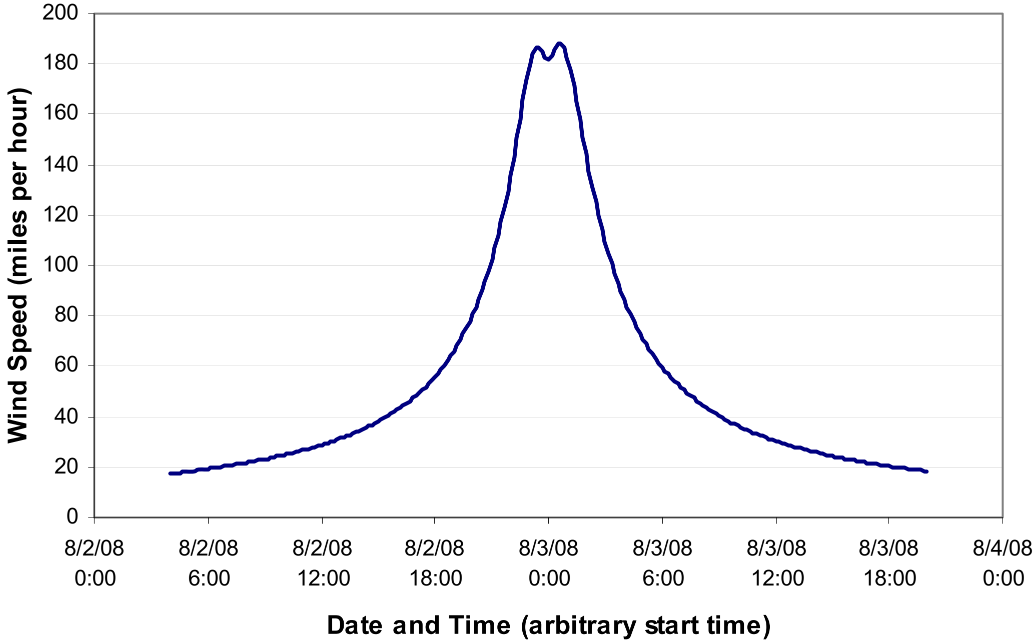
PTN COL 2.4-2 **Figure 2.4.5-209 The Envelope of Maximum Surge Elevation in the SLOSH Biscayne Bay, Florida Basin Model for PMSS at Units 6 & 7**



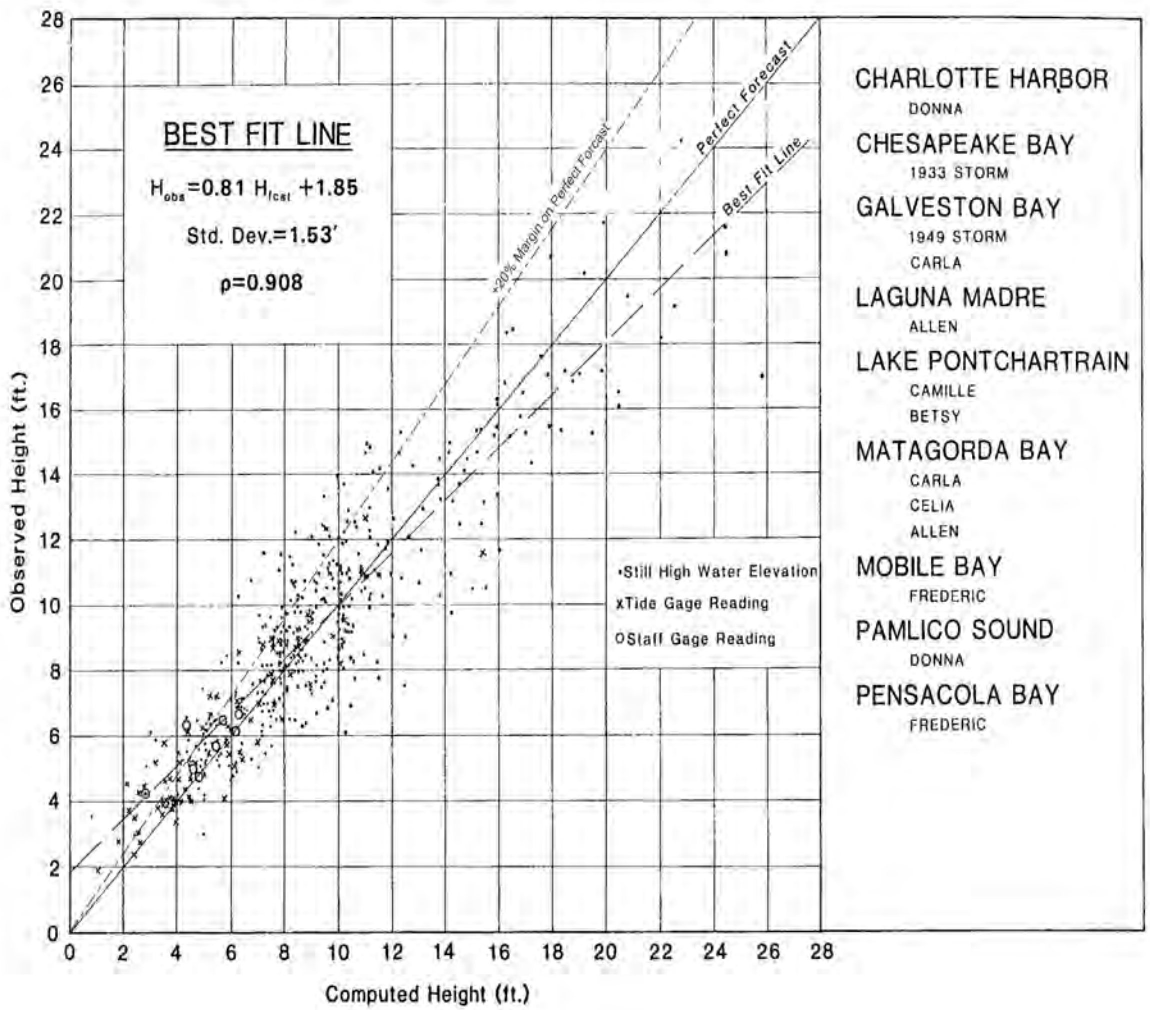
Note: Number in the flag indicates the maximum surge elevation (in NGVD 29) at Units 6 & 7.

PTN COL 2.4-2

Figure 2.4.5-210 Time History of PMH Wind Speed at Units 6 & 7



PTN COL 2.4-2 **Figure 2.4.5-211 Comparison of SLOSH Simulated Surge Heights Against Observed Data in different Basins**



Note: Modified from Reference 205 by adding a line showing the +20 percent margin on the perfect forecast.

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2.4.6 PROBABLE MAXIMUM TSUNAMI HAZARDS

PTN COL 2.4-2 This subsection examines the tsunamigenic sources and identifies the probable maximum tsunami (PMT) that could affect the safety-related facilities of Units 6 & 7. It evaluates potential tsunamigenic source mechanisms, source parameters, and resulting tsunami propagation from published studies, and estimates tsunami water levels at the site based on site-specific numerical model simulation results. Historical tsunami events recorded along the Florida coast are reviewed to support the PMT assessment. The approach taken is aligned with the PMT evaluation methodology proposed in NUREG/CR-6966 (Reference 201).

Units 6 & 7 are adjacent to the Biscayne Bay shore approximately 8 miles west of Elliott Key Barrier Island on the coast of the Atlantic Ocean, as shown on Figure 2.4.1-201. The grade elevations at the Units 6 & 7 plant area vary from approximately 19.0 feet to 25.5 feet NAVD 88. The entrance floor elevation of all safety-related structures (also referred to as the design plant grade elevation in the AP1000 DCD, which is 100 feet, or 30.48 meters, in the DCD reference datum) is at elevation 26 feet NAVD 88. The plant area is protected by a retaining wall structure with top elevation of 20.0 feet to 21.5 feet NAVD 88. As the grade is relatively high, tsunami events are not expected to pose any hazard to safety-related structures, systems, and components (SSCs) of Units 6 & 7, as described in the subsections below.

2.4.6.1 Probable Maximum Tsunami

The Atlantic and Gulf of Mexico Tsunami Hazards Assessment Group (AGMTHAG) evaluated potential tsunamigenic source mechanisms that may generate destructive tsunamis and affect the U.S. Atlantic and Gulf of Mexico coasts (Reference 202). The major tsunamigenic sources that may affect the southeastern U.S. coasts can be summarized as follows: submarine landslides along the U.S. Atlantic margin, submarine landslides in the Gulf of Mexico, far-field submarine landslide sources, earthquakes in the Azores-Gibraltar plate boundary, and earthquakes in the north Caribbean subduction zones (referred to as the Caribbean-North American plate boundary in Subsection 2.5.1).

Based on the below descriptions of the different source mechanisms, transoceanic tsunamis as a result of earthquakes in the Azores-Gibraltar (east Atlantic) plate boundary and tsunamis generated in the northeastern Caribbean

region are identified as the primary candidates of the PMT generation that could affect Units 6 & 7.

2.4.6.1.1 Submarine Landslides along the U.S. Atlantic Margin

Submarine landslide zones along the U.S. Atlantic margin are concentrated along the New England and Long Island, New York sections of the margin, outward of major ancient rivers in the mid-Atlantic region, and in the salt dome province offshore of North and South Carolinas, as shown in Figure 2.4.6-201 (Reference 202). Although submarine landslides along the U.S. Atlantic margin, from Georges Bank offshore of the New England coast to Blake Spur south of the Carolina Trough, have the potential to cause devastating tsunamis locally, the presence of a wide continental shelf is expected to reduce their impact at the shoreline near the landslides (Reference 202).

AGMTHAG mapped a total of 48 landslide affected areas based on data compiled from bathymetry, GLORIA (Geological Long-Range Inclined Asdic) sidescan sonar imagery, seismic reflection profiles, and sediment core data (Reference 202). The general characteristics of the mapped landslides are summarized in Table 2.4.6-201. The distribution of landslide locations identified along the U.S. Atlantic margin from the Georges Bank to the Carolina Trough is shown in Figure 2.4.6-202. The largest submarine landslide area near Units 6 & 7 is the Cape Fear Slide complex, identified in an area south of Cape Hatteras, off the Carolina Trough. The Cape Fear Slide headwall is described as an amphitheater-shaped scarp centered on a lower slope at a depth of approximately 2300 to 2600 meters (7545.9 to 8530.2 feet), 50 kilometers (31.1 miles) long, and approximately 120 meters (393.7 feet) high. Within the headwall's failure area, two large salt diapirs project above the sea floor. A complex of slumps extends more than 40 kilometers (24.9 miles) upslope from the major headwall scarp, and mass-movement deposits are traceable for more than 400 kilometers (248.5 miles) downslope to a water depth of over 5.4 kilometers (3.35 miles) on the Hatteras Abyssal Plain (References 202, 223, 225, 226 and 227). Longitudinal lines in the 1987 GLORIA side-scan sonar image, Figure 2.4.6-238, (reproduced from Figure 4 in Reference 225), are interpreted as evidence of mass movement. The longitudinal lines represent both debris chutes between the salt diapirs at the head of the landslide area indicated by the Label A in Figure 2.4.6-238, and debris flow paths further downslope indicated by the Label B (Reference 225). In the proximal area of the landslide, Label C in Figure 2.4.6-238, an area of irregular, hummocky topography on the sea floor provides evidence of mass movement. At the distal portion of the slide, the landslide material extends across an older slope failure, the Cape Lookout Slide (Reference 225).

Multibeam swath bathymetric data from the SeaBeam 2100/12 system and single channel Chirp data using a Knudsen 320B/R echosounder acquired in 2007 (Reference 223), provide the basis for a new interpretation of the Cape Fear slide. The multibeam bathymetric images combined with the Chirp data revealed at least five major escarpments (labeled S1 through S5 in Figure 2 of Reference 223). The S1 scarp is the westward and shallowest of the scarps, at approximately 890 meters below sea level, and with a crown-shaped headwall that extends 40 kilometers (24.9 miles) downslope of both sides of the slide scar. The S1 scarp crosscuts the S4 and S5 scarps and extends upslope of the main headwall (S4 and S5 headwalls). The S2 and S3 scarps are located within the S1 debris field. The S2 scarp is an approximately 20-kilometer (12.4-mile)-long and approximately 3-kilometer (1.9-mile)-wide chute that abruptly widens downslope. The approximate headwall height for the S2 scarp is at least 30 meters. The S3 scarp is associated with the smallest disrupted area and has a height of at least 20 meters above the rupture surface. The main headwall scarp, S4, is likely the largest slide in the complex with an approximately 120-meter high headwall that extends over approximately 50 kilometers (31.1 miles). The S5 scarp intersects the northern flank of the S4 scarp and is a secondary slide. It extends approximately 10 kilometers (6.2 miles) north of the S4 slide and has a headwall height of approximately 30 meters. In addition to collecting data on the S1 through S5 scarps, the bathymetric data showed a north-south linear depression running subparallel to the continental slope break at the extreme southern end of the S4 escarpment. The Chirp data suggests, “this ~40 kilometers (24.9 miles) long feature represents the scarp of a previously unrecognized, seafloor breaking normal fault” (Reference 223).

Based on radiocarbon (C-14) analyses of core samples from within 50 kilometers (31.1 miles) of the slide’s headwall, the age of the slide is estimated as between 9 to 14.5 thousands of years (References 228 and 229). However, an unconformity occurs between 0.5 and 2 meters depths within the Cape Fear Slide complex. The ages of the samples collected from the cores below the unconformity are older than 29 thousands of years. An interpretation of these data indicated a hiatus on the sole of the slide that separated the sediments that are younger than 14.5 thousands of years from those that are older than 29 thousands of years and that the slide was active during that time (Reference 228). This period of slide activity most likely occurred at the transition between the end of the last glaciation (Wisconsinan Stage) and the present interglacial age. This age bracket appears to be associated with the Pleistocene sea-level lowstand that occurred between approximately 12,000 and 28,000 years ago during the last glacial maximum (References 202, 223, 227, 228, 229, 230, 231 and 232). The possible triggering

mechanisms for the slide activity are salt movement, driven by sediment loading, with salt diapirism causing over steepening of the seabed slope followed by failure and potential sediment instability due to gas hydrate decomposition (References 202, 223, 230, 231 and 232).

Units 6 & 7 are located approximately 400 miles (640 kilometers) southwest of Blake Spur with a wide and shallow continental slope and shelf in between (Figure 2.4.6-201). Details of the Atlantic continental shelf near the site are described in Subsection 2.5.1.1.1.1. Additionally, the landslide zones are oriented in a manner that Units 6 & 7 would be away from the main axis of submarine landslide-generated tsunamis. The impact of any submarine landslide-generated tsunami on the continental slope and shelf north of Blake Spur would be considerably reduced before reaching Units 6 & 7. For example, Hornbach et al. (Reference 223) simulated a tsunami generated by the largest landslide from the Cape Fear Slide complex. The model results include contours of tsunami amplitudes 30 minutes after initiation of the landslide (see Figure 2.4.6-227). The major tsunami waves propagate along the axis of the landslide, both toward the coast and seaward. Geometrical spreading of the tsunami wave is prominent along the direction perpendicular to the axis of slide and toward the Straits of Florida. Based on the model results, the tsunami wave amplitude 30 minutes after slide initiation and about 200 kilometers (124 miles) along the Units 6 & 7 direction is approximately 1.5 meters (4.9 feet). In contrast, the tsunami amplitude off Miami, Florida, at a water depth of 783 meters (2569 feet) for the 1755 Lisbon Earthquake tsunami (which corresponds to the PMT) is 2.0 meters (6.6 feet) (Reference 209). The distance between the Cape Fear Slide complex and the off-Miami site at a water depth of 783 meters (2569 feet) is more than 800 kilometers (497 miles). Therefore, the tsunami maximum water level at the Units 6 & 7 site due to the Cape Fear Slide complex landslide would be lower than that from the 1755 Lisbon Earthquake tsunami.

To provide additional support to the conclusion based on the results of Hornbach et al (Reference 223) and to assess independently how a tsunami generated by a submarine slope failure at Cape Fear would affect PMT water levels at the Units 6 & 7 site, numerical models were used to estimate the wave that would be generated by such a failure and simulate its propagation towards the site, as described in Subsection 2.4.6.4.2.

Twichell et al. studied submarine erosion and characterized morphologic provinces for the Blake Escarpment (Figure 2.4.6-203) northeast of Units 6 & 7 (Reference 203). The Blake Escarpment, extending approximately 450 kilometers (280 miles) to the south from Blake Spur, is one of the largest cliffs in the ocean

with a relief of about 4000 meters (13,120 feet) (Reference 203). Near the southern edge of the escarpment, it crosses with the Jacksonville fracture zone, which underlies the Blake plateau at the location of Abaco Canyon. The escarpment was isolated from the continent-derived sediments since late Cretaceous, first by the currents in the Suwannee Straits and later by the Gulf Stream, and erosion of the escarpment is evident over the period (Reference 203).

Twichell et al. identified three morphologic provinces along the Blake Escarpment with varying erosional behavior (Reference 203). These are (1) valleys with tributary gullies, (2) box canyons, and (3) strait terraces. Valleys with tributary gullies are in the northern part of the escarpment near Blake Spur that have undergone no or very little erosion over time. Box canyons are formed by the differential settlement of base rock probably over a long period and are identified south of the Jacksonville fracture zone. The overlying carbonate strata in box canyons are fragmented with continued erosion. The middle reach of the escarpment has straight terraces formed by differential erosion of lithologic differences in the strata exposed along the cliff faces and has lower erosion potential than box canyons (Reference 203). The study by Twichell et al. identified evidence of debris accumulation at the base of the escarpment; however, it did not characterize any tsunamigenic source in the escarpment (Reference 203). Units 6 & 7 are sheltered by the islands of the Bahamas from tsunamis, if any, generated in the region, thus protecting Units 6 & 7 from being affected by large tsunamis.

The Ocean Drilling Program (ODP) provides stratigraphic information on the Bahama platform and the Straits of Florida from borehole and seismic reflection survey results. The ODP data suggest evidence of significant submarine debris flows and turbidite deposits during a four million year interval in the middle Miocene (Reference 217). However, no stratigraphic evidence could be established to relate these Miocene gravity flows to any tsunami deposit or tsunami-like event along the southern Florida coasts. After the Miocene, no debris flow or turbidite deposit could be identified in this region, possibly due to the erosional effects of the Gulf Loop Current that was first established in the Pliocene. It is hypothesized that the debris flow and turbidite deposit resulted from materials that had accumulated atop the carbonate banks at a marine high stand, which became unstable as sea level fell (Reference 217). Such debris flows are not expected to occur in the recent geological environment of eustatic sea level rise. Therefore, submarine landslide in the Straits of Florida and Bahamas regions is precluded as a PMT source candidate for the Units 6 & 7 site. Details of

stratigraphic information in the Bahamas and the Straits of Florida are provided in Subsection 2.5.1.1.1.2. Potential geological hazards near the site region are described in Subsection 2.5.1.1.5.

Information on submarine landslide along the northern coast of Cuba is very scarce. Iturralde-Vinent (Reference 218) summarizes the current understanding of tsunami hazards in Cuba, details of which are provided in Subsection 2.5.1.1.5. Iturralde-Vinent identifies potential tsunami hazards for the Cuban north coast region based on large carbonate boulders found on marine terraces; however, no submarine landslide zones were identified in this region. Consequently, a submarine landslide along the north coast of Cuba was not included as a candidate PMT source for the Units 6 & 7 site.

Units 6 & 7, therefore, would not be impacted by significant submarine landslide-generated tsunamis from the U.S. Atlantic margin, the straits of Florida, Bahamas, or Cuba regions.

2.4.6.1.2 Submarine Landslides in the Gulf of Mexico

Within the Gulf of Mexico, evidences of submarine landslides are recorded in all three geological provinces (Carbonate, Salt, and Canyon/Fan) (Reference 202). The geological provinces within the Gulf of Mexico are shown in Figure 2.4.6-204. The largest submarine failures are found in the Canyon/Fan Province within the Mississippi Fan that was probably active 7500 years ago. The largest failure in the Salt Province is identified offshore of the Rio Grande River. Landslide evidences in the Carbonate Province are identified in the West Florida and Campeche Escarpments along the eastern and southern Gulf of Mexico, respectively (Reference 202).

Significant landslides on the West Florida Slope above the Florida Escarpment (Figure 2.4.6-205) are sourced in Tertiary and Quaternary carbonate deposit. This landslide zone, which is located approximately 300 miles (480 kilometers) west of Units 6 & 7, is hypothesized to be a composite of at least three generations of failures (Reference 202).

Based on the mapping of landslide zones in the Gulf of Mexico, AGMTHAG identified four likely landslide zones and characterized tsunamigenic source parameters that could be used to calculate corresponding tsunami amplitudes (Reference 202).

The West Florida Escarpment is the major marine geomorphic feature on the west coast of Florida. It has undergone significant erosion since its initial formation

during the Cretaceous as part of a reef complex, with as much as 8 kilometers (5.0 miles) of erosional retreat of its base (Reference 203). In general, the slope on the West Florida Escarpment increases below 1750 meters (5741.5 feet) depth and frequently exceeds 40 degrees. The front of the escarpment is composed of Lower and Middle Cretaceous platform-interior bedded lagoonal limestones and dolostones. Accumulations of younger Pliocene and Pleistocene sediments associated with the Mississippi Fan (submarine deltaic deposits from the Mississippi Embayment) onlaps at the base of the escarpment (References 202 and 247).

A study was conducted in 1985 using SeaBeam bathymetric data and GLORIA (Geologic LOng-Range Inclined Asdic) side-scan sonar data collected by the USGS and the Institute of Oceanographic Sciences of the United Kingdom to examine the submarine mass failures in the West Florida Escarpment. The GLORIA images covered a broad area about 220 kilometers (136.7) in length along the escarpment between 25°N and 27°N. This study concluded that erosion has occurred since the initial formation of the escarpment and that erosional processes changed its morphology at different rates (Reference 250).

In the area north of 27°N, the escarpment is a relatively linear landform with slope gradients of less than 28 degrees and is dissected by numerous valleys spaced 1 to 5 kilometers (3.1 miles) apart with tributary gullies feeding into them (Reference 203, Figure 6-2). The Cenozoic sediments in this area have not been exposed to extensive erosion due to the presence of the thin discontinuous Cenozoic sediment cover as well as possible undisturbed reef structures in the underlying Cretaceous section. The slope above this part of the escarpment is smooth and is interrupted by only a few mass wasting scarps. Below the escarpment are aprons (as seen in GLORIA imagery and SeaBeam bathymetry [Reference 203, Figure 6-2]), which are inferred to be carbonate debris material that have been eroded and transported off the escarpment and interfinger with late Pleistocene-age fan deposits (Reference 203).

South of 27°N, part of the escarpment is also relatively linear but is terraced, and parts are deeply incised by large canyons. On the straight part of the escarpment, which occurs between 25.5°N and 26.5°N, the lower part of the escarpment is terraced, whereas the upper part is steeper and unterraced (Reference 203, Figure 6-3). The terraces have gradients of 10 degrees to 20 degrees, while the terrace risers and the upper part of the escarpment have gradients of 30 degrees to 42 degrees. The canyons incise the edge of the Florida platform by as much as 15 kilometers (9.3 miles). The canyon heads are 1 to 3 kilometers (0.6 to 1.9 miles) wide, and the mouths are 3 to 7 kilometers (1.9 to 4.3 miles) wide

(Reference 203, Figure 6-4). The canyon's floors are flat and at the same depth as the abyssal plain floor except immediately below. The canyon's headwalls where the depressions occur are as much as 80 meters (262.5 feet) deeper than the abyssal plain floor. Talus deposits that have been eroded from the headwalls are seen in the GLORIA image (Reference 203, Figure 6-4). The headwalls have gradients that exceed 40 degrees and do not have terraces; however, the sidewalls are not as steep and do have discontinuous terraces. These canyons are called box canyons and are concentrated in two groups along the southern part of the escarpment. One group occurs between 26.5°N and 27°N and the second between 24.3°N and 25.6°N (Reference 203).

The area that is postulated to be the site for a maximum credible submarine landslide is identified along the southern part of the West Florida Slope as delineated in Figure 2.4.6-263 (Reference 239). Doyle and Holmes (Reference 249) and Twichell et al. (Reference 250) have stated that this area has undergone collapse. The area is described as characterized by "scarps [that] are still exposed on the seafloor and have 50-150 meters relief and are 10-70 kilometers in length" (Reference 239). According to ten Brink et al. (Reference 239), "some of the mass movement deposits are on the slope above the Florida Escarpment, but it is unknown how much of the failed material was transported farther and deposited at the base of the Florida Escarpment." These landslides from the West Florida Slope are composed of several smaller failure events as seen in the crosscutting relationships of the headwall scarps in the GLORIA imagery (Reference 250). The age of these failures is not known, but it is suggested by Mullins et al. (Reference 248) and Doyle and Holmes (Reference 249) that periods of increased mass wasting are associated with periods of higher sedimentation rates. Therefore, it is possible that the landslides along the southern part of the West Florida Slope are likely early Holocene (4500-10,000 years before the present) or older in age (Reference 251). The runout distance of the existing slope failure is uncertain, as landslide deposits at the base of the West Florida Escarpment are buried under younger Mississippi Fan deposits (Reference 239).

Because Units 6 & 7 are located on the eastern side of the Florida peninsula opposite of the Gulf of Mexico shoreline and a very wide continental shelf exists along the Gulf Coast of Florida, tsunamis generated within the Gulf of Mexico would likely be dissipated before reaching Units 6 & 7. Therefore, it was concluded that landslide-generated tsunamis from the Gulf of Mexico sources would not affect the safety-related facilities of Units 6 & 7 that have a design plant grade elevation of 7.92 meters (26 feet) NAVD 88. To provide additional support to

this conclusion and to assess how a tsunami generated by a submarine slope failure at the Florida Escarpment would affect PMT water levels at the Units 6 & 7 site, numerical models were used to estimate the wave that would be generated by such a failure and simulate its propagation toward the site as described in Subsection 2.4.6.3.

2.4.6.1.3 Landslide Sources along the Great Bahama Bank

A number of publications examined the various aspects of sediment deposits and sedimentary/geomorphic processes on and affecting the Great Bahama Bank (GBB), its western margin and the Straits of Florida. A review of this literature indicates that different investigators (References 253, 254, 255, 256, 257, 258, and 259) have proposed multiple hypotheses to explain the distribution of the cyclical successions of deposits as displayed in boring data obtained in the region (such as ODP Site 626, Clino borehole, and the Great Isaac Well, etc.) and interpreted from seismic reflection surveys as described below.

Mullins and Neumann (Reference 255) studied the carbonate deposits in the Bahamas using high-frequency; high-resolution seismic reflection profiles and bottom grab samples. They determine that, in general, the leeward deep bank margins are steeper, narrower, more dissected, and contain significantly greater amounts of coarse grained sediments than their windward margin counterparts. According to Mullins and Neumann (Reference 255), the processes that are responsible for the development of deep carbonate bank margins include: basement faulting, direction and magnitude of off-bank sediment transport, oceanic circulation, gravity and pelagic sedimentation, submarine cementation; and biological buildups. “Of these, basement faulting is primarily responsible for the initiation of carbonate platform edges. Off bank sediment transport is controlled by the physical energy flux such as winds, waves, storms at the sea surface and controls the availability of shallow water sediment for transport to the deep flanks” (Reference 255, p. 165).

Fulthorpe and Melillo (Reference 253) interpret the carbonate sediment cored at ODP Site 626 in the Straits of Florida to have been deposited by gravity flows having the characteristics of debris flows and high-density turbidity currents. These gravity flows could have been caused by gravitational instability that was the result of sediment loading of a carbonate platform slope during a period of rising sea level, triggering of slope failure by a decrease in sea level, or triggering by tectonics and earthquake activity during the middle Miocene.

Kuhn and Meischner (Reference 256) interpret the carbonate sediment from ODP Leg 101 Sites 628 (Little Bahama Bank), 632 (Exuma Sound), and 635 (Northeast Providence Channel) to have been deposited downslope during the initial stage of falling sea level. Gravity flows may occur along the entire slope, flowing downslope in a regional canyon system that is less prominent than on a steeper slope. Therefore, the gravity flows erode and entrain large amounts of fine-grained slope sediment (Reference 256).

By examining the seismic data and limited well data from the northwestern GBB, Eberli et al. (Reference 257) interpret that the deposits developed as a result of pulses of prograding sediments generated by fluctuations in sea level and that an aggradation phase on the marginal slope preceded progradation. The timing, amount, and mode of progradation and the geometries of the prograding units are controlled by several factors such as sea level, subsidence, carbonate production and accumulation, direction of wave energy, and angle of repose. Eberli et al. (Reference 257, p. 1002) state that the “sea level changes are responsible for the pulsed mode of progradation, and the sequences seen on seismic lines.”

Betzler et al. (Reference 258) interpret deposits of the Miocene-Lower Pliocene Bahamian carbonate ramp from core, geophysical logging, and high-resolution seismic reflection data from ODP Leg 166 (in the western margin of the GBB south of ODP Site 626 in the Straits of Florida). The deposits consist of cyclic alternations of light and dark grey wackestones/packstones with interbedded calciturbidite packages and minor slumps. These deposits are interpreted by Reference 258 to be the result of high-frequency sea level changes. Betzler et al. (Reference 258) propose two models to explain the cycle generation. The first model applies the principle of highstand shedding and correlates the dark grey layers to low sea level (i.e., lowstands). The second model assumes that the dark grey layers formed as condensed sections during sea level rises (i.e., highstands). Betzler et al. (Reference 258, pp. 1141-1142) favor the second model “because the shallow water carbonate production area was not reduced significantly during sea level lowstands . . . the dark-grey/light-grey cyclicity is linked to the Miocene ramp geometry. . . it disappeared during the Early Pliocene, as the ramp began to change into a flat-topped platform.” In addition to high-frequency sea level changes, Betzler et al. (Reference 258) interpret the depocenter shifts of Miocene gravity flows from an outer ramp position during the Early and Middle Miocene to a basin floor position during the Late Miocene and Early Pliocene (i.e., depocenter shifted from east to west) to be the result of increasing strength of bottom currents during the Late Miocene.

Betzler et al. (Reference 259) studied the shedding pattern along the slope and toe of slope deposits of the carbonate ramp of the western margin of the GBB using seismic lines, logging data, and quantitative petrographic data from ODP Leg 166. Betzler et al. (Reference 259) interpret two types of turbidite sequences. The first sequence is characterized by aggradation to weak progradation of the inner ramp that leads to gradual uphole increases in shallow water components within individual depositional sequences, whereas the second type formed during sea level falls and are characterized as fan depositional systems, which are laterally discontinuous. The first type of turbidite sequence on a large to medium seismic stratigraphy scale is laterally continuous over longer distances. The second type of turbidite sequence is characterized by a mixture of shallow water particles and other components with each turbidite package consisting of a distinct composition with no large scale compositional trends (Reference 259). Betzler et al. (Reference 259) interpret the shedding pattern to have recorded five orders of sea level changes with the turbidite packages reflecting the Middle Miocene sea level fall.

Considering the uncertainty in the actual mechanism of deposition of the sediments encountered at ODP sites near the GBB, and evidences of seabed instabilities as cited by some investigators, the potential of submarine slope failures along the western margin of the GBB and the associated tsunami flooding hazard at the Turkey Point Units 6 & 7 site warrants further evaluation.

Several areas that exhibit mass gravity flow deposits (Reference 264) occur on the western margin of the GBB. The western margin, which contains several areas of past and potential future slope failures, has been studied by References 256, 260, 263, 265, and 266 for various purposes. The data provided by References 264, 265, and 266 comprise part of the ODP Legs 101 and 166; scientific investigations and proceedings. Paleontological, biostratigraphic, geochemical, geophysical (seismic reflection survey), and sedimentological data were collected from ODP Legs 101 and 166. Data documented in Reference 263 consists of high-resolution seismic reflection profiles with submersible reconnaissance and bottom sediment samples. More recently, Mulder et al. (Reference 260) (supported by the French Institut National des Sciences de l' Univers program “Action Marges”) acquired new high-quality multibeam bathymetry, high-resolution seismic profiles, and 17 gravity cores. The seismic reflection profiles (i.e., ODP Legs 101 and 166, and Reference 263) and multibeam bathymetry (i.e., Reference 260) contain features interpreted as the result of slope failure and mass gravity flow deposits (Figure 2.4.6-294). The seismic profiles (Figures 2 and 3 of Reference 263) are defined by a bank edge, a

steep upper rocky slope interval or wall and a lower slope. The slopes observed on the seismic profiles are interpreted to be relatively young; possibly Holocene in age. The data supporting this evaluation is comprised of the clean, sharp slope profiles in Figures 2 and 3 of Reference 263. In addition, the bathymetric images on Figure 1 of Reference 260, Figure 1 of Reference 261, and Figure 8 of Reference 267 depict what appear to be relatively steep slopes that do not indicate significant modification. In addition, uranium/thorium dating methods give dates of approximately 810 to 10,120 years before the present on cored sediments from the slope (Reference 263). These data support a Holocene age for the slope failures. While these deposits may have formed as a result of downslope (east to west) transport of sediment formed on the Bahama's bank top, Mulder et al. (Reference 260, p. 605) interpret the mass gravity flow deposits as a result of slope failures and state, "due to their large size, mass transport complexes can be tsunamigenic and have to be considered in the assessment of natural hazards." Therefore, it is conservatively assumed that a future failure in the slope instability areas on the western margin of the GBB can generate a tsunami. The two areas on the western margin of the GBB that have a potential for a probable maximum tsunami (PMT) to the Turkey Point Units 6 & 7 site are the southern site and the northern site.

Southern Site

High-resolution multi-beam bathymetric and seismic reflection data collected recently have provided the basis for understanding the morphology of the western margin of the GBB and the adjacent seafloor of the Straits of Florida (References 260 and 261). These data display evidence of slope instabilities starting at a water depth of approximately 450 to 550 meters. Scars from slope failures are typically approximately 1 kilometer wide. These scars "evolve longitudinally toward a fan-lobe system in which erosional processes dominate over depositional systems. Tongue-shape patches of blind echo-facies are observed locally and could result from debris flow transport of reworked coarse sediment originating from the bank, or from deep-water coral mounds. The most impressive morphological feature is a large sediment failure and its associated mass transport complex" (Reference 260) (Figure 2.4.6-295). This mass gravity flow feature includes three failure scarps, spanning an area approximately 9 kilometers wide and ranging in height from 80 to 110 meters. Downslope of the scars, the seafloor is hummocky in nature (i.e., debris field). The debris field extends westward over 20 kilometers. The surface of the entire deformed area is approximately 300 square kilometers (Reference 260). This area, referred to as the southern site as shown in Figure 2.4.6-295, is located at approximately

24.9534°N, 79.2358°W and is approximately 90 kilometers west of the Great Bahama Island, approximately 90 kilometers south of the Bimini Islands and 125 kilometers from the Turkey Point Units 6 & 7 site. Figure 2.4.6-296 shows a profile of the bathymetry (Reference 260) at this location. As shown in Figure 2.4.6-296, the length of the steeper slope (>1.5 degrees) along this profile is approximately 3 kilometers with the upper third of the profile having a slope of < 5.8 degrees, while the middle third of the profile has a slope of < 3.8 degrees. Figure 2.4.6-293, which is reproduced from Reference 260, shows these scars and suggests that a larger area that encompasses these scars and some smaller adjacent scars is approximately 14 to 15 kilometers wide, which is consistent with the 13-kilometer width stated in Mulder et al. (Reference 260). The large- and small-scale morphologies in this area “include bypass areas, channel-levee lobe systems, gullied slopes, and products of slope instabilities at various scales, including long slump scars at the lower slope and mass transport complexes that extend approximately 30 kilometers into the adjacent basin floor” (Reference 260).

Northern Site

The northern site is located at approximately 25.6134°N, 79.3213°W, approximately 104 kilometers east of the site. This location is the closest potential slope failure area to the Turkey Point Units 6 & 7 site. This area is discussed in detail in Reference 263 and is briefly summarized here. It is described as consisting of a bank edge, a lithified accretionary slope (steep rocky slope interval or wall and thinned Holocene sequence), and a lower slope. The bank edge consists of vertical (1-5 meters) steps, separated by gently sloping, sediment covered terraces in water depths of less than 10 meters. The lower part of this interval is smooth or hummocky with a surface of thin (10-30 centimeters) hardgrounds (i.e., cementation by either aragonite or Mg-calcite) (References 263 and 268). A monotonous and generally smooth lithified accretionary slope with a gradient of approximately 15 to 20 degrees is located west and downslope of the bank edge. The water depth at its upper, shallow end occurs at depths between 15 and 65 meters. The deeper part of the slope occurs in water depths of 65 to 150 meters. The 1-5 meter wide ledges in the upper portion of the slope appear to act as steps for cascading sand from above. However, near Bimini and Riding Rocks, approximately 104 kilometers east of the Turkey Point Units 6 & 7 site, the accretionary slope is described as a vertical wall (>45 degrees) that is locally undercut between 35 and 80 meters. Below this wall, the slope gradients decrease from 30 to 35 degrees at 100 meters to 15 degrees at 300 meters. The slope is concave and lithified throughout the lower interval (References 263 and 268). Seaward of this location, a trough and “dump bump” topography marks the

beginning of the lower slope. The lower slope west of and below the “dump bump” is a very low energy environment, found in water depths greater than 150 meters.

Figure 2.4.6-299 shows the bathymetry of the northern site near the Bimini Islands which exhibits failure scars, “Fs” (Reference 260). Figure 2.4.6-297 shows the location of several seismic reflection profiles presented in Reference 263. The seismic reflection profile along Line 5 in the study area near Bimini Island is shown in Figure 2.4.6-298. Near the top of the profile of Line 5, the steepest slope is approximately 20 degrees. Within approximately 1 kilometer, the slope decreases to approximately 17 degrees and further west (downslope) to 5 degrees along the profile. The slope of the face of the scarp at the northern site, based on the profile shown in Figure 2.4.6-300 is approximately 7 degrees. Different seismic profiles presented in Reference 263 suggest that low angle slopes to 20 degrees slope could be subject to failure.

Therefore, among slope failures of similar size, the impact on the Turkey Point Units 6 & 7 site would depend on the proximity of the tsunami source, the direction of the wave, and the bathymetry along the path of its propagation. The northern site location is referred to henceforth as the Postulated Slide Location. Based on this consideration, the Postulated Slide Location shown in Figures 2.4.6-295 and 2.4.6-297 was identified as being the most likely to generate a tsunami that would produce the maximum wave height at the Turkey Point Units 6 & 7 site. The Postulated Slide Location is approximately 13 kilometers southwest of South Bimini Island. At a distance of approximately 104 kilometers, the Postulated Slide Location at this point along the western margin of the GBB is the closest to the Turkey Point Units 6 & 7 site with the direction of a potential failure pointing directly towards the site.

The conservative approach to the GBB tsunami flooding evaluation is to incorporate source characteristics from both the hypothetical slide areas described above. The northern site, at approximately 25.6134° N, 79.3213° W, is therefore selected as the source location of the postulated slide for the tsunami modeling because of its proximity and direct path of tsunami wave propagation to the Turkey Point Units 6 & 7 site.

2.4.6.1.4 Far-Field Submarine Landslide Sources

Ward and Day (Reference 204) postulated a mega-tsunami scenario as a result of a possible catastrophic flank failure of the Cumbre Vieja volcano at La Palma of Canary Islands. They estimated that a future volcanic eruption of Cumbre Vieja could slide up to 500 cubic kilometers (120 cubic miles) of rock volume into the

ocean running westward 60 kilometers (37.3 miles) offshore at a speed of 100 meters per second (328 feet per second) resulting in a tsunami amplitude of 20–25 meters (66-82 feet) at the Florida Atlantic coast. However, Mader pointed out that the assumption of linear propagation of shallow water wave, as used in Ward and Day's analysis, only described geometrical spreading of waves and ignored the effects of short period wave dispersion (Reference 205). Such an assumption would overpredict the tsunami amplitude. Using the SWAN computer code, Mader computed a maximum tsunami amplitude less than 3.0 meters (10.0 feet) along the U.S. Atlantic coast and less than 1.0 meter (3.3 feet) near Miami, Florida (Reference 205). Mader adopted the initial tsunami amplitude as obtained from the physical model study of the Cumbre Vieja volcano flank failure performed at the Swiss Federal Institute of Technology (Reference 205). The Swiss Federal Institute of Technology experiment considered the failure as a single monolithic block (Reference 205). Pararas-Carayannis also disputed the claim by Ward and Day that a collapse of the Cumbre Vieja volcano is imminent (Reference 206).

More recent modeling efforts by Gisler et al. of the Cumbre Vieja volcano flank failure also showed significant wave dispersion (Reference 207). From the model simulation results, Gisler et al. demonstrated that the tsunami amplitude decay is proportional to $r^{-1.85}$ and $r^{-1.0}$, where r is the distance from tsunami source, for the two- and three-dimensional models, respectively. The simulated tsunami amplitude varied between 1 and 77 centimeters (0.4 and 30 inches) along the Florida Coast (Reference 207). Gisler et al. used smaller slide volume but much higher slide speed compared to those used in Ward and Day (Reference 202). The amplitude in Ward and Day model scales proportionally with rock volume times slide speed. Hence, the much smaller predicted amplitude of Gisler et al. for the Florida coast cannot be attributed to the smaller slide volume (Reference 202). AGMTHAG concluded that a tsunami from this source is not expected to cause a devastating tsunami along the east coast of the United States (Reference 202).

The other notable far-field submarine landslide tsunami sources are located along the glaciated margins of northern Europe and Canada (Reference 202). The Storegga landslide in northern European margin is identified as a composite of seven slides over the past one-half million years with the largest and most recent landslide dated at 8150 years before present. The resulting tsunamis affected the coasts of Norway, Faeroes islands, Shetland islands, Scotland and northern England. The impacted areas were all within 600 kilometers (375 miles) of the slide (Reference 202).

The Grand Banks landslide in the Scotian margin near Newfoundland, Canada generated a devastating tsunami locally in 1929 (References 202 and 208). AGMTHAG indicated that increased deposition and slope failure on the Scotian margin was due to glacial advance that reached close to the shelf edge about one-half million years before present. However, deposition rate decreased significantly about 8000 years ago as deglaciation ended (Reference 202). The 1929 Grand Banks landslide is one of the only two landslide occurrences in the Scotian margin postdated to the Holocene. Units 6 & 7 would not be affected by teletsunamis from these landslide sources because the tsunamis would be dissipated before reaching them.

2.4.6.1.5 Earthquakes in the Azores-Gibraltar Plate Boundary

Tsunamigenic earthquake sources that may affect the Florida Atlantic Coast are located west of Gibraltar in the Azores-Gibraltar plate boundary near Portugal in the East Atlantic Ocean (at the Africa-Eurasia plate boundary) and in the northeastern Caribbean Basin (Caribbean-North American plate boundary). The Azores-Gibraltar plate boundary separates the African and Eurasian plates, as shown in Figure 2.4.6-206, and has been identified as the source of the largest earthquakes and tsunamis in the north Atlantic basin (Reference 202). AGMTHAG summarized six large tsunamigenic earthquakes that had occurred in this region over the past 300 years—in 1722, 1755, 1761, 1941, 1969 and 1975 (Reference 202). The 1755 Great Lisbon Earthquake, which was estimated in earthquake moment magnitude (M_W) to be 8.5–9.0, had the largest documented felt area of any shallow water earthquake in Europe, and was the largest natural disaster to have affected Europe in the past 500 years (Reference 202). The earthquake motion and ensuing submarine landslide contributed to tsunami waves of 5 to 15 meters (16.4 to 49.2 feet) that devastated the coasts of southwest Iberia and northwest Morocco and were reported as far north as Cornwall, England (Reference 202). Figure 2.4.6-206 shows the general tectonic setting and bathymetry of the eastern segment of the Azores-Gibraltar plate boundary.

The large tsunami waves also travelled across the Atlantic reaching as far north as Newfoundland, Canada and as far south as Brazil, and caused widespread damage in the eastern Lesser Antilles (Reference 202). However, there is no record of tsunami run-up on the U.S. east coast from this event, although several populated cities existed along the U.S. Atlantic coast in 1755 (Reference 202). Computer simulations by Mader (Reference 209) indicated that the maximum tsunami amplitude including run-up in the U.S. east coast was approximately 3.0 meters (10.0 feet). AGMTHAG simulated the 1755 earthquake tsunami with

the source location varying within the Azores-Gibraltar region. The maximum tsunami amplitude in the deep water along the U.S. Atlantic margin was obtained as approximately 0.6 meter (2.0 feet) for a tsunami source location east of the Madeira Tore Rise (Figure 5-8, Reference 202). Further discussion of the 1755 earthquake-generated tsunami is provided in Subsections 2.4.6.2 and 2.4.6.3.

2.4.6.1.6 Earthquakes in the North Caribbean Subduction Zones

The Caribbean region is characterized by high seismic activities and is associated with a large number of past tsunamis (References 210 and 211). Tsunami sources in the northeastern Caribbean Basin that may affect the Florida Atlantic coast include the Puerto Rico and Hispaniola trenches, as shown in Figure 2.4.6-207. AGMTHAG simulated the distribution of peak offshore tsunami amplitude along the Gulf of Mexico and Atlantic Coasts from a postulated earthquake in the Puerto Rico trench. The simulation, which used a linear long-wave model for the deepwater regions and did not include frictional effects, predicted the maximum tsunami amplitude to be no more than 0.1 meter (0.3 foot) at a water depth of 250 meters (820 feet) near the longitude of approximately 80.2° W (longitude position estimated from Figure 8-2c of Reference 202). This longitude position represents generally the location within the Straits of Florida, which is south-southwest of Units 6 & 7. The maximum deepwater tsunami amplitudes along the U.S. Atlantic coast, however, were much higher, close to 5 meters (16.4 feet) near latitude 40° N (latitude position represents generally a location offshore of the New York/New Jersey coast) and approximately 3 meters (10 feet) near latitude 33.2° N (offshore of the South Carolina coast). The model simulated a maximum deepwater tsunami amplitude of about 3.5 meters (11.5 feet) near 28° N (offshore of Palm Bay, Florida) (Figure 8-3c of Reference 202). The relatively small tsunami amplitude near Units 6 & 7 is primarily a result of the presence of the Bahama platform to the east, as shown in Figure 2.4.6-208 and Figure 2.4.6-228. AGMTHAG did not model the propagation of tsunami waves across the continental shelf (water depth less than 250 meters or 820 feet) and run-up (Reference 202).

A similar tsunami model study was also performed by the West Coast and Alaska Tsunami Warning Center using a two-dimensional hydrodynamic model developed at the University of Alaska, Fairbanks (Reference 211). Four hypothetical worst-case scenarios with tsunami sources located in the Gulf of Mexico and the Caribbean regions were simulated using the West Coast and Alaska Tsunami Warning Center model. The simulations predicted the peak tsunami amplitude near Virginia Key, Florida, to be approximately 15 centimeters (0.5 foot) for an earthquake magnitude M_w of 9.0 in the Puerto Rico Trench. The

simulated earthquake is larger in magnitude than any recorded earthquake in this region. The maximum recorded earthquake magnitude in this region is 8.3 (unknown earthquake scale) that struck the Guadeloupe Island in Lesser Antilles, as obtained from the National Geophysical Data Center (NGDC) earthquake database (Reference 212). Also tabulated in the NGDC earthquake database are two events with earthquake surface wave magnitude (M_S) of 8.1 that occurred near Haiti in 1842 and the Dominican Republic in 1946.

2.4.6.1.7 Other Sources

An extensive literature search did not return any information of seismically induced seiche in Biscayne Bay. In addition, because of low and flat topography near Units 6 & 7, the possibility of any subaerial slope failure that would generate tsunamis affecting Units 6 & 7 is precluded.

Earthquakes within the Gulf of Mexico are also recorded with epicenters located within the North American plate boundaries. Such “midplate” earthquakes are less common than earthquakes occurring on faults near plate boundaries and are unlikely to produce any destructive tsunami (Reference 213).

A significant tsunami generated directly by an earthquake only occurs if the earthquake is large (magnitude, with few exceptions, greater than about 6.5) and if the fault slip associated with the earthquake has a significant vertical seafloor displacement (thrust or normal faults). There is no record of surface fault rupture and significant seismic wave displacement at the seafloor associated with any historical earthquake in the central and eastern United States including the 1886 Charleston, South Carolina event of about magnitude 7, the largest historical earthquake in the U.S. Atlantic coastal region. Consequently, the conditions for tsunamigenesis by seafloor displacement associated with an earthquake do not appear to exist along the U.S. Atlantic margin; Units 6 & 7, therefore, would not be impacted by significant tsunamis as a result of vertical seafloor displacement associated with the U.S. Atlantic margin earthquakes.

Although the north Caribbean subduction zone is noted for several seismically-generated tsunamis in recent times, as described in Subsection 2.4.6.1.6, potential submarine landslides of the carbonate platform edge north of Puerto Rico are capable of producing large tsunamis locally (see Subsections 2.4.6.2 and 2.5.1.1.5 for detailed discussions). However, because the Units 6 & 7 site is sheltered by the Bahamas Islands, such landslide-generated tsunamis are not expected to affect the site. This sheltering effect can be seen from the results of a tsunami model simulation caused by an earthquake in the Puerto Rico Trench

(North Puerto Rico/Lesser Antilles subduction zone). Figure 2.4.6-228, taken from Reference 202, shows contours of tsunami amplitudes and the associated regional tsunami propagation pattern due to an earthquake at the Puerto Rico Trench. As indicated in the figure, the southeast Florida coast is sheltered by the Bahamas from tsunami waves generated in the area north of Puerto Rico. Although the mechanism of tsunami generation by earthquakes and landslides is different, the regional tsunami propagation pattern between the two is expected to be similar for the Puerto Rico Trench area. As Figure 2.4.6-228 indicates, the apparent earthquake tsunami beaming is along an azimuth perpendicular to the strike, i.e., in the north direction. For a landslide tsunami that may originate in the Puerto Rico Trench, the direction of the seaward tsunami propagation would also be in the north direction, and the tsunami amplitude would be relatively lower at far-field. This is because landslide tsunamis are greatly attenuated at far-field due to non-linear and dispersive effects compared to earthquake tsunamis (Reference 202). Therefore, a landslide in the carbonate platform north of Puerto Rico is not considered as a PMT source for the Units 6 & 7 site.

2.4.6.1.8 Summary of Potential Sources for PMT at Units 6 & 7

Units 6 & 7 are not located in the immediate vicinity of any tsunamigenic source. The landslide zone nearest to Units 6 & 7 is located on the west Florida slopes within the Gulf of Mexico, separated by a very wide and shallow continental shelf and the entire width of the Florida peninsula. There is no historical evidence of any tsunami from landslides in the Gulf of Mexico. Landslides in the U.S. Atlantic margin may potentially generate local destructive tsunamis. However, because Units 6 & 7 are located far away from any such sources, is mostly sheltered by the Bahama platform, and is protected by a retaining wall structure with top elevation of 20.0 feet to 21.5 feet NAVD 88, such tsunamis are not expected to cause any flooding concern to the safety-related facilities of Units 6 & 7. The orientation of the Puerto Rico trench and the presence of the Bahama platform prevents any destructive tsunami to impact Units 6 & 7 from this source. Therefore, it is concluded that the PMT would likely be caused by earthquake-generated transoceanic tsunamis from the Azores-Gibraltar plate boundary. Characteristics of tsunami source generators for both Azores-Gibraltar plate boundary and Caribbean region are presented in Subsection 2.4.6.3.

2.4.6.2 Historical Tsunami Record

Records of historical tsunami run-up events along the U.S. Atlantic coast near Units 6 & 7 are obtained from the NGDC tsunami database (Reference 214). The NGDC database contains information on source events and run-up elevations for

tsunamis worldwide from approximately 2000 B.C. to the present time (Reference 214). A search of the NGDC tsunami database returned 11 historical tsunamis that have affected the U.S. and Canada east coast, as indicated in Table 2.4.6-202.

Three events in the record are the result of a combination of earthquakes and submarine landslides in the Nova Scotia margin off the coast of Newfoundland, Canada, and in the Labrador Sea off Newfoundland, Canada. The most recent and most severe tsunami from this area was that from the M_w = 7.2 earthquake and associated submarine landslide in the Nova Scotia margin in 1929. The ensuing tsunami, with a maximum run-up of approximately 7 meters (23 feet) at Taylor’s Bay, Newfoundland, Canada, was recorded as far south as Charleston, South Carolina (12 centimeters or 4.7 inches).

Three earthquakes in the Caribbean region generated tsunamis that were recorded in the U.S. east coast. The strongest earthquake was the M_s = 8.1 earthquake of August 4, 1946, with an epicenter northeast of the Dominican Republic, which was followed by the August 8, 1946 aftershock (magnitude 7.9 of unknown scale). The maximum tsunami run-ups from the two events were 5.0 meters (16.4 feet) and 0.6 meter (2.0 feet) at the coasts of Dominican Republic and Puerto Rico, respectively, for the August 4 and August 8 events. No run-up data is available from these events on the Florida Atlantic coast. The other tsunami event was caused by the earthquake of 1918 (M_w = 7.3) in Mona passage, located northwest of Puerto Rico, resulting from the displacement of four segments of a normal fault (Reference 214). A recent study hypothesized a combined earthquake- and landslide-generated tsunami for this event (Reference 215). The NGDC database indicates a tsunami amplitude of 6 centimeters (2.4 inches) near Atlantic City, New Jersey. However, no run-up was reported on the Florida Atlantic coast from this event. The maximum tsunami amplitude from this event reported along the western and northern Puerto Rico was 6.1 meters (20.0 feet).

The NGDC database also includes three tsunami events generated in the U.S. Atlantic margin with the Charleston, South Carolina, earthquake-generated (M_w = 7.7) tsunami of 1886 being the only confirmed tsunami. An earthquake event was also reported at Jacksonville, Florida, on the same day approximately an hour before the Charleston, South Carolina, earthquake. It has not been established if the two events were related (Reference 214). The resulting tsunami waves were reported in Jacksonville and Mayport, Florida, although no run-up information is available. The two other tsunami events are reported as probable in the NGDC database. The first tsunami event was the result of an earthquake in

High Bridge, New Jersey (magnitude computed from the felt area, Mfa = 4.4) that produced a tsunami-like wave in Long Island, New York, in 1895. The second event was a possible landslide- or explosion-generated tsunami near Long Island, New York, that produced a maximum tsunami amplitude of 0.28 meter (0.9 foot) at Plum Island, New York, in 1964. No tsunami wave from the two events was reported in the Florida Atlantic coast.

The remaining two records in the NGDC database are transoceanic tsunami events: the Great Lisbon Earthquake tsunami of 1755 off the Portugal coast and the Boxing Day tsunami of 2004 off the west Sumatra coast, Indonesia. The earthquake west of Sumatra (M_W = 9.0) generated a tsunami that was recorded nearly worldwide and killed more people than any other tsunami in recorded history (Reference 214). A tsunami amplitude of 0.17 meter (0.6 foot) was recorded at Trident Pier on the Florida Atlantic coast. The Great Lisbon Earthquake that destroyed the city of Lisbon stuck at approximately 9:40 a.m. on November 1, 1755. Mader reported an estimated magnitude (M_W) of approximately 8.75–9.0 for the earthquake that was felt over an area of a million square miles (Reference 209). The earthquake generated a tsunami, which arrived at Lisbon between 40 minutes and 1 hour after the earthquake as a withdrawing wave, that emptied the Lisbon Oeiras Bay (Reference 209). The following tsunami wave arrived with an amplitude of approximately 20 meters (65.6 feet) followed by two more waves approximately an hour apart (Reference 209). The tsunami wave had amplitudes of 4 meters (13.1 feet) along the English coast, and 7 meters (23 feet) at Saba, Netherland Antilles, in the Caribbean after approximately 7 hours of travel (Reference 209). Lockridge et al. also reported tsunami arrival in the harbor at Cape Bonavista, Newfoundland, Canada, with a retreating wave and a subsequent returning wave approximately 10 minutes later (Reference 208). Model simulation by Mader showed that the tsunami wave arrived at the Florida Atlantic coast approximately 8 hours after the earthquake (Reference 209). The deepwater tsunami amplitude off the coast of Miami, Florida, was simulated to be approximately 2 meters (6.6 feet) with a period between 1.25 and 1.5 hours. Mader suggested a maximum tsunami amplitude of approximately 3.0 meters (10 feet) including wave run-up along the U.S. east coast (Reference 209).

Lockridge et al. reported tsunamis and tsunami-like events in the U.S. east coast in addition to the events reported in the NGDC database (Reference 208). Most of these additional events originated along the New York, New Jersey, and Delaware coasts, and the Florida Atlantic coast remained unaffected. No seismically-induced paleotsunami deposits have been positively identified in available

scientific literature within the 200-mile radius of the Turkey Point site, as described in Subsection 2.5.1.1.5. Distinguishing characteristics of tsunami versus storm deposits are also described in Subsection 2.5.1.1.5. Turkey Point site boring log data interpretation and relevance to paleotsunami deposits is described in Subsection 2.5.1.2.2

2.4.6.3 Source Generator Characteristics

There is no tsunamigenic source present in the immediate vicinity of Units 6 & 7. The submarine landslide zones in the U.S. Atlantic margin and along the Gulf of Mexico coast are located far away from Units 6 & 7 and are separated by a wide and shallow continental slope and shelf, which would reduce the impact of any landslide-generated tsunamis at Units 6 & 7. The north Caribbean subduction zone and Azores-Gibraltar plate boundary are identified as the primary tsunamigenic earthquake sources that could affect the site. Model simulation results indicate that the shallow Bahama platform shields Units 6 & 7 from tsunamis generated in the northern Caribbean region (Reference 211). Therefore, the PMT for Units 6 & 7 would likely be transoceanic tsunamis from the Azores-Gibraltar region. The most recent major earthquake in the region occurred in 1969 (M_w = 7.8) and generated a small tsunami amplitude locally (Reference 202).

2.4.6.3.1 Azores-Gibraltar Plate Boundary

The Azores-Gibraltar plate boundary separates the African and Eurasian plates and extends from Azores in the west at the junction of North American, African, and Eurasian plates to east of Gibraltar strait, the area southwest of the Iberian Peninsula (see Figure 2.4.6-206). Based on literature on plate kinematic models and focal mechanisms, AGMTHAG indicated that the motion between the two plates is slow, changing along the boundary from divergent extension in the Azores to compression towards the east end that includes the Gorringe Bank and the Gibraltar Arc (Figure 2.4.6-206). The location of plate boundary in the east near Iberia is uncertain where a diffuse compression zone exists over a 200–330 kilometers (124–205 miles) width. The dominant active structures in the region are the Gorringe Bank Fault (GBF), the Marqués de Pombal Fault (MPF), the St. Vincente Fault (SVF), and the Horseshoe Fault (HSF) (Figure 2.4.6-206) (Reference 202).

The source location of the 1755 earthquake is still the subject of research in the scientific community. AGMTHAG summarizes the three major views on fault solution for the 1755 earthquake (Reference 202). First, in 1996, Johnson (also in 2007, Grandin et al.) suggested a northeast-southwest trending thrust fault,

possibly outcropping at the base of the northwest flank of the Gorringe Bank (GBF). Second, Zitellini et al. in 2001 (also Grácia et al. in 2003) suggested active thrusting along the MPF as the source located approximately 80 kilometers (50 miles) west of Cape Sao Vincente. Third, Gutscher et al. in 2002 and 2006 (also Thiebot and Gutscher in 2006) proposed a fault plane in the western Gulf of Cádiz (Gulf of Cádiz Fault, GCF), possibly as part of an African plate subduction beneath Gibraltar (Reference 202).

AGMTHAG used the same set of fault parameters as proposed by Johnson to investigate constraints on the 1755 Lisbon earthquake epicenter, and potential tsunami hazard to the U.S. East Coast from possible future earthquake sources located in the east Atlantic region (Reference 202). The parameters are (Reference 202):

Source depth at the top of the fault plane = 5 kilometers (3.1 miles)
Length = 200 kilometers (124 miles)
Width = 80 kilometers (50 miles)
Dip = 40 degrees
Strike = 60 degrees
Average slip = 13.1 meters (43 feet)

The strike orientation as proposed for MPF and GCF sources differs considerably from the description for the GBF source proposed by Johnston. AGMTHAG investigated the effects of the variation in the location of earthquake epicenter and strike orientation on near-field and far-field tsunami amplitudes. Based on a comparison of model simulation results with reported tsunami amplitudes, AGMTHAG concluded that the 1755 earthquake was likely generated by a northwest-southeast trending fault located in the center of the Horseshoe plain south of Gorringe Bank (Reference 202).

2.4.6.3.2 Hispaniola-Puerto Rico-Lesser Antilles Subduction Zone

The Hispaniola-Puerto Rico-Lesser Antilles subduction zone was formed as the North American plate was subducting southwesterly beneath the Caribbean plate (Figure 2.4.6-207) (Reference 202). Relative plate movement changed to a more easterly direction resulting in a more oblique subduction beginning at 49 million years ago, which remained fairly stable afterwards as evidenced by the opening of the Cayman Trough between Cuba and Honduras (Reference 202). AGMTHAG describes the present subduction at the Puerto Rico trench as an old oceanic crust of 90–110 million years in age, subducting under Puerto Rico and Virgin

Islands and at the Hispaniola trench as a thick crust of an unknown origin, which underlies the Bahama platform (Reference 202).

Although there are geometric similarities between the Puerto Rico trench and Sumatra-Andaman trench where the devastating 2004 Indian Ocean tsunami originated, AGMTHAG pointed out that the slip during the earthquake in the Puerto Rico trench is highly oblique and nearly parallel to the convergence direction unlike the Sumatra-Andaman trench (Reference 202). This difference in the slip angles indicates the potential for only small deformations of the overlying Caribbean plate.

In contrast to the Puerto Rico trench, slip on the Hispaniola trench is sub-perpendicular to the trench. Therefore, a large vertical motion is expected for a given magnitude of slip. Unlike the Puerto Rico trench, where a normal thickness oceanic crust is subducting, the crust entering the Hispaniola trench is very thick and would likely allow more stress to accumulate resulting in large earthquakes to occur (Reference 202).

The rupture parameters for the Puerto Rico and Hispaniola trenches, as proposed by AGMTHAG, are listed below (Reference 202):

Puerto Rico Trench (single rupture)

Length = 675 kilometers along the trench between 68° W and 62° W
Depth = 5 to 40 kilometers (3.1 to 25 miles)
Dip = 20 degrees
Strike = 70 degrees
Slip = 10 meters (32.8 feet)
Slip direction = 60 degrees
Shear modulus = 3×10^{10} Pa (6.3×10^{8} pounds/square feet)
Earthquake magnitude, M_w = 8.85

Hispaniola Trench

Length = 525 kilometers (326 miles) along the trench between 73° W and 68° W
Depth = 0 to 40 kilometers (0 to 25 miles)
Dip = approximately 20 degrees
Strike = 95–102 degrees
Slip = 10 meters (32.8 feet) assuming complete rupture of the Hispaniola trench
Slip direction = 23 degrees
Earthquake magnitude, M_w = 8.81

The magnitude of the earthquake-generated tsunami is related to the slip vector. The direction of slip vector is given by the slip angle, or rake, which is measured in the plane of the fault from the strike direction to the slip vector showing the motion of the hanging wall relative to the footwall. The slip (rake) angle of the fault is often estimated from analysis of focal mechanisms. In those cases where the slip angle cannot be directly measured, the assessment of the sense of slip could be based on an integration of direct observations of the fault and tectonic indicators (Reference 216). Based on dislocation theory, the amplitude of seafloor displacement is linearly proportional to the magnitude and direction of the slip vector, which vary for the dip-slip and strike-slip faults. The vertical displacement of an oblique-slip fault is estimated as the sum of the displacement fields derived from the dip-slip and strike-slip components.

AGMTHAG modeled three different source segments for the northern Puerto Rico/Lesser Antilles subduction zone, including the Puerto Rico and Hispaniola trenches (Reference 202). Tsunami propagation from these sources was modeled by linear long-wave theory, as described in AGMTHAG (Reference 202). The source parameters for the Puerto Rico and Hispaniola faults used in the model are slightly different than the source parameters described above and result in an earthquake moment magnitude ranging between 9.11 and 9.15. A summary of the tsunami source parameters including the expected range of magnitude and average slip angles for each tsunamigenic fault in Caribbean region is given in Table 8-1 of AGMTHAG (Reference 202).

2.4.6.4 Tsunami Analysis

The maximum tsunami water level at Units 6 & 7 is obtained for the postulated PMT generated by earthquake in the Azores-Gibraltar fracture zone. Tsunami propagation and the effects of near shore bathymetric variation at the Florida Atlantic coast are simulated in a two-dimensional computer model, the development of which is summarized in the following subsections. Detailed water level records near Units 6 & 7 are not available for tsunamis generated by past earthquakes in the Azores-Gibraltar fracture zone or in the Caribbean subduction zone for the listed earthquake magnitudes. In order to establish the model boundary condition, the resulting water levels in deep waters in the computer simulations by Mader (Reference 202) and Knight (Reference 211) for tsunamis generated from the Azores-Gibraltar and Caribbean sources are used as guidance for the PMT model. The PMT simulation for Units 6 & 7 uses the computer code Delft3D-Flow, which is a multi-dimensional modeling system that is capable of simulating the hydrodynamics and transport processes for fluvial,

estuarine, and coastal environments (Reference 219). The analysis of the postulated PMT is described in Subsection 2.4.6.4.1.

In addition the generation and propagation of a tsunami caused by the Cape Fear slide was simulated to examine the water levels it produces at the site and to confirm that they are smaller than those produced by the postulated PMT. The simulation of the Cape Fear tsunami for Units 6 & 7 uses the model FUNWAVE-TVD (Reference 234). The analysis of the Cape Fear tsunami is described in Subsection 2.4.6.4.2.

In addition, the generation and propagation of tsunamis caused by postulated submarine slides near Cape Fear, the west Florida Escarpment, and the western margin of the GBB were simulated to examine the water levels they would produce at the site and to confirm that they are smaller than those produced by the postulated PMT. The simulation of these tsunamis for Units 6 & 7 uses the model FUNWAVE-TVD (Reference 234). The analyses are described in Subsections 2.4.6.4.2, 2.4.6.4.3, and 2.4.6.4.4.

2.4.6.4.1 Analysis of the PMT (Azores-Gilbraltar Fracture Zone Earthquake Tsunami)

2.4.6.4.1.1 Numeric Modeling Approach and Conceptualization

Subsection 2.4.6.1 establishes the Azores-Gibraltar fracture zone (specifically the 1755 Lisbon Earthquake source) as the candidate PMT source for Units 6 & 7. It is postulated that the earthquake-generated transoceanic tsunami from this source would propagate across the Atlantic Ocean and would be modified at the Bahama platform before reaching the site. Tsunami generation and transoceanic propagation from this source were studied previously using numerical model simulations (References 202 and 209). However, tsunami wave modification on the shallow Bahama platform and wave run-up onshore near Units 6 & 7 have not been reported in any literature. The primary objectives in developing the numerical model for Units 6 & 7 therefore are to account for the effects of near shore bathymetric variation on tsunami wave modification and tsunami run-up onshore.

Delft3D-FLOW, the flow module of the Delft3D modeling system, simulates two- or three-dimensional unsteady flow problems from tide or meteorological forcing. The FLOW module provides hydrodynamic solutions for which the horizontal length and time scales are significantly larger than the vertical scales (Reference 219) representing the shallow water conditions. Delft3D-FLOW has the capability of invoking the FLOOD solver, which employs a numerical technique

(Reference 220) that can be applied to problems involving rapidly varied flows, for example, in hydraulic jumps and bores, and sudden flow transitions including rapid flooding and drying of land. The FLOOD scheme is suitable for simulating the tsunami waves, embankment breaches, hydraulic jumps, and flows over obstructions (Reference 219). Consequently, in the present analysis, the Delft3D-FLOW module along with the FLOOD solution scheme is applied to simulate tsunami propagation and run-up at Units 6 & 7.

Delft3D-FLOW assumes hydrostatic pressure distribution and therefore ignores frequency dispersion. As a result, model simulation results on tsunami propagation generally show steeper wave fronts with larger wave amplitudes compared to analytical solutions or benchmark laboratory test results (Reference 221). The shallow water conditions adopted in Delft3D-FLOW therefore are capable of resolving the tsunami wave propagation where the frequency dispersion is not significant and would be conservative in simulating the near shore tsunami amplitude.

2.4.6.4.1.2 Model Setup

AGMTHAG and Mader reported modeling of the 1755 Lisbon Earthquake tsunami and included most of the Atlantic Ocean in the model domain (References 202 and 209). The PMT model for Units 6 & 7, on the other hand, a portion of the Atlantic Ocean and the Gulf of Mexico are considered in the model setup, as described below.

<u>Model Domain and Grids</u>

To be able to investigate nearshore tsunami wave modification and onshore run-up, the tsunami model domain is selected to include detailed bathymetric variations in the area bounded by the Atlantic continental shelf, the Florida platform, Cuba, Dominican Republic, and the Blake-Bahama basin (as shown in Figure 2.4.6-209). In light of the uncertainties in defining the 1755 Lisbon Earthquake source in the Azores-Gibraltar region (References 202 and 209), tsunami generation at the source was not included in the model. Instead, the model (open) boundary in the Atlantic Ocean is established based on tsunami propagation patterns reported in existing literature, as described in Subsection 2.4.6.4.1.3.

The selected model domain is shown on Figure 2.4.6-210. The east model boundary in deep waters generally follows the simulated propagation of tsunami wave front after 6.5 hours of travel in Mader's analysis (Reference 209). The 6.5

hour wave front is selected to maximize the coverage of the ocean in the model and also allow the model to be defined by one open sea boundary with a uniform boundary condition. This open boundary extends from Havelock, North Carolina to north east of the Dominican Republic. The north and west model boundaries follow mostly the coastlines of the southeastern United States. The south model boundary is set along the northern coastlines of the Dominican Republic, Haiti, and Cuba. The small passage between Haiti and Cuba is conservatively assumed to be blocked. Southwest of the site, the model includes a portion of the Straits of Florida, the area protruding past the Florida Keys, to allow the tsunami wave to travel farther into the Gulf of Mexico so that the effect of this boundary on the site is minimized. Extending the model farther into the Gulf of Mexico is not necessary, as the maximum tsunami water level at the site would occur before the effect of this boundary is reflected back at the site. Consequently, the model boundary in the Gulf of Mexico is simulated as a closed boundary.

The model uses curvilinear orthogonal grids that are generated with RGFGRID, the Delft3D module for grid generation and processing. The curvilinear option allows fitting grids cells along coastlines and contours of changing bathymetry. In addition, curvilinear grids could be oriented in relation to anticipated flow direction or wave propagation, thereby improving model accuracy.

A nested grid system with three different grid resolutions is developed using the domain decomposition tool within RGFGRID to appropriately resolve tsunami wave modification near the site. The three grid subdomains are shown on Figure 2.4.6-210. The first subdomain, SITE, covers the area near the site including the Biscayne Bay and the adjacent Straits of Florida, and has the finest grid resolution. The second subdomain, ISLANDS, includes most of the Bahamas with intermediate grid resolution. The third subdomain, DEEP, covers the rest of the model domain with a coarse grid resolution, which is mostly deep waters and is farther away from SITE and ISLANDS subdomains. At the interfaces between the subdomains, every third point in the finer grid is aligned with successive grid points in the coarser grid. Subdomain grid resolutions, represented by the square root of grid cell area, and grid spacings in the two orthogonal directions are given in Table 2.4.6-203. Figures 2.4.6-211 through 2.4.6-213 show the grids of the three subdomains.

<u>Model Bathymetry</u>

Tsunami model bathymetric and topographic data are obtained from the following public sources:

- Biscayne Bay sounding data from NOAA estuarine bathymetric database
- LiDAR (Light Detection And Ranging) data from NOAA Coastal Ocean Service database
- Coastal Relief data from NOAA National Geophysical Data Center (NGDC)
- ETOPO1 data from NOAA NGDC

The last two sources include both bathymetric and topographic (land) data, whereas the first source includes only bathymetric data, and the second source includes only topographic data. The four data sets have different horizontal and vertical resolutions. The Biscayne Bay sounding and LiDAR data have high vertical and horizontal resolutions compared to the Coastal Relief and ETOPO1 data. Therefore, they were given high priority and used first in populating the model depth data. The Coastal Relief data has higher horizontal resolution compared to the ETOPO1 data and therefore was given priority in populating the remaining model domain. A summary of resolution of available data is given in Table 2.4.6-204.

Bathymetric data from all sources are projected to the Azimuthal Equidistant map projection centered at Unit 6 & 7 for a uniform horizontal datum description. The Azimuthal Equidistant map projection is used to minimize distortion in both distance and direction from the site. All bathymetric and topographic elevations are converted relative to mean sea level (MSL) from their original source datum. Conversion relationships between MSL and various vertical datums are selected based on NOAA's Virginia Key, Florida station.

The bathymetric and topographic elevations for the tsunami model are developed by using the Delft3D-QUICKIN module. Elevations at the grid points are determined by interpolating from the source data surrounding the grid points. Model bathymetric elevations at grid points with seabed located below the MSL are specified as positive, whereas, all grid points on land are given negative bathymetric (topographic) values. The developed model bathymetric map is shown on Figure 2.4.6-214.

<u>Bed Roughness Condition</u>

Bed roughness conditions in the tsunami model are specified through Manning's n roughness coefficient. For the initial tsunami model that is used to validate the open boundary condition where incoming tsunami waves are specified, a constant

Manning's roughness coefficient of 0.025 (a typical value appropriate for the site) is used for the entire model domain, which represents natural channels in good condition (Reference 222). However, a Manning's *n* of 0.02 is used conservatively in the final analysis because the Manning's *n* sensitivity analysis results indicate that lower values give higher maximum tsunami water level at the site. This Manning's n value represents roughness conditions similar to a smooth earth surface (Reference 222). Water levels in deep areas, such as off Miami at water depth of 783 meters (2569 feet), would not be sensitive to Manning's *n* values because of very small flow velocities associated with deep areas. Water levels in shallow areas are sensitive to Manning's *n* values because of relatively higher velocities.

Initial Condition

The antecedent water level including the 10 percent exceedance high spring tide, initial rise, and long-term sea level rise, as specified in Subsection 2.4.5.2.2.1, is used as the initial water level for the tsunami model. The initial water level in the tsunami model, after conversion to MSL, is 1.36 meters (4.46 feet) MSL.

Time Step and Simulation Time

The tsunami model is run with a time step of 0.2 minute (12 seconds). The model simulations are continued for a period of 9 hours, although the travel time from the open boundary to the site is about 2.5 hours and the maximum tsunami water level at the site is reached after about 4.5 hours from the start of simulation. Therefore, simulation period of 9 hours is sufficient to capture the maximum water level at the site. The start and end time for model simulations are selected arbitrarily.

2.4.6.4.1.3 Selection and Validation of Open Boundary Condition

The model requires time history of incoming tsunami water level as the boundary condition along the eastern open boundary. However, no measured water level data from the 1755 Lisbon Earthquake tsunami is available at the model boundary location. Consequently, a synthetic time history of tsunami water level assuming a sinusoidal tsunami waveform is used to establish the model boundary condition.

Tsunami water level on the Atlantic coast near Miami, Florida, is obtained from the model simulation results performed by Mader for the 1755 Lisbon Earthquake tsunami (Reference 209). Because the source location and characteristics for the 1755 Lisbon Earthquake are not precisely known, Mader developed tsunami source parameters in such a way that the model reproduces tsunami amplitude

and arrival time within reasonable accuracy at near- and far-field locations where these are known. Mader assumed the source location to be close to Gorringe Bank in the Azores-Gibraltar region, near the source location of the 1969 earthquake (1969 earthquake location is shown on Figure 2.4.6-206). To produce a tsunami amplitude of 20 meters (65.6 feet) with a 1-hour wave period that arrives at Lisbon, Portugal, 40 minutes after the earthquake, Mader considered fracture in a 300 kilometers (186.4 miles) arc-fault with a slip of 30 meters (98.4 feet). Although Mader did not provide information on the strike angle or location, the curved fault structure resembles closely to the composite fault zone assumed by Gutscher et al. in 2002, 2006 and discussed in AGMTHAG (Reference 202). In addition, the slip magnitude assumed by Mader is higher than that listed in Subsection 2.4.6.3.

AGMTHAG also performed numerical model simulations of the 1755 Lisbon Earthquake tsunami to evaluate the potential tsunami impact on the U.S. east coast. AGMTHAG first investigated the constraints on the earthquake epicenter from far field simulations. AGMTHAG modeled three different source segments for the northern Puerto Rico/Lesser Antilles subduction zone including the Hispaniola, Puerto Rico and Virgin Island faults. The earthquake moment magnitude from the selected source parameters ranges between 9.11 and 9.15. Using a linear long-wave model, AGMTHAG obtained a maximum tsunami amplitude near the site of no more than 0.1 meter (0.3 foot), as described in Subsection 2.4.6.1.6. AGMTHAG simulated tsunami propagation for 16 such potential source locations as shown in Figure 2.4.6-215. Based on model simulation results, AGMTHAG concluded that the variation in local seafloor bathymetry significantly controls tsunami propagation across the Atlantic Ocean. The Gorringe Bank and the Madeira Tore Rise (see Figure 2.4.6-206 for locations) act as near source barriers protecting most of the U.S. east coast. For sources located east of Madeira Tore Rise and south of Gorringe Bank, Florida might be at risk if sufficient wave energy passes through the Bahamas (Reference 202). AGMTHAG did not simulate tsunami wave run-up in the near shore region and considered relative amplitude evaluation only (Reference 202). Because the simulated deepwater tsunami amplitude in the southeastern U.S. coast from AGMTHAG is smaller than the tsunami amplitude reported in Mader (References 202 and 209), the present analysis adopted tsunami amplitude from Mader in developing the boundary condition in the tsunami model.

Mader performed numerical modeling of the tsunami wave using the SWAN nonlinear shallow water wave code including the Coriolis and friction effects. The model domain extended from 20° N to 65° N and 100° W to 0° W with a 10-minute

grid resolution. Model bathymetry information was generated from the 2-minute Mercator Global Marine Gravity topography of Sandwell and Smith of the Scripps Institute of Oceanography (Reference 209). A model time step of 10 seconds was used for the simulation. Mader obtained tsunami amplitude of 20 meters (65.6 feet) at 953 meters (3127 feet) water depth off Lisbon, Portugal, and 5 meters (16.4 feet) at 825 meters (2707 feet) water depth east of Saba, Netherlands Antilles in the Caribbean. Mader argued that with a run-up amplification of the wave, the maximum near-shore wave amplitude would be two to three times the deepwater tsunami amplitude. However, he also pointed out that some of the run-up effects were probably included in the simulation for water depths less than 1000 meters (3281 feet). This assumption would provide a maximum tsunami water level above 20 meters (65.6 feet) at Lisbon and above 7 meters (23 feet) at Saba, higher than the tsunami amplitudes reported by Lockridge et al. (Reference 208). Consequently, simulated water levels obtained by Mader along the U.S. east coast would likely be conservative. Mader obtained tsunami amplitude of 2 meters (6.6 feet) at 783 meters (2569 feet) water depth east of Miami, Florida with a tsunami period of 1.5 hours, and suggested a maximum tsunami wave amplitude, including run-up, of approximately 10 feet (3 meters) along the U.S. east coast (Reference 209).

The synthetic tsunami marigram at the model boundary is selected such that the maximum tsunami wave amplitude and drawdown off Miami, Florida at a water depth of 783 meters (2569 feet) are comparable or conservative compared to Mader's results for the same location. Mader estimated the maximum wave amplitude and drawdown of 2.0 meters (6.6 feet) and -3.5 meters (-11.5 feet), respectively, from the initial water level at MSL (Reference 209). To generate the tsunami marigram at the model boundary, three different sinusoidal wave patterns are considered, each with 2.0 meter (6.6 feet) amplitude and 1.5 hours wave period. The first case considers a single wave, the second case considers a continuous wave train, and the third case considers only two consecutive waves. Figure 2.4.6-216 shows the marigrams for the three cases.

Figure 2.4.6-217 shows the simulated tsunami water levels for the three selected cases at the 783 meters (2569 feet) water depth off Miami, Florida. Similar to Mader, model simulations for the three cases consider the initial water level to be at MSL. Continuous wave train at the boundary generates the maximum tsunami amplitude and drawdown of about 5.5 meters (18 feet) and -6.5 meters (-21.3 feet), respectively, with respect to the MSL. These amplitude and drawdown are much higher than what is indicated in Mader's analysis, and therefore model input conditions with continuous wave train are not considered to be realistic. The

single wave boundary condition produced the maximum wave amplitude and drawdown of about 2 meters (6.6 feet) and -3.5 meters (-11.5 feet), respectively, which are in very good agreement with Mader's results. However, because more than one wave was reported to have impacted the Portuguese and Canadian coasts (References 208 and 209), the single wave boundary condition is not considered in the present analysis. The boundary condition with two consecutive waves generates the maximum wave amplitude and drawdown of 4.5 meters (14.8 feet) and -5.3 meters (-17.4 feet), respectively. Although these values are much higher compared to Mader's results, they are conservatively adopted for this analysis. This tsunami amplitude is also much higher than the tsunami amplitudes reported in AGMTHAG for many different earthquake source locations and orientations in the Azores-Gibraltar fracture zone and for the Caribbean sources (Reference 202).

2.4.6.4.1.4 Sensitivity of Model Parameters and Conditions

Model sensitivity analysis is conducted for the following parameters and conditions: grid size, time step, Manning's n value, tsunami wave period, Coriolis effects, non-reflective boundaries, and tsunami wave form and steepness.

Grid Size

Model grid configuration is selected based on bathymetric data resolution, computational economy, etc. A finer mesh model grid is developed as part of grid size sensitivity analysis to demonstrate that the selected grid sizes resolves the required flow problems reasonably well. In the finer mesh model, grid sizes for the ISLANDS and SITE subdomains are refined by a factor of 5/3 (1.67), whereas the grid sizes in subdomain DEEP remained unchanged because of computational economy. Additionally, because the DEEP subdomain is located farther away from the site and in high water depths, a finer grid resolution in this area is not expected to produce any significant variation in tsunami water level at the site. The difference in tsunami water levels at the site from the two grid descriptions is very small, as shown in Figure 2.4.6-218. The selected coarser grid configuration therefore is considered adequate.

Time Step

Model simulations are performed with a computational time step of 0.2 minute (12 seconds). However, to demonstrate time step independence, a model simulation with 0.1 minute (6 seconds) time step is performed. Because the water levels at

the site from the two simulations are nearly identical, the use of 12 seconds time step is considered acceptable.

Manning's n value

Model simulations are performed for two additional Manning's *n* values of 0.02 and 0.03. The results indicate that a lower Manning's *n* value produces a higher water level at the site. For this analysis a Manning's *n* of 0.02 is selected conservatively, which represents a smooth earth surface (Reference 222).

Tsunami Wave Period

Mader indicated that for the 1755 Lisbon Earthquake tsunami, the eastern U.S. coast, and the Caribbean would experience tsunami wave periods varying between 1.25 and 1.5 hours (Reference 209). Results from an additional model simulation with a tsunami wave period of 1.25 hours show that the maximum water level at the site is lower than maximum water level from the selected wave period of 1.5 hours. Therefore, the selected wave period is adopted in this analysis.

Coriolis Effects

Coriolis forces depend on the latitude and angular velocity of earth's rotation on its own axis. Model simulation results with and without Coriolis forces indicate that the effect of Coriolis force on the maximum water level at the site is insignificant. Coriolis forces therefore are not considered in model simulations.

Non-Reflective Boundaries

A sensitivity analysis is performed to assess the effect of non-reflective boundary conditions on the maximum tsunami water level at the site. The two open boundaries of the model, i.e., the forcing boundary where the incoming tsunami waves are specified and the southwest boundary where no-flow boundary conditions were specified, are made non-reflective by utilizing the Riemann type boundary condition (Riemann BC) of Delft3D (Reference 219). This type of boundary allows waves approaching the boundary from within the modeling domain to leave the boundary without reflecting back into the modeling domain.

The sensitivity analysis results indicate that the maximum tsunami water level at the site is not that sensitive to the non-reflective boundary condition. The tsunami water level time history at the site with and without Riemann BCs is shown in Figure 2.4.6-229. As indicated in the figure, the maximum water level at the site

for the case without Riemann BC is slightly higher by 0.1 meters (0.3 feet), compared to the case with Riemann BCs. This demonstrates that the impact of Riemann BC on the maximum water level, the use of the Riemann BC results in a slightly larger difference in the predicted water level as indicated in Figure 2.4.6-229.

Tsunami Wave Form and Steepness

To test the effect of steeper tsunami waves on the maximum water level at the site, two wave forms with steeper wave fronts at the forcing boundary were considered: (1) isosceles N-wave (same crest and trough wave amplitude) and (2) steeper sinusoidal wave. Details are given below.

The first wave form is isosceles N-wave that was formulated based on Reference 224 as given below:

$$\zeta(t) = \alpha \frac{3\sqrt{3}}{2} A \cosh^{-2}(k'(t - t_n))\tanh(k'(t - t_n)) \quad (1)$$

where ζ is water level with respect to still water level, α is wave height adjustment factor, *t* is time, *A* is wave amplitude, *k′* is a factor that determines the shape of the wave, and t_n is time associated with the location of the center of the wave.

The following isosceles N-wave parameters were selected so that the approximate wave period and wave height of the isosceles N-wave matches that of a sinusoidal wave: $\alpha = \frac{2}{3\sqrt{3}}$ k' = 0.077/min., and t_n = 45 min.

Figure 2.4.6-230 shows the wave form of the isosceles N-wave and sine-wave.

The second wave form tested is a combination of two sinusoidal wave forms such that the rising portion of the wave form is steeper than a regular sinusoidal wave. To accomplish this, the wave period of the rising portion was reduced by a factor of three (from 90 to 30 min.), and the wave period of the falling portion was increased by a factor of 1.67 (from 90 to 150 min.) so that the overall period is the same as the regular sinusoidal wave (90 min.). The formulation used is provided below:

For t = 0 to 7.5 min. (first rising portion): $\zeta(t) = A\sin\left(3\frac{2\pi}{90}t\right)$ (2a)

For t = 7.5 min. to 82.5 min. (falling portion): $\zeta(t) = A\sin\left(\frac{2\pi(t+30)}{2(90-2*7.5)}\right)$ (2b)

For t = 82.5 min. to 90 min. (end rising portion): $\zeta(t) = A\sin\left(3\frac{2\pi}{90}(t-(90-4*7.5))\right)$ (2c)

Where t is time in min.

Figure 2.4.6-231 shows the wave form of the regular and steep sine-waves.

Figures 2.4.6-232 to 2.4.6-234 compare the water levels between the case that did not include steepening of the wave form and the sensitivity test case with steepened sine-wave at the forcing boundary, off Miami at 783 meters (2569 feet) depth, and at the site, respectively. Figures 2.4.6-235 to 2.4.6-237 compare the water levels between the case that did not include steepening of the wave form and the sensitivity test case with isosceles N-wave at the forcing boundary, off Miami at 783 meters (2569 feet) depth, and at the site, respectively. As shown on Figures 2.4.6-234 and 2.4.6-237, the results indicate that wave steepening does not increase the maximum tsunami water level at the site. One of the reasons is that the steepened wave forms have less wave volume compared to the non-steepened sinusoidal wave form in that the amount of wave energy available to produce run-up is less, especially in regard to the isosceles N-wave.

2.4.6.4.1.5 Model Simulation Results

As described in Subsections 2.4.6.4.1.2 and 2.4.6.4.1.3, the maximum tsunami water level at the site is simulated for a boundary condition with two consecutive sinusoidal tsunami waves of 2.0 meters (6.6 feet) amplitude and 1.5 hours wave period. This boundary condition approximates the 1755 Lisbon tsunami that was generated at the Azores-Gilbaltar region, as simulated by Mader (Reference 209). An initial water surface elevation of 1.36 meters (4.46 feet) MSL is used to evaluate the maximum tsunami water level at the site.

Water level contours at different times are plotted to track the tsunami wave propagation from the open boundary to the site. These time-lapsed snap-shots of water level contours are given in Figures 2.4.6-219a through 2.4.6-219i. As the figures indicate, the tsunami waves propagate from the open boundary to Blake-Bahama Escarpment unimpeded and nearly perpendicular to the escarpment. As the waves reach the Bahama platform, tsunami waves north of the platform (north of Grand Bahama and Abaco Islands) are diffracted southwestward towards the Straits of Florida. The diffracted waves propagate through the Straits of Florida before reaching the site. The tsunami waves reaching the platform are affected by shoaling and travel through the channels and passages between the islands of the Bahamas. These transmitted tsunami waves then interact with the diffracted waves from the north.

From the Straits of Florida the tsunami waves enter the Biscayne Bay first through the openings, cuts, and channels in the barrier islands, and then by overtopping the barrier islands before affecting the site. The maximum tsunami water level at the site is reached as the barrier islands are overtopped. Water level contours in Biscayne Bay corresponding to the time close to the maximum water level at the site is shown in Figure 2.4.6-220.

The site is protected by the Bahamas from direct impact of the tsunami waves. The diffracted tsunami waves have less energy and therefore less flooding potential at the site. In addition, the islands and the vast extent of the Bahamas dissipate some of the tsunami wave energy before it reaches the deep waters of the Straits of Florida and ultimately the site.

Time history of tsunami water levels at key locations are plotted to show tsunami wave modification as it propagates and reaches shore. Figures 2.4.6-221a through 2.4.6-221d show the locations of the water level monitoring points. Track 1 (Figure 2.4.6-221a) generally follows tsunami wave propagation from the open boundary to east of the Bahamas and then the diffraction towards the Straits of Florida. The tsunami marigrams for the monitoring points are given in Figure 2.4.6-222. The figure shows that as the tsunami waves travel from the open boundary towards the Bahamas, its amplitude increases due to shoaling. The maximum shoaling is seen near the edge of the escarpment north of Little Bahama Bank at monitoring point 4. Waves then dissipate on the shallow waters and diffract towards the Straits of Florida (points 5 and 6). The tsunami amplitudes increase as the diffracted waves interact with the waves passing through the Islands of the Bahamas (points 6 and 7). However, as the tsunami waves travel further south towards the site, its amplitude decreases slightly due to propagation and possibly friction loss.

For Track 2 (Figures 2.4.6-221b and 2.4.6-223), tsunami amplitudes increase as the waves shoal east of the Bahamas similar to that observed for Track 1. Between monitoring points 3 and 4, tsunami amplitude decreases slightly. At monitoring point 5 south of Grand Bahama Island, where the depth is relatively shallow, the wave amplitude increases due to shoaling. In the Straits of Florida, wave modifications are the same as described for Track 1.

Track 3 (Figures 2.4.6-221c and 2.4.6-224 shows modifications of tsunami wave amplitudes along the eastern U.S. Atlantic coast. Between monitoring points 1, 2, and 3, tsunami amplitudes remain nearly the same while the arrival time changes due to their distance from the boundary. However, tsunami amplitudes at

monitoring points 4 through 7 are higher owing to the interaction of diffracted and propagated waves from the Bahamas.

Figure 2.4.6-225 shows tsunami marigrams in Biscayne Bay and vicinity. Grid cells (339, 270) and (339, 232) are located within the Straits of Florida adjacent to the site; grid cell (339, 172) is located between Biscayne Bay and the Straits at a shallow water depth (6.1 meters); and grid cells (339, 132), (339, 119), (307, 125), and (272, 146) are located within Biscayne Bay (Figure 2.4.6-221d). As shown in the figure, tsunami amplitudes within the Straits at the selected locations including the location with shallow water depth remain nearly the same. Water level variations within the Biscayne Bay, however, are markedly different compared to that in the Straits of Florida with the minimum water level in the bay considerably higher. This is because the barrier islands do not allow quick draining of the bay during tsunami drawdowns. In addition, the barrier islands dissipate wave energy during overtopping resulting in smaller wave amplitude and delayed arrival.

2.4.6.4.2 Analysis of the Cape Fear Tsunami

2.4.6.4.2.1 Representation of the Cape Fear Slide in the Model

The maximum potential slide at Cape Fear was schematized for modeling purposes as having a Gaussian shape with an elliptical footing that extends from the uppermost head scarp to the salt diapirs in the downslope region. This shape was chosen because a Gaussian shape has been used for several investigations and studies of landslide tsunamis, including benchmark cases (References 237, 242, 243). Grilli and Watts (Reference 237) state that a Gaussian shape is a more realistic representation of a submarine mass failure than other arbitrary fixed shapes. Enet & Grilli (Reference 235) used a Gaussian shape in the experiments that provide the basis for the validation of the model used to simulate the generation of a wave by a submarine slide (Reference 235). The Gaussian shape of the slide was approximated in the numerical model by truncated hyperbolic secant squared functions (Reference 235). The center of the elliptical base of the slide was initially located near the S1 headwall in Figure 2 of Reference 223, at 33.14° N, 76.29° W, which places the uppermost end of the slide area at a depth of approximately 710 meters (2329.4 feet).

The length (minor axis of the elliptical base) of the slide is 38 kilometers (23.6 miles), based on the distance from the upper scarp (described as S1 in Reference 223 and as the upper headwall scarp in Reference 225) to the salt diapirs downslope shown in Figure 2 of Reference 223. This length represents a conservative upper bound for the length of a potential slide. The width (major axis

of the elliptical base) of the slide was assumed to be 50 kilometers (31.1 miles) taken conservatively from the width of the largest scarp S4 (the main scarp). The use of 50 kilometers (31.1 miles) as the width of the slide is conservative as it is five times the width of the upper scarp at the centroid of the postulated slide (reported as 10 kilometers [6.2 miles] in Reference 223).

The maximum thickness of the postulated slide was taken as approximately 120 meters (393.7 feet). This thickness is equal to the maximum height of the main scarp of the Cape Fear slide, S4, located at 2300 meters (7545.9 feet) depth, and is larger than the thicknesses of all the other scarps. For instance, the height of the uppermost scarp at 890 meters (2919.9 feet) depth is much smaller, at about 20 meters (65.6 feet) (Reference 236). Using a thickness of 120 meters (393.7 feet) is therefore a conservative assumption because the centroid of the postulated slide for the tsunami simulations is placed near the uppermost scarp, S1, at much smaller depth than the lower scarp of the Cape Fear slide. The assumed dimensions and shape of the postulated slide give an area of 1492 km^2 (576.1 mi^2) for the base of the slide and a total volume of 68 km^3 (16.3 mi^3).

The bottom slope used was 3.09 degrees, based on a measured depth difference of 1350 meters (4429.1 feet) over a distance of 25 kilometers (15.5 miles) in the area of the downslope movement of the slide. The distance of 25 kilometers (15.5 miles) is based on the presence of a slope break in the Cape Fear profile at about 25 kilometers (15.5 miles) from the initial location of the centroid, after which the slope decreases by approximately one-half. The direction of the downslope movement of the slide forms a 10 degree angle clockwise with the West-East direction. This direction is based on the delineation and orientation of the Cape Fear slide from the GLORIA mapping data.

The initial acceleration of the slide, 0.529 m/s^2 (1.74 ft/s^2) was estimated directly from the bed slope. Using Equation (10) in Reference 235, the terminal velocity of the slide was estimated to be 138 m/s (452.76 ft/s). As stated earlier, this estimate was obtained using a specific gravity for the slide equal to 2 (Reference 223), and a bed slope of 3.09 degrees, and a length of 38 kilometers (23.6 miles). The global drag coefficient was set equal to 1 (Reference 237), which is conservative. Based on its initial acceleration, the slide reaches its terminal velocity within 260 seconds.

2.4.6.4.2.2 Initial Wave Generated by the Cape Fear Slide

Two alternative approaches were used for the generation of the initial wave in the tsunami simulations. The two approaches are referred to as the dynamic source

approach and the static source approach. Two source approaches are used as the velocity components from the dynamic source can differ significantly from the static source with respect to the total slide energy.

The dynamic source approach defined the initial condition for the tsunami propagation simulations in terms of both the water surface displacement and the depth-averaged horizontal velocity fields. This source was computed from the slide geometry and its movement using the computer model NHWAVE (Non-Hydrostatic Wave), Version 1.1 (Reference 238). NHWAVE solves the fully non-hydrostatic Navier-Stokes equations in the sigma coordinate system. The model assumes a single-valued water surface and represents turbulent stresses in terms of an eddy viscosity closure scheme. Turbulent stresses are not modeled in this analysis, and thus the model is basically solving the Euler equations for incompressible flow with a moving surface and bottom.

Input to NHWAVE includes the bathymetric grid, the slide dimensions, the initial slide position and orientation, and the terminal velocity. The modeled domain was set up so that the landslide event was centrally located and the generated motion did not reach the lateral boundaries during the simulated time. Bathymetric data for the model domain of NHWAVE and the three nested grids of FUNWAVE-TVD used in the simulations were obtained from the National Geophysical Data Center (NGDC) ETOPO 1 (Reference 244) and the Coastal Relief Model (CRM) (Reference 245) data sets. Results from the NHWAVE model output at 500 seconds were saved and used as initial conditions in the tsunami propagation model FUNWAVE-TVD. The reason for selecting the NHWAVE solution at 500 seconds as input to the tsunami propagation model, was that at that time the maximum wave height is about equal to the maximum thickness of the slide (120 meters [393.7 feet]). After 500 seconds, the NHWAVE model produces wave heights greater than the maximum thickness of the slide, which would be overly conservative.

At 500 seconds, the slide volume moves downslope 64.6 kilometers (40.1 miles), i.e., a distance equal to 1.7 times the length of the minor axis of the elliptical base of the slide, which is aligned with the direction of downslope movement (38 kilometers [23.6 miles]). The present approach neglects the spreading and flattening of the sliding mass during the slide process. This assumption results in a higher and narrower initial elevation hump at the final slide location than what would have occurred if the slide were allowed to deform. The initial and final positions of the slide are displayed in Figure 2.4.6-239. The water depth at the initial location of the centroid of the slide is 1100 meters (3608.9 feet). The water

depth at the final position of the centroid of the slide is 3300 meters (10,826.8 feet) (Figure 2.4.6-239).

The resulting water surface displacement from NHWAVE at that time (500 seconds) is shown in Figures 2.4.6-240 and 2.4.6-241, which also shows the water surface profile in the direction of the slide motion simulated with NHWAVE at different times after the initiation of the slide. As shown in Figure 2.4.6-241, the maximum water surface at 500 seconds is 122 meters (400.3 feet), and the minimum –166 meters (-544.6 feet).

The second approach to the generation of the initial condition for the tsunami propagation model used a static source based on the geometry of the initial and final positions of the slide mass. A static source is defined as an initial displacement of the water surface in the form of a depression over the initial slide location, equal in areal extent, shape and volume to the displaced material volume during the submarine slide. It was assumed that the initial slide volume described above translates downslope along its axis in the direction of the slope beyond its original footprint. A positive displacement of the water surface equal to the volume, shape and size of the slide was assumed at that point, i.e., extending over an elliptical area with minor axis equal to 38 kilometers (23.6 miles), a major axis of 50 kilometers (31.1 miles) and maximum thickness 120 meters (393.7 feet), and a corresponding negative displacement representing the missing volume of the slide mass was added at the slide starting point. The centroid of the depression of the water surface was placed at 33.14° N, 76.29° W, same as the initial location of the centroid of the slide for the dynamic source. A water rise equal in shape and size with the depression was assumed downslope of the initial depression and at a distance equal to translation distance of the dynamic case, i.e., over a distance of 64.6 kilometers (40.1 miles). The maximum water surface rise is equal to 120 meters (393.7 feet). Figure 2.4.6-242 shows the assumed initial water surface wave for the Cape Fear tsunami simulation with FUNWAVE-TVD based on a static source. Using an initial static source, it was assumed that the initial horizontal velocities were zero over the entire model domain of FUNWAVE-TVD.

2.4.6.4.2.3 Modeling of Tsunami Propagation and Inundation

The propagation, shoreline runup and inundation caused by the Cape Fear tsunami were simulated using the Boussinesq wave model FUNWAVE-TVD, developed at the University of Delaware. In its present application, FUNWAVE-TVD solved the spherical-polar form of the weakly-nonlinear, weakly-dispersive Boussinesq equations described in Reference 234. Reference 240 describes the

operation of both Cartesian and spherical-polar versions of the code. The model incorporates bottom friction and subgrid lateral turbulent mixing effects.

The Cartesian coordinate version of FUNWAVE-TVD, described in References 240 and 241, has been validated using several PMEL-135 benchmarks (Reference 242), which are the presently accepted benchmarking standards adopted by the National Tsunami Hazard Mitigation Program (NTHMP) for judging model acceptance for use in development of coastal inundation maps and evacuation plans. Benchmark tests for the Cartesian version of FUNWAVE-TVD are described in Reference 240. Benchmark tests for the spherical version of the code are described in Reference 234.

The equations solved by FUNWAVE-TVD consist of a depth-integrated volume conservation equation together with depth-integrated horizontal momentum equations. These equations are summarized in Reference 234. For tsunami applications, FUNWAVE-TVD is run with closed boundaries and an initial hot start condition consisting of either a surface displacement alone (in the case of static initial conditions) or a surface displacement and initial velocity field (in the case of a dynamic initial condition based on the results of calculations with NHWAVE). The model is run from the initial start until past the time when significant wave activity has decayed at the target site.

In most large scale problems, FUNWAVE-TVD is run on more than one nested grid. The grid nesting scheme uses a one-way nesting technique, which passes surface elevation and velocity components calculated from a large domain to a nested small domain through ghost cells at nesting boundaries. A linear interpolation is performed between the large and the small domain at the nesting boundaries. A test of the nesting process is included in the FUNWAVE-TVD verification and validation document (Reference 234).

In the simulations of the Cape Fear tsunami, three nested grids are used, which are referred to as Grid A, Grid B and Grid C. The output from Grid A is used as input to FUNWAVE-TVD on Grid B. The same process is repeated in going from Grid B to Grid C.

The domain covered by each of these three grids is shown in Figure 2.4.6-243. All the grids are based on geographic coordinates. The coordinates of the southwest corner of each grid, the grid spacing, and number of grid cells in each grid are given in Table 2.4.6-205.

It is noted that because of the curvature of the earth, having a uniform grid size in degrees leads to variable-length (in the west-east direction) cells at different latitudes within the model domain.

There is a sponge layer along the open boundaries of the model, which was used for the definition of the boundary conditions. The thickness of the sponge layer was 200 kilometers (124.3 miles) along the eastern boundary, and 100 kilometers (62.1 miles) along the northern and southern boundaries.

The antecedent water surface level was equal to the 10 percent exceedance spring tide level, plus the initial rise and long term sea-level rise, which produce an initial water level equal to 1.68 meters (5.5 feet) mean low water (MLW), or 3.6 feet (1.10 meters) NAVD 88.

2.4.6.4.2.4 Simulation Results

Two sets of simulation results for the tsunami propagation and inundation by the Cape Fear tsunami are presented. The first set of results is for the dynamic initial condition and the second set of results is for a static initial condition.

Dynamic Source Initial Condition

Figures 2.4.6-244 and 2.4.6-245 show the propagation of the tsunami wave over the domain of model Grid A during the first three hours of the FUNWAVE-TVD simulation, presenting snapshots of the wave height every 20 minutes. Time zero in the FUNWAVE-TVD simulation is 500 seconds after the initiation of the slide. It should be noted that the color scale indicating wave height differs in the different panels of these two figures. As can be seen in these figures, the highest waves travel towards the east. The wave traveling west towards the east coast of the United States is relatively smaller. Relatively high water levels are also predicted towards the southeast. This is illustrated in Figure 2.4.6-246 which shows the maximum water surface elevation within the model domain of Grid A during the simulation period. The highest water levels are within a fan-shaped zone towards the east, and over a relatively narrow zone towards the southeast. The latter seems to coincide with the relatively shallower ocean depths along Blake Ridge (Figure 2.4.6-243).

Figure 2.4.6-247 shows the propagation of the tsunami wave in Grid B, from 100 minutes in the FUNWAVE-TVD simulation, a little after the wave enters the Grid B domain, until 180 minutes after the slide simulation. Snapshots of the wave height every 20 minutes are shown. Figure 2.4.6-248 shows the maximum water surface elevation within the model domain of Grid B during the simulation period. As can

be seen in this figure, the highest water levels occur in the northern part of Grid B, while the water levels toward the south and in the vicinity of Units 6 & 7 are much lower.

Figure 2.4.6-249 shows the propagation of the tsunami wave in Grid C, from 140 minutes until 240 minutes in the FUNWAVE-TVD simulation. Snapshots of the wave height every 20 minutes are shown. Figure 2.4.6-250 shows the maximum water level over Grid C. As can be seen in these figures, the area surrounding the site of Units 6 & 7 is inundated. However, the Units 6 & 7 site itself and other parts of the Turkey Point station, which are elevated above the existing grade, are not inundated and remain dry. However, this is not caused by the Cape Fear tsunami. It is a consequence of the assumption regarding the initial sea water level rise which accounts for the 10 percent exceedance spring tide level, 1.097 meters (3.6 feet) MLW, initial rise, 0.274 meter (0.9 foot), and long term sea-level rise, 0.305 meter (1.0 foot), which produce an initial water level, i.e., prior to the arrival of the tsunami, equal to 1.68 meters (5.5 feet) MLW, or 1.10 meters (3.6 feet) NAVD 88. This initial level is enough to inundate a large zone along the Florida coast, including the entire area around Units 6 & 7. This is made clear in Figure 2.4.6-251, which shows the water depth over the area of Grid C relative to two different levels of the water surface. The left panel shows the water depth relative to MLW. The right panel shows the water depth relative to the assumed initial water surface in the Cape Fear tsunami simulations, i.e., relative to 10 percent exceedance spring tide + initial rise + long-term sea-level rise. As can be seen in the right panel of Figure 2.4.6-251, the area surrounding Units 6 & 7 is inundated even prior to the arrival of the tsunami. Again, the Units 6 & 7 site itself and other parts of the Turkey Point station, which are elevated above the existing grade, are not inundated and remain dry. The maximum water surface elevation is 2.32 meters (7.5 feet) MLW or 1.75 meters (5.7 feet) NAVD 88. Figure 2.4.6-252 shows the maximum water surface rise in the vicinity of Units 6 & 7, relative to the initial sea water level.

Figure 2.4.6-253 shows the water level near Units 6 & 7 from the dynamic source simulation as a function of time. The maximum water surface level rise caused by the Cape Fear tsunami is 0.6 meter (1.97 feet) over the initial water level, occurring a little after five hours from the initiation of the Cape Fear slide, and about two hours after the arrival of the first waves caused by the Cape Fear tsunami.

Figures 2.4.6-254 and 2.4.6-255 show the propagation of the tsunami wave generated by a static source over the domain of Grid A during the first three hours of the FUNWAVE-TVD simulation, presenting snapshots of the wave height every

20 minutes. The tsunami propagation pattern is similar to that in the dynamic source simulation, but the wave heights away from the source, especially towards the east are much smaller than those for the dynamic source shown in Figures 2.4.6-244 and 2.4.6-245.

Figure 2.4.6-256 shows the maximum water surface elevation within the model domain of Grid A during the simulation period. Comparing Figure 2.4.6-256 with Figure 2.4.6-246 shows that the static source produces much smaller water surface elevations over most of the domain of Grid A, and especially to the east and southeast. An exception is the area right over the slide and its immediate vicinity to the west, where the maximum water surface levels with the static source are substantially higher than those obtained with the dynamic source. This difference could be attributed to the fact that in the case of the dynamic source the initial condition entered in FUNWAVE-TVD includes the velocities obtained with NHWAVE, while in the case of the static source the initial velocities in the vicinity of the source are zero. Assigning a velocity to the initial wave in the dynamic source case results in a higher total energy than in the static source case where the initial velocity is assumed to be zero.

Figure 2.4.6-257 shows the propagation of the tsunami wave in Grid B, from 100 minutes in the FUNWAVE-TVD simulation, a little after the wave enters the Grid B domain, until 180 minutes after the slide simulation. Snapshots of the wave height every 20 minutes are shown. Figure 2.4.6-258 shows the maximum water surface elevation within the model domain of Grid B during the simulation period. The predicted water surface levels in Grid B for the static source are quite similar to those for the dynamic source shown in Figures 2.4.6-247 and 2.4.6-248.

Figure 2.4.6-259 shows the propagation of the tsunami wave in Grid C, from 140 minutes until 240 minutes in the FUNWAVE-TVD simulation. Snapshots of the wave height every 20 minutes are shown. Figure 2.4.6-260 shows the maximum water level over Grid C. Again the predicted water surface elevations over Grid C for the static source are quite similar to those predicted with a dynamic source, shown in Figures 2.4.6-249 and 2.4.6-250.

The maximum water surface elevation is 2.08 meters (6.8 feet) MLW, or 1.51 meters (5.0 feet) NAVD 88. Figure 2.4.6-261 shows the maximum water surface rise in the vicinity of Units 6 & 7, relative to the initial sea water level.

Figure 2.4.6-262 shows the water level (relative to the initial water level) near Units 6 & 7 from the static source simulation as a function of time. The maximum water surface level rise caused by the Cape Fear tsunami is 0.4 meter (1.31 feet),

occurring a little after four hours from the initiation of the Cape Fear slide, and about one hour after the arrival of the first waves caused by the Cape Fear tsunami. The maximum water level at Units 6 & 7 predicted with the static source (0.4 meter [1.31 feet]) is slightly lower than that predicted using a dynamic source (0.6 meter [1.97 feet]).

2.4.6.4.2.5 Comparison of the Cape Fear Tsunami with the PMT

The simulations of a tsunami generated by a conservatively large submarine mass failure on the continental margin off Cape Fear suggest that the impact of such an event on water levels near Units 6 & 7 will be smaller than that of the postulated PMT presented in Subsection 2.4.6.4.1. The maximum predicted water level due to the Cape Fear tsunami event is 2.28 meters (7.5 feet) MLW, or 1.75 meters (5.7 feet) NAVD 88, representing a rise of 0.6 meter (1.97 feet) of the initial sea water level. The assumed initial sea water level includes the 10 percent exceedance spring tide, 1.097 meters (3.6 feet) MLW, an initial rise, 0.274 meter (0.9 foot), plus the long-term sea level rise, 0.304 meter (1.0 foot). This water level is much smaller than the maximum tsunami water level of 4.5 meters (14.76 feet) MSL (4.82 meters [15.8 feet] MLW) reported for the PMT case in Subsection 2.4.6.5.

2.4.6.4.3 Analysis of the Florida Escarpment Tsunami

2.4.6.4.3.1 Representation of the Florida Escarpment Slide in the Model Simulations

The maximum potential slide at the Florida Escarpment was schematized for modeling purposes as having a Gaussian shape with an elliptical footing. This shape was chosen because a Gaussian shape has been used for several investigations and studies of landslide tsunamis, including benchmark cases (References 237, 242, 243). Grilli and Watts (Reference 237) state that a Gaussian shape is a more realistic representation of a submarine mass failure than other arbitrary fixed shapes. Enet and Grilli (Reference 235) used a Gaussian shape in the experiments that provide the basis for the validation of the model used to simulate the generation of a wave by a submarine slide (Reference 235). The Gaussian shape of the slide was approximated in the numerical model by truncated hyperbolic secant squared functions (Reference 235). The center of the elliptical base of the slide prior to the initiation of movement is located at 25.92° N, 84.80° W (Figure 2.4.6-264). The length (minor axis of the elliptical base) of the slide shown in Figure 2.4.6-264 is 19.2 kilometers (11.93 miles), and the width (major axis of its elliptical base) of the slide

is approximately 42.9 kilometers (26.7 miles). These dimensions were selected so the ellipse approximately covers the area of the outline of maximum credible submarine slide above the Florida Escarpment, and it has an area equal to 647.57 square kilometers (250.03 square miles), given in Reference 239.

The maximum thickness of the postulated slide was taken as approximately 66 meters (216.5 feet). This was estimated so the volume of the schematized slide used in the model is equal to 16.2 cubic kilometers (3.9 cubic miles), which was estimated based on the bathymetric data (Reference 239).

The bottom slope used in the model was 5.8 degrees. This was estimated based on the water depth difference between the centroid of the slide at its initial position and a point downslope at a distance equal to the minor axis of the elliptical base of the slide, i.e., 19.2 kilometers (11.9 miles). The water depth at these two points is 1355 and 3307 meters (4445.5 and 10,849.7 feet), respectively.

The initial acceleration of the slide, 0.992 meter (3.25 feet) per second squared, was estimated directly from the bed slope. The terminal velocity of the slide was estimated as equal to 134.3 meters (440.6 feet) per second, using a specific gravity for the slide equal to 2 and a bed slope of 5.8 degrees and length of 19.2 kilometers (11.9 miles). The global drag coefficient was assumed to be equal to 1 (Reference 237), which is conservative. Based on its initial acceleration, the slide reaches its terminal velocity within 135 seconds.

2.4.6.4.3.2 Initial Wave Generated by the Florida Escarpment Slide

Two alternative approaches were used for the generation of the initial wave in the tsunami simulations. The two approaches are referred to as the dynamic approach and the static source approach. Two source approaches are used as the velocity components from the dynamic source can differ significantly from the static source with respect to the total slide energy.

The dynamic source approach defined the initial condition for the tsunami propagation simulations in terms of both the water surface displacement and the depth-averaged horizontal velocity fields. This source was computed from the slide geometry and its movement using the computer model NHWAVE (Non-Hydrostatic Wave), Version 1.1 (Reference 238).

Input to NHWAVE includes the bathymetric grid, the slide dimensions, the initial slide position and orientation, and the terminal velocity of the slide. The modeled domain was set up so that the landslide event was centrally located and the generated motion did not reach the lateral boundaries during the simulated time.

Bathymetric data for the model domain of NHWAVE and the three nested grids of FUNWAVE-TVD used in the simulations were obtained from the National Geophysical Data Center (NGDC) ETOPO 1 (Reference 244) and the Coastal Relief Model (CRM) (Reference 246) data sets. Results from the NHWAVE model at 250 seconds were saved and used as initial conditions in the tsunami propagation model FUNWAVE-TVD, Version 1.1 (Reference 252).

The assumed runout distance of the slide volume as it moves downslope along its minor axis is 24.5 kilometers (15.2 miles). It is the distance between the centroid of the elliptical base of the slide in its initial position and the intersection of an extension of the bottom slope and the sea floor beyond the base of the escarpment. This is a very conservative assumption because the sea floor beyond 9.6 kilometers (5.97 miles) from the initial position of the centroid of the slide is practically horizontal. Therefore, assuming that the slide will continue moving at the same velocity up to 24.5 kilometers (15.2 miles) from its initial position would produce conservative estimates of the initial wave. The present approach neglects the spreading and flattening of the sliding mass during the slide process in the present simulations. This results in a higher and narrower initial elevation hump at the final slide location than what would have occurred if the slide were allowed to deform. The initial and final positions of the slide are displayed in Figure 2.4.6-266.

The NHWAVE model was run for a period of time, and the surface displacement field and horizontal velocity fields at 250 seconds, the time required to travel the postulated run out distance of 24.5 kilometers (15.2 miles), were saved and used as input into FUNWAVE-TVD. The resulting water surface displacement from NHWAVE at that time (250 seconds) is shown in Figures 2.4.6-267 and 2.4.6-268 which also shows the water surface profile in the direction of the slide motion simulated with NHWAVE at different times after the initiation of the slide. As shown in Figure 2.4.6-268, the maximum water surface at 250 seconds is 47.2 meters (154.9 feet), and the minimum is –77.5 meters (-254.3 feet).

The second approach to the generation of the initial condition for the tsunami propagation model used a static source based on the geometry of the initial and final positions of the slide mass. A static source is defined as an initial displacement of the water surface in the form of a depression over the initial slide location, equal in areal extent, shape and volume to the displaced material volume during the submarine slide. It was assumed that the initial slide volume described above translates downslope along its axis in the direction of the slope beyond its original footprint. A positive displacement of the water surface equal to the volume, shape, and size of the slide was assumed at that point, i.e., extending

over an elliptical area with minor axis equal to 19.2 kilometers (11.9 miles), major axis equal to 42.9 kilometers (26.7 miles), maximum thickness equal to 66 meters (216.5 feet), and a corresponding negative displacement representing the missing volume of the slide mass was assumed over the initial position of the slide. The centroid of the depression of the water surface was placed at 25.92° N, 84.80° W, same as the initial location of the centroid of the slide for the dynamic source. A water rise equal in shape and size with the depression was assumed downslope of the initial depression and at a distance equal to translation distance of the dynamic case, i.e., 24.5 kilometers (15.2 miles). The maximum water surface rise is equal to 66 meters (216.5 feet). Figure 2.4.6-281 shows the assumed initial water surface wave for the Florida Escarpment tsunami simulation with FUNWAVE-TVD based on a static source. Using an initial static source, it was assumed that the initial horizontal velocities were zero over the entire model domain of FUNWAVE-TVD.

2.4.6.4.3.3 Modeling of Tsunami Propagation and Inundation

The propagation, shoreline runup, and inundation caused by the Florida Escarpment tsunami were simulated using the Boussinesq wave model FUNWAVE-TVD.

In the simulations of the Florida Escarpment tsunami, three nested grids are used, which are referred to as Grid A, Grid B, and Grid C. The output from Grid A is used as input to FUNWAVE-TVD on Grid B. The same process is repeated in going from Grid B to Grid C. The domain covered by each of these three grids is shown in Figure 2.4.6-265. All the grids are based on geographic coordinates. The coordinates of the southwest corner of each grid, the grid spacing, and number of grid cells in each grid are given in Table 2.4.6-206.

It is noted that because of the curvature of the earth, having a uniform grid size in degrees leads to variable-length (in the west-east direction) cells at different latitudes within the model domain.

There is a sponge layer along the open boundaries of the model, which was used for the definition of the boundary conditions. The thickness of the sponge layer was 200 kilometers (124.3 miles) along the eastern and northern boundaries, 100 kilometers (62.1 miles) along the southern boundary, and 150 kilometers (93.2 miles) along the western boundary.

The antecedent water surface level used for the model simulation was equal to the 10 percent exceedance high tide level, plus the initial rise and long-term sea

level rise, which produce an initial water level equal to 1.68 meters (5.5 feet) MLW or 1.10 meters (3.6 feet) NAVD 88, which is the same as that used for the PMT numerical simulation in Subsection 2.4.6.4 and for the probable maximum storm surge evaluation as explained in Subsection 2.4.5.2.2.1.

2.4.6.4.3.4 Simulation Results

Two sets of simulation results for the tsunami propagation and inundation by the Florida Escarpment tsunami are presented. The first set of results is for the dynamic initial condition and the second set of results is for a static initial condition.

Figures 2.4.6-269 and 2.4.6-270 show the propagation of the tsunami wave over the domain of model Grid A during the first 3 hours after the generation of the initial wave by the slide, presenting snapshots of the wave height every 20 minutes. Time zero in the FUNWAVE-TVD simulation is 250 seconds after the initiation of the slide. It should be noted that the color scale indicating wave height differs in the different panels of these two figures.

Figure 2.4.6-271 shows the maximum water surface elevation within the model domain of Grid A during the simulation period. The highest water levels are in the vicinity and to the west of the slide.

Figures 2.4.6-272 and 2.4.6-273 show the propagation of the tsunami wave in Grid B, from 80 minutes in the FUNWAVE-TVD simulation and after the wave enters the Grid B domain until 240 minutes. Snapshots of the wave height every 20 minutes are shown. Figure 2.4.6-274 shows the maximum water surface elevation within the model domain of Grid B during the simulation period. The maximum water level rise within the domain of Grid B is less than 0.1 meter (0.33 feet). As shown in Figure 2.4.6-274, the highest water levels occur over a relatively shallower area between Florida and Cuba, which can be seen in Figure 2.4.6-265.

Figures 2.4.6-275 and 2.4.6-276 show the propagation of the tsunami wave in Grid C, from 140 minutes to 240 minutes in the simulation. Snapshots of the wave height every 20 minutes are shown. Figure 2.4.6-277 shows the maximum water level over Grid C. As can be seen in these figures, the area surrounding the site of Units 6 & 7 is inundated. However, the Units 6 & 7 site itself and other parts of the Turkey Point station, which are elevated above the existing grade, are not inundated and remain dry. The inundation of the area surrounding the Units 6 & 7 site is not caused by the Florida Escarpment tsunami. It is a consequence of the

assumption regarding the initial sea water level that accounts for the 10 percent exceedance tide level, initial rise, and long-term sea level rise, the sum of which produces an initial water level, i.e., prior to the arrival of the tsunami, equal to 1.68 meters (5.5 feet) MLW or 1.10 meters (3.6 feet) NAVD 88. This initial water level rise is enough to inundate a large zone along the Florida coast, including the area around Units 6 & 7. This is made clear in Figure 2.4.6-278, which shows the water depth over the area of Grid C relative to two different levels of the water surface. Figure 2.4.6-278 (a) shows the water depth relative to MLW without the water level rise that is used to define the initial condition for the tsunami propagation simulations. Figure 2.4.6-278 (b) shows the water depth relative to the assumed initial water surface in the Florida Escarpment tsunami simulations, i.e., relative to 10 percent exceedance tide plus initial rise plus long-term sea-level rise. As can be seen in Figure 2.4.6-278 (b), the area surrounding the Units 6 & 7 site and its vicinity is inundated even prior to the arrival of the tsunami, i.e., under the assumed initial condition for the tsunami propagation simulations. Again, the Units 6 & 7 site itself and other parts of the Turkey Point station, which are elevated above the existing grade, are not inundated and remain dry. Figure 2.4.6-279 shows the maximum water surface rise in the vicinity of Units 6 & 7 relative to the initial seawater level. The maximum water surface level rise over this area, shown in Figure 2.4.6-279, is very small, less than 0.07 meter (0.23 foot).

Figure 2.4.6-280 shows the water level near Units 6 & 7 from the dynamic source simulation as a function of time. The maximum water surface level rise caused by the Florida Escarpment tsunami is less than 0.02 meter (0.065 foot) over the initial water level, occurring after 4 hours from the initiation of the Florida Escarpment slide and about an hour and a half after the arrival of the first waves caused by the Florida Escarpment tsunami. The predicted maximum water surface level is 1.71 meters (5.6 feet) MLW or 1.14 meters (3.5 feet) NAVD 88.

Figures 2.4.6-282 and 2.4.6-283 show the propagation of the tsunami wave generated by a static source over the domain of Grid A during the first 160 minutes, presenting snapshots of the wave height every 20 minutes. As can be seen in these figures, the tsunami propagation pattern is similar to that in the dynamic source simulation, but the wave heights away from the source toward the west are much smaller than those for the dynamic sources shown in Figure 2.4.6-269. The wave propagation to the east toward Florida is quite similar as that simulated with a dynamic source.

This is illustrated in Figure 2.4.6-284, which shows the maximum water surface elevation within the model domain of Grid A during the simulation period. Comparing Figure 2.4.6-284 with Figure 2.4.6-271 shows that the static source

produces smaller water surface levels to the west of the source but similar water levels to the east. This could be attributed to the fact that in the case of the dynamic source, the initial condition entered in FUNWAVE-TVD includes the velocities obtained with NHWAVE, while in the case of the static source, the initial velocities in the vicinity of the source are zero. Assigning a velocity to the initial wave in the dynamic source case results in a higher total energy than in the static source case where the initial velocity is assumed to be zero. In the area right over the slide and its immediate vicinity to the west, the maximum water surface levels with the static source are higher than those obtained with the dynamic source.

Figures 2.4.6-285 and 2.4.6-286 show the propagation of the tsunami wave in Grid B, from 80 minutes in the simulation and after the wave enters the Grid B domain until 240 minutes. Snapshots of the wave height every 20 minutes are shown. Figure 2.4.6-287 shows the maximum water surface elevation within the model domain of Grid B during the simulation period. The predicted water surface levels in Grid B for the static source are quite similar to those for the dynamic source shown in Figures 2.4.6-272, 2.4.6-273, and 2.4.6-274.

Figures 2.4.6-288 and 2.4.6-289 show the propagation of the tsunami wave in Grid C, from 140 minutes until 240 minutes in the simulation. Snapshots of the wave height every 20 minutes are shown. Figure 2.4.6-290 shows the maximum water level over Grid C. Again, the predicted water surface elevations over Grid C for the static source are quite similar to those predicted with a dynamic source, shown in Figures 2.4.6-275, 2.4.6-276, and 2.4.6-277.

Figure 2.4.6-291 shows the maximum water surface rise in the vicinity of the Turkey Point Power Station, relative to the initial sea water level. Figure 2.4.6-292 shows the water level at the Turkey Point Power Station from the static source simulation as a function of time. The maximum water surface level rise caused by the Florida Escarpment tsunami is 0.02 meter (0.065 foot), occurring after 4 hours from the initiation of the Florida Escarpment slide and about 1.5 hours after the arrival of the first waves caused by the Florida Escarpment tsunami. The maximum water level near Units 6 and 7 predicted with the static source is the same as that predicted using a dynamic source, i.e., 1.71 meters (5.6 feet) MLW or 1.14 meters (3.7 feet) NAVD 88.

2.4.6.4.3.5 Comparison of the Florida Escarpment Tsunami with the PMT

The simulations of a tsunami generated by a conservatively large submarine mass failure at the Florida Escarpment suggest that the impact of such an event on water levels near Units 6 & 7 will be smaller than that of the postulated PMT

presented in Subsection 2.4.6.4.1. The maximum predicted water level near Units 6 & 7 due to this tsunami event will be 1.71 meters (5.6 feet) MLW or 1.14 meters (3.7 feet) NAVD 88, representing a rise of only 0.02 meter (0.065 foot) above the initial sea water level. The assumed initial sea water level in the FUNWAVE model simulation includes the 10 percent exceedance high tide, an initial rise plus the long-term sea level rise, all of which add up to 1.68 meters (5.5 feet) MLW or 1.11 meters (6 feet) NAVD 88. This water level is much smaller than the maximum tsunami water level of 4.5 meters (14.76 feet) MSL (4.82 meters [15.81 feet] MLW) reported for the PMT case in Subsection 2.4.6.5. This conclusion is also consistent with the results of the Florida Escarpment Slide evaluation described in Subsection 2.4.6.1.2.

2.4.6.4.4 Analysis of the Great Bahama Bank Tsunami

2.4.6.4.4.1 Representation of the Great Bahama Bank Slide in the Model

The maximum credible slide was schematized for modeling purposes as having a Gaussian shape with an elliptical footing. This shape was chosen because a Gaussian shape has been used for several investigations and studies of landslide tsunamis, including benchmark cases (References 235, 242, 243). Grilli and Watts (Reference 237) state that a Gaussian shape is a more realistic representation of a submarine mass failure than other arbitrary fixed shapes. Enet & Grilli (Reference 235) used a Gaussian shape in the experiments that provide the basis for the validation of the model used to simulate the generation of a wave by a submarine slide (Reference 235). Although actual slides usually have more pronounced head shapes, the Gaussian surface shape is deemed as providing a reasonable approximation of the shape of actual slides. The Gaussian shape of the slide was approximated in the numerical model by truncated hyperbolic secant squared functions. The center of the elliptical base of the slide before the initiation of movement is located at 25.6134°N, 79.3213°W. The length (minor axis of the elliptical base) of the slide is 3 kilometers, and its width (major axis of its elliptical base) of the slide is approximately 30 kilometers.

The length of the slide is postulated based on the ocean floor profile at the site investigated in detail by Mulder et al. (Reference 260) shown in Figure 2.4.6-296, where the length of the steepest slope in the southern site with a slope up from approximately 1.5 degrees is approximately 3 kilometers. Figure 2.4.6-298 shows that the length of the steepest slope at the Postulated Slide Location of the northern site with slopes greater than 5 degrees is close to 1 kilometer. As a conservative assumption, the larger failure length between the northern and

southern sites, i.e., 3 kilometers, is selected to define the source (Case 1) in the numerical simulations.

The width of the slide, i.e., its dimension in the direction normal to the direction of the slope failure, is conservatively selected to be 30 kilometers This width is about twice the combined width of all the scars identified in the southern site through multibeam bathymetric surveys shown in Figure 2.4.6-293.

The height of the three scars in the southern site shown in Figure 2.4.6-293 is between 80 and 110 meters (Reference 260). The upper end of this range is selected as a conservative estimate of the slide thickness at both postulated tsunami source locations along the GBB. It is also noted that the thickness of the material subject to potential mass failure on the seismic profile shown in Figure 2.4.6-298 (Line 5 in Reference 263) near the northern site is of the order of 100 meters.

The slope of the face of the scarp of the southern site shown in Figure 2.4.6-293 ranges from 3.8 to 5.8 degrees as illustrated in Figure 2.4.6-296. The slope of the ocean floor beyond the foot of the scarp is of the order of 1.5 degrees. The slope of the face of the scarp at the Postulated Slide Location in the northern site, based on the profile shown in Figure 2.4.6-300, is approximately 7 degrees. This slope is used in the simulation of a 3-kilometer long slide, presented as Case 1. The center of the elliptical base of the Case 1 slide was placed at 25.59°N, 79.33°W. In addition, the effect of a steeper but shorter potential slide is evaluated in Case 2. Based on the seismic profile shown in Figure 2.4.6-298, reproduced from Reference 263, the source in Case 2 is represented by a bed slope of 20 degrees and a slide length of 1.5 kilometers. The center of the elliptical base of the Case 2 slide was placed at 25.62°N, 79.34°W.

For Case 1, the initial acceleration of the 3-kilometer slide on a 7-degree bed slope is 1.2 meters per second squared, and its terminal velocity 58.3 meters per second. This estimate was obtained using a specific gravity for the slide equal to 2, and global drag coefficient equal to 1. Based on its initial acceleration the slide reaches its terminal velocity within 49 seconds. For Case 2, the initial acceleration of the 1.5-kilometer slide on a 20-degree bed slope is 3.4 meters per second squared, and its terminal velocity 69.1 meters per second, reached in 21 seconds from the initiation of motion.

2.4.6.4.4.2 Initial Wave Generated by the Great Bahama Bank Slide

Two alternative approaches were used for the generation of the initial wave in the tsunami simulations. The two approaches are referred to as the dynamic source approach and the static source approach.

The dynamic source approach defines the initial condition for the tsunami propagation simulations in terms of both the water surface displacement and the depth-averaged horizontal velocity fields. This source was computed from the slide geometry and its movement using the computer model NHWAVE (Non-Hydrostatic Wave), Version 1.1 (Reference 238). NHWAVE solves the fully non-hydrostatic Navier-Stokes equations in the sigma coordinate system.

Input to NHWAVE includes the bathymetric grid, the slide dimensions, the initial slide position and orientation, the terminal velocity, and the down-slope acceleration of the slide. For the dynamic approach, the modeled domain was set up so that the landslide event was centrally located and the generated motion did not reach the lateral boundaries during the simulated time. Results from the NHWAVE model at the time the amplitude of the generated wave becomes equal to the maximum thickness of the slide were saved and used as initial conditions in the tsunami propagation model FUNWAVE-TVD.

The approach conservatively neglects the spreading and flattening of the sliding mass during the slide process in the present simulations. This results in a higher and narrower initial elevation hump at the final slide location than what would have occurred if the slide were allowed to deform. The initial and final positions of the 3-kilometer slide are displayed in Figure 2.4.6-301.

For Case 1 that simulated the 3-kilometer slide on a 7-degree slope, the NHWAVE model was run for a period of time and the surface displacement field and horizontal velocity fields at 110 seconds, the time that the maximum drawdown (negative wave height) became approximately equal to the maximum thickness of the slide were saved and used as input into FUNWAVE-TVD. The resulting water surface displacement from NHWAVE at that time (110 seconds) for the 3-kilometer slide on a 7-degree slope is shown in Figure 2.4.6-302. Figure 2.4.6-303 shows the water surface profile in the direction of the slide motion simulated with NHWAVE at different times after the initiation of the slide. The maximum water surface at 110 seconds is 63 meters, and the minimum –108 meters. Figure 2.4.6-303 shows the evolution of the simulated water surface profile over time.

For Case 2 that simulated the 1.5-kilometer slide on a 20-degree slope, the NHWAVE model was run until the maximum drawdown became about equal to the maximum thickness of the slide, which in this case as 140 seconds. Figure 2.4.6-304 shows the water surface at that time which was used as input in the FUNWAVE-TVD simulation. The maximum water surface is 61 meters and the minimum –120 meters. Figure 2.4.6-305 shows the evolution of the simulated water surface profile over time.

The second approach to the generation of the initial condition for the tsunami propagation model used a static source. A static source is defined as an initial displacement of the water surface in the form of a depression over the initial slide location, equal in areal extent, shape, and volume to the displaced material volume during the submarine slide. A negative displacement of the water surface equal to the volume, shape, and areal extent of the slide was assumed at the initial slide location, i.e., extending over an elliptical area with minor axis equal to 3 kilometers, major axis 30 kilometers and maximum thickness 110 meters. A corresponding positive displacement representing the missing volume of the slide mass was also added. The centroid of the depression of the water surface was placed at 25.63°N, 79.34°W.

2.4.6.4.4.3 Modeling of Tsunami Propagation and Inundation

As in the case of the tsunamis discussed in Subsections 2.4.6.4.2 and 2.4.6.4.3, the propagation, shoreline runup and inundation caused by the GBB slide were simulated using the Boussinesq wave model FUNWAVE-TVD in spherical-polar coordinates (Reference 240).

In the simulations of the tsunami generated by a landslide on the western margin of the GBB, two grids are used, which are referred to as Grid B and Grid C. These are the same grids used in analysis of tsunamis generated by a submarine slide at the Florida Escarpment discussed in Subsection 2.4.6.4.3. The output from Grid B is used as input to FUNWAVE-TVD on Grid C.

The domain covered by each of the grids is shown in Figure 2.4.6-265. All the grids are based on geographic coordinates. The coordinates of the southwest corner of each grid, the grid size and number of grid cells in each grid are given in Table 2.4.6-207.

It is noted that because of the curvature of the earth, having a uniform grid size in degrees leads to variable-length (in the west-east direction) cells at different latitudes within the model domain.

There is a sponge layer along the open boundaries of the model that was used for the definition of the boundary conditions. The thickness of the sponge layer was 40 kilometers along the eastern and the western boundary, 50 kilometers along the southern boundary and 20 kilometers along the northern boundary.

2.4.6.4.4.4 Simulation Results

Simulations were performed for three cases representing different assumptions for the initial tsunami wave that can be generated by a submarine slide at the west margin of the GBB. Case 1 uses a dynamic source, i.e., a wave produced by

NHWAVE, for a tsunami generated by a 3-kilometer slide on a 7-degree slope. Case 2 uses also a dynamic source for tsunami generated by a 1.5-kilometer slide on a 20-degree slope. Case 3 uses a static source for a tsunami generated by a 3-kilometer slide on a 7-degree slope.

With respect to Case 1, Figure 2.4.6-306 shows the propagation of the tsunami wave in Grid B, at 2, 4, 6, and 14 minutes in the FUNWAVE-TVD simulation. Figure 2.4.6-307 shows the maximum water surface elevation within the model domain of Grid B during the simulation period.

Figure 2.4.6-308 shows the propagation of the same tsunami wave in Grid C, at 18, 30, 44, and 100 minutes in the FUNWAVE-TVD simulation. Figure 2.4.6-309 shows the maximum water level over Grid C. As can be seen in these figures, the area surrounding the Turkey Point Units 6 & 7 site is inundated. However, as already discussed in Subsection 2.4.6.4.3.4, the inundation of the area surrounding the site of Units 6 & 7 is not caused by the GBB tsunami. It is a consequence of the assumption regarding the initial seawater level that accounts for the 10 percent exceedance high tide level of 3.6 feet MLW, initial rise of 0.9 feet and long-term sea level rise of 1.0 foot, the sum of which produces an initial water level, i.e., prior to the arrival of the tsunami, equal to 1.68 meters (5.5 feet) MLW, or 3.6 feet (1.10 meters) NAVD 88. This initial water level is enough to inundate a large zone along the Florida coast, including the area around Units 6 & 7 (Figure 2.4.6-278). Figure 2.4.6-310 shows the maximum water surface rise in the vicinity of the site relative to the initial seawater level.

Figure 2.4.6-311 shows the water level at the Turkey Point Units 6 & 7 site as a function of time. The maximum water surface level rise over the initial water level is 2.9 meters, occurring approximately 50 minutes from the initiation of the slide. The predicted maximum water surface level is 4.6 meters (15.0 feet) MLW, or 4.0 meters (13.1 feet) NAVD 88. The predicted maximum water level near the site is derived from Figure 2.4.6-310.

With respect to Case 2, Figure 2.4.6-304 shows the water surface profile simulated with NHWAVE that was used as input in the simulation of the propagation of a tsunami caused by a 1.5-kilometer-long slope failure on a 20-degree slope.

The simulation with FUNWAVE-TVD was again performed in two steps, modeling the propagation of the tsunami wave first within Grid B, then in Grid C using the output from the Grid B as input in Grid C to define the wave surface elevation and velocity conditions along its boundaries. Figure 2.4.6-312 shows the propagation of the tsunami wave in Grid B, at 2, 6, 8, and 14 minutes in the FUNWAVE-TVD

simulation. Figure 2.4.6-313 shows the maximum water surface elevation within the model domain of Grid B during the simulation period.

Figure 2.4.6-314 shows the propagation of the same tsunami wave in Grid C, at 18, 30, 44, and 100 minutes in the FUNWAVE-TVD simulation. Figure 2.4.6-315 shows the maximum water level over Grid C. As in Case 1, the area surrounding the Turkey Point Units 6 & 7 site is inundated. The inundation of the area surrounding the site of Units 6 & 7 is not caused by the GBB tsunami. It is a consequence of the assumption regarding the initial seawater level, as explained above. Figure 2.4.6-316 shows the maximum water surface rise in the vicinity of the Turkey Point Units 6 & 7 site relative to the initial seawater level.

Figure 2.4.6-317 shows the time history of the water level at the Turkey Point Units 6 & 7 site. The maximum water surface level caused by this tsunami is 3.0 meters over the initial water level, also occurring after approximately 50 minutes from the initiation of the slide. The predicted maximum water surface level is 4.68 meters (15.4 feet) MLW, or 4.1 meters (13.5 feet) NAVD 88, taking into account the antecedent seawater level. The predicted maximum water level near the site is derived from Figure 2.4.6-316.

With respect to Case 3, the initial displacement of the water surface in this case is in the form of a depression approximately equal to the slide, i.e., extending over an elliptical area with its minor axis equal to 3 kilometers, its major axis equal to 30 kilometers, and maximum thickness 110 meters. The volume of the depression is approximately 3 cubic kilometers. A water rise equal to the depression, both in shape and size, is formed downslope of the initial depression. The displacement volume of the positive wave and negative wave were set equal to the landslide volume. The maximum water surface rise is equal to 110 meters, equal to the height (thickness) of the slide. Figure 2.4.6-318 shows the assumed initial water surface wave for the tsunami simulation with FUNWAVE-TVD based on a static source.

Figure 2.4.6-319 shows the propagation of the tsunami wave in Grid B, at 2, 4, 6, and 14 minutes in the FUNWAVE-TVD simulation. Figure 2.4.6-320 shows the maximum water surface elevation within the model domain of Grid B during the simulation period.

Figure 2.4.6-321 shows the propagation of the tsunami wave in Grid C, at 18, 30, 44, and 100 minutes in the FUNWAVE-TVD simulation. Figure 2.4.6-322 shows the maximum water level over Grid C.

Figure 2.4.6-323 shows the maximum water surface rise in the vicinity of the Turkey Point Units 6 & 7 site relative to the initial seawater level. Figure 2.4.6-324 shows the water level at the site from the static source simulation as a function of

time. The maximum water surface rise caused by the tsunami generated by a submarine slide at the Postulated Slide Location is 1.7 meters over the initial water level, occurring after approximately 58 minutes from the initiation of the slide. The predicted maximum water level at the Turkey Point Units 6 & 7 site is 3.38 meters (11.1 feet) MLW, or 2.8 meters (9.2 feet) NAVD 88, taking into account the antecedent seawater level. The predicted maximum water level near the site is derived from Figure 2.4.6-323.

2.4.6.4.4.5 Comparison of the Great Bahama Bank Tsunami with the PMT

Simulations were performed for a tsunami generated by a conservatively large slope failure along the western margin of the GBB. The maximum predicted water level at the Turkey Point Units 6 & 7 site due to this tsunami event is 4.68 meters (15.4 feet) MLW, or 4.1 meters (13.5 feet) NAVD 88. The assumed initial seawater level in the FUNWAVE-TVD model simulation includes the 10 percent exceedance spring tide, an initial rise plus the long-term sea level rise, all of which add up to 1.68 meters (5.50 feet) MLW or 1.10 meters (3.6 feet) NAVD 88.

The maximum predicted water level at the Turkey Point Units 6 & 7 site caused by a tsunami at the GBB is less than the maximum water level predicted for the 1755 Lisbon earthquake PMT scenario, which was estimated to be equal to 4.2 meters (13.9 feet) NAVD 88.

2.4.6.5 Tsunami Water Level

The time history of tsunami water level at the site is given in Figure 2.4.6-226. The maximum tsunami water level at the site from model simulation results is 4.5 meters (14.76 feet) MSL or 4.2 meters (13.9 feet) NAVD 88 including the initial water level of 1.36 meters (4.46 feet) MSL, which is rounded up to 14.0 feet (4.3 meters) NAVD 88. This maximum tsunami water level is 12 feet lower than the entrance floor elevation of all safety-related structures at 26 feet NAVD 88.

2.4.6.6 Hydrography and Harbor or Breakwater Influences on Tsunami

Units 6 & 7 are located adjacent to Biscayne Bay approximately 8 miles west of the Elliott Key barrier island. The PMT water level near Units 6 & 7 is analyzed based on published numerical simulation results and includes a conservatively assumed tsunami run-up. Therefore, the effect of hydrography of the area has been considered in the estimation of the PMT water level. There are no breakwaters located near the Units 6 & 7 that may affect the PMT water level.

2.4.6.7 Effects on Safety-Related Facilities

A conservative estimate of the PMT still water level near Units 6 & 7 is approximately 4.3 meters (14 feet) NAVD 88. This PMT water level along with coincidental wind-wave run-up, as presented in Subsection 2.4.5, would be lower than the design plant grade elevation of 26 feet NAVD 88 for the safety-related facilities. Therefore, the postulated PMT event does not affect the safety functions of Units 6 & 7. Because the PMT water level is lower than the design plant grade, debris, waterborne projectiles, sediment erosion, and deposits are not a concern to the functioning of the safety-related SSCs of Units 6 & 7.

2.4.6.8 References

201. Prasad, R., *Tsunami Hazard Assessment at Nuclear Power Plant Sites in the United States of America (Draft Report for Comments)*, Pacific Northwest National Laboratory, PNNL-1-7397, Office of New Reactors, U.S. NRC, NUREG/CR-6966, August 2008.

202. Atlantic and Gulf of Mexico Tsunami Hazard Assessment Group, *Evaluation of Tsunami Sources with the Potential to Impact the U.S. Atlantic and Gulf Coasts — An Updated Report to the Nuclear Regulatory Commission*, U.S. Geological Survey, Administrative Report, August 2008.

203. Twichell, D., W. Dillon, C. Paull, and N. Kenyon, *Morphology of Carbonate Escarpments as an Indicator of Erosional Processes, Geology of the Unites States Seafloor — A View from GLORIA*, Cambridge University Press, 1996.

204. Ward, S., and S. Day, *Cumbre Vieja Volcano — Potential Collapse and Tsunami at La Palma, Canary Islands,* Geophysical Research Letters, Vol. 28, No. 17, pp. 3397–3400, 2001.

205. Mader, C., *Modeling the La Palma Landslide Tsunami,* Science of Tsunami Hazards, Vol. 19, No. 50–70, 2001.

206. Pararas-Carayannis, G., *Evaluation of the Threat of Mega Tsunami Generation from Postulated Massive Slope Failures of Island Stratovolcanos on La Palma, Canary Islands, and on the Island of Hawaii,* Science of Tsunami Hazards, Vol. 20, No. 5, pp. 251–277, 2002.

207. Gisler, G., R. Weaver, and M. Gittings, *Sage Calculations of the Tsunami Threat from La Palma,* Science of Tsunami Hazards, Vol. 24, No. 4, pp. 288–301, 2006.

208. Lockridge, P., S. Lowell, and J. Lander, *Tsunamis and Tsunami-Like Waves of the Eastern United States,* Science of Tsunami Hazards, Vol. 20, No. 3, pp. 120–157, 2002.

209. Mader, C., *Modeling the 1755 Lisbon Tsunami,* Science of Tsunami Hazards, Vol. 19, No. 2, pp. 93–98, 2001.

210. Lander, J., L. Whiteside, and P. Lockridge, *A Brief History of Tsunamis in the Caribbean Sea,* Science of Tsunami Hazards, Vol. 20, No. 2, pp. 57–94, 2002.

211. Knight, B., *Model Prediction of Gulf and Southern Atlantic Coast Tsunami Impacts from a Distribution of Sources,* Science of Tsunami Hazards, Vol. 24, No. 5, pp. 304–312, 2006.

212. National Geophysical Data Center, *Significant Earthquake Database*, revised August 27, 2008. Available at http://www.ngdc.noaa.gov/hazard/earthqk.shtml, accessed August 27, 2008.

213. National Earthquake Information Center, *M 5.8 Gulf of Mexico Earthquake of 10 September 2006*, U.S. Geological Survey, September 2006.

214. National Geophysical Data Center, *Historical Tsunami Database*, revised August 27, 2008. Available at http://www.ngdc.noaa.gov/seg/hazard/tsu_db.shtml, accessed August 1, 2008.

215. Hornbach, M., S. Mondziel, N. Grindlay, C. Frohlich, and P. Mann, *Did a Submarine Slide Trigger the 1918 Puerto Rico Tsunami?,* Science of Tsunami Hazards, Vol. 27, No. 2, pp. 22–31, 2008.

216. Geist, E., *Local Tsunamis and Earthquake Source Parameters*, R. Dmowska and B. Saltsman (eds.), Tsunamigenic Earthquakes and their Consequences, Advances in Geophysics, Vol. 39, pp. 117–209, 1998.

217. Ocean Drilling Program, Shipboard Scientific Party, *Chapter 5. Site 626: Straits of Florida,* J. Austin, Jr. and W. Schlager (eds.), Proceedings of the Ocean Drilling Program, Initial Report, Vol. 101, pp. 49-109, 1986.

218. Iturralde-Vinent, M. (ed.), *Geologia de Cuba para Todos*, Edicion Cientifica, Museo Nacional de Historia Natural-CITMA, preprint, 2009.

219. Deltares, *Delft3D-FLOW*, Simulation of Multi-Dimensional Hydrodynamic Flows and Transport Phenomena, Including Sediments, Rotterdamseweg 185, 2009.

220. Stelling, G. and S. Duinmeijer, *A Staggered Conservative Scheme for Every Froude Number in Rapidly Varied Shallow Water Flows,* International Journal for Numerical Methods in Fluids, Vol. 43, pp. 1329–1354, 2003.

221. Apotsos, A., M. Buckley, and G. Gelfenbaum, *Tsunami Benchmark Simulations Using Delft3D,* ISEC Community Workshop: Simulation & Large-Scale Testing of Nearshore Wave Dynamics, Corvallis, July 8–10, 2009.

222. Imamura, F., A. Yalciner, and G. Ozyurt, *Tsunami Modeling Manual*, International Oceanographic Commission, 2006.

223. Hornbach, M., L. Lavier, and C. Ruppel, *Triggering Mechanism and Tsunamogenic Potential of the Cape Fear Slide Complex, U.S. Atlantic Coastal Margin,* Geochemistry, Geophysics, and Geosystems, Vol. 8, No. 10, 2007.

224. Apotsos, A., B. Jaffe, and G. Gelfenbaum, *Wave Characteristics and Morphologic Effects on the Onshore Hydrodynamic Response of Tsunamis,* Coastal Engineering, Vol. 58, pp. 1034–1048, November 2011.

225. Popenoe, P., E. Schmuck, and W. Dillon, *The Cape Fear Landslide: Slope Failure Associated with Salt Diapirism and Gas Hydrate Decomposition,* in *Submarine Landslides: Selected Studies in the U.S. Exclusive Economic Zone*, W. Schwab, H. Lee, and D. Twichell (eds.), U.S. Geological Survey, Bulletin 2002, pp. 40–53, 1993.

226. Popenoe, P., and W. Dillon, *Characteristics of the Continental Slope and Rise Off North Carolina from GLORIA and Seismic-Reflection Data: The Interaction of Downslope and Contour Current Processes,* J. Gardner, M. Field, and D. Twichell (eds.), Geology of the United States' Seafloor, The View from GLORIA, Cambridge University Press, Cambridge, United Kingdom, pp. 59–80, 1996.

227. Paull, C., R. Matsumoto, P. Wallace, et al., *Chapter 1: Introduction,* Proceedings of the Ocean Drilling Program, Initial Reports, Vol. 164, pp. 5–12, 1996.

228. Paull, C., W. Buelow, W. Ussler III, and W. Borowski, *Increased Continental-Margin Slumping Frequency During Sea-Level Lowstands Above Gas Hydrate-BearingSediments,* Geology, Vol. 24, No. 2, pp. 143–146, 1996.

229. Lee, H., *Timing of Occurrence of Large Submarine Landslides on the Atlantic Ocean Margin,* Marine Geology, Vol. 264, No. 1-2, pp. 53–64, 2009.

230. Rodriguez, N., and C. Paull, *Chapter 32. Data Report: 14C Dating of Sediment of the Uppermost Cape Fear Slide Plain: Constraints on the Timing of this Massive Submarine Landslide,* C. Paull, R. Matsumoto, P. Wallace, and W. Dillon (eds.), Proceedings of the Ocean Drilling Program, Scientific Results, Vol. 164., pp. 325–327, 2000.

231. Owen, M., S. Day, and M. Maslin, *Late Pleistocene Submarine Mass Movements: Occurrence and Causes,* Quaternary Science Reviews, Vol. 26, No. 7-8, pp. 958–978, 2007.

232. Tappin, D., *Submarine Mass Failures as Tsunami Sources: Their Climate Control,* Philosophical Transactions of the Royal Society, Vol. 368, pp. 2417–2434, 2010.

233. Twichell, D., J. Chaytor, U. ten Brink, and B. Buczkowski, *Morphology of Late Quaternary Submarine Landslides Along the U.S. Atlantic Continental Margin*, Marine Geology, Vol. 264, pp. 4–15, 2009.

234. Shi, F., J. Kirby, and B. Tehranirad, *Tsunami Benchmark Results for Spherical Coordinate Version of FUNWAVE-TVD* (Ver. 1.1), Research Report No. CACR-12-02, Center for Applied Coastal Research, University of Delaware, Newark, 2012.

235. Enet, F., and S. Grilli, *Experimental Study of Tsunami Generation By Three-Dimensional Rigid Underwater Landslides*, Journal of Waterway, Port, Coastal and Ocean Engineering, Vol. 133, No. 6, pp. 442–454, 2007.

236. Carpenter, G., *Coincident Sediment Slump/Clathrate Complexes on the US Atlantic Continental Slope*, Geo-Marine Letters, Vol. 1, No. 1, pp. 29–32, 1981.

237. Grilli, S., and P. Watts, *Tsunami Generation by Submarine Mass Failure, Part I: Modeling, Experimental Validation, and Sensitivity Analyses*, Journal of Waterway, Port, Coastal, and Ocean Engineering, Vol. 131, No. 6, pp. 283–297, 2005.

238. Ma, G., F. Shi, and J. Kirby, *Shock-Capturing Non-Hydrostatic Model for Fully Dispersive Surface Wave Processes*, Ocean Modeling, Vol. 43-44, pp. 22–35, 2011.

239. ten Brink, U., D. Twichell, P. Lynett, E. Geist, J. Chaytor, H. Lee, B. Buczkowski, and C. Flores, *Regional Assessment Of Tsunami Potential in the Gulf of Mexico: U.S. Geological Survey Administrative Report*, Report to the National Tsunami Hazard Mitigation Program, Revision, September 2, 2009.

240. Tehranirad, B., F. Shi, J. Kirby, J. Harris, and S. Grilli, *Tsunami Benchmark Results for Fully Nonlinear Boussinesq Wave Model FUNWAVE-TVD,* Ver. 1.0, Research Report No. CACR-11-02, Center for Applied Coastal Research, University of Delaware, Newark, 2011.

241. Shi, F., J. Kirby, B. Tehranirad, J. Harris, and S. Grilli, *FUNWAVE-TVD Version 1.0, Fully Nonlinear Boussinesq Wave Model with TVD Solver, Documentation and User's Manual*, Research Report No. CACR-11-04, Center for Applied Coastal Research, University of Delaware, Newark, 2011.

242. Synolakis, C., E. Bernard, V. Titov, U. Kanoglu, and F. Gonzalez, *Standards, Criteria, and Procedures for NOAA Evaluation of Tsunami Numerical Models*, NOAA Technical Memorandum OAR PMEL-135, Pacific Marine Environmental Laboratory, Seattle, Washington, 2007.

243. Liu, P., P. Lynett, and C. Synolakis, *Analytical Solutions for Forced Long Waves on a Sloping Beach*, J. Fluid Mech. 478: pp. 101–109, 2003.

244. Amante, C., and B. Eakins, *ETOPO1 1 Arc-Minute Global Relief Model: Procedures, Data Sources and Analysis*, NOAA Technical Memorandum NESDIS NGDC-24, 2009.

245. National Oceanic and Atmospheric Administration, *NGDC 3 Arc-Second Coastal Relief Model Development*. Available at http://www.ngdc.noaa.gov/mgg/coastal/model.html, accessed April 20, 2012.

246. National Oceanic and Atmospheric Administration, *National Geophysical Data Center*, U.S. Coastal Relief Model, Vol. 2 (U.S. South East Atlantic Coast Grids) and Vol. 3 (Florida and Eastern Gulf of Mexico Grids). Available at http://www.ngdc.noaa.gov/mgg/coastal/crm.html, accessed June 13 and June 17, 2011.

247. U.S. Geological Survey, *2012: Gulf of Mexico GLORIA Geology Interpretation Map,* U.S. Geological Survey, GLORIA Mapping Program, U.S. EEZ Gulf of Mexico Region, GLORIA Geology Interpretation. Available at http://coastalmap.marine.usgs.gov/gloria/gomex/geology.html, accessed February 14, 2012.

248. Mullins, H., A. Gardulski, and A. Hine, *Catastrophic Collapse of the West Florida Carbonate Platform Margin*, Geology, Vol. 14, No. 2, pp. 167–170, 1986.

249. Doyle, L., and C. Holmes, *Shallow Structure, Stratigraphy, and Carbonate Sedimentary Processes of West Florida Upper Continental Slope*, American Association of Petroleum Geologists Bulletin, Vol. 69, pp. 1133–1144, 1985.

250. Twichell, D., P. Valentine, and L. Parson, *Slope Failure of Carbonate Sediment on the West Florida Slope,* in W. Schwab, H. Lee, and D. Twichell, (eds.), Submarine Landslides: Selected Studies in the U.S. Exclusive Economic Zone: U.S. Geological Survey, Bulletin 2002, pp. 69–78, 1993.

251. Holmes, C., *Accretion of the South Florida Platform, Late Quaternary Development*, American Association of Petroleum Geologists Bulletin, Vol. 69, pp. 149–160, 1985.

252. Shi, F., J. Kirby, B. Tehranirad, J. Harris, and S. Grilli, *FUNWAVE-TVD Version 1.1, Fully Nonlinear Boussinesq Wave Model with TVD Solver*, Documentation and User’s Manual, Research Report No. CACR-11-04, Center for Applied Coastal Research, University of Delaware, Newark, 2012.

253. Fulthorpe, C. and A. Melillo *Chapter 12, Middle Miocene Carbonate Gravity Flows in the Straits of Florida* at Site 626, J. Austin, Jr. and W. Schlager (eds.), Proceedings of the Ocean Drilling Program, Scientific Results, Vol. 101, pp. 179–191, 1988.

254. Anselmetti, F., G. Eberli, and Z. Dong Ding, *From the Great Bahama Bank into the Straits of Florida: A Margin Architecture Controlled by Sea Level Fluctuations and Ocean Currents*, Geological Society of America, Bulletin, Vol. 112, pp. 829–844, 2000.

255. Mullins, H., and A. Neumann, *Deep Carbonate Bank Margin Structure and Sedimentation in the Northern Bahamas*, The Society of Economic Paleontologists and Mineralogists, SEPM Special Publication, No. 27, pp. 165–192, 1979.

256. Kuhn, G. and D. Meischner Chapter *14, Quaternary and Pliocene Turbidites in the Bahamas*, Leg 101, Sites 628, 632, and 635, J. Austin, Jr. and W. Schlager (eds.), Proceedings of the Ocean Drilling Program, Scientific Results, Vol. 101, pp. 203–212, 1988.

257. Eberli, G., C. Kendall, P. Moore, G. Whittle, and R. Cannon, *Testing a Seismic Interpretation of Great Bahama Bank with a Computer Simulation*, AAPG Bulletin, Vol. 78, No. 6, pp. 981–1004, 1994.

258. Betzler, C., J. Reijmer, K. Bernet, G. Eberli, and F. Anselmetti, *Sedimentary Patterns and Geometries of the Bahamian Outer Carbonate Ramp (Miocene-Lower Pliocene, Great Bahama Bank)*, Sedimentology, Vol. 46, pp. 1127–1143, 1999.

259. Betzler, C., M. Pfeiffer, and S. Saxena, *Carbonate Shedding and Sedimentry Cyclicities of a Distally Steepened Carbonate Ramp (Miocene, Great Bahama Bank)*, International Journal of Earth Science, Vol. 89, pp. 140–153, 2000.

260. Mulder, T., E. Ducassou, G. Eberli, V. Hanquiez, E. Gonthier, P. Kindler, M. Principaud, F. Fournier, P. Léonide, I. Billeaud, B. Marsset, J. Reijmer, C. Bondu, R. Joussiaume, and M. Pakiades, *New Insights into the Morphology and Sedimentary Processes Along the Western Slope of Great Bahama Bank*, Geology, Vol. 40, No. 7, pp. 603–606, July 2012.

261. Eberli, G., and T. Mulder, *Geometry and Initiation of Large Slope Failure Along Little and Great Bahama Bank*, in the Research Program Prospectus of the Comparative Sedimentology Laboratory, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 2011.

262. Correa, T., M. Grasmueck, G. Eberli, J. Reed, K. Verwer, and S. Purkis, *Variability of Cold-Water Coral Mounds in a High Sediment Input and Tidal Current Regime*, *Straits of Florida*, Sedimentology 59, pp. 1278–1304, 2012.

263. Wilber, R., J. Milliman, and R. Halley, *Accumulation of Bank-Top Sediment on the Western Slope of Great Bahama Bank: Rapid Progradation of a Carbonate Megabank*, Geology, Vol. 18, pp. 970–974, 1990.

264. Eberli, G., P. Swart, M. Malone, et al., *Proceedings of the Ocean Drilling Program*, Initial Reports, 166. 1997. Available at http://www-odp.tamu.edu/publications/166IR/166TOC.HTM, accessed January 8, 2013.

265. Austin, J., J. Ewing, J. Ladd, H. Mullins, and R. Sheridan, *Seismic Stratigraphic Implications of ODP Leg 101 Site Surveys*, J. Austin, Jr., W. Schlager et al. (eds.), Proceedings of the Ocean Drilling Program, Scientific Results, Vol. 101, pp. 391–424, 1988.

266. Swart, P., G. Eberli, M. Malone, et al., *Proceedings of the Ocean Drilling Program*, Scientific Results, Bahamas Transect, Ocean Drilling Program, Vol. 166, 2000.

267. Grasmueck, M., G. Eberli, T. Correa, D. Viggiano, J. Luo, G. Wyatt, J. Reed, A. Wright, and S. Pomponi, *AUV-Based Environmental Characterization of Deep-Water Coral Mounds in the Straits of Florida*, Presented at the 2007 Offshore Technology Conference, Houston, Texas, April 30–May 3, 2007.

268. Freile, D, and J. Milliman, *Sedimentary Facies of Western Great Bahama Bank: Bank-Edge Margin to Slope Transition*, Proceedings of the 9th Symposium on the Geology of the Bahamas and Other Carbonate Regions, H. Curran and J. Mylroie, (eds.), Bahamian Field Station, Ltd. San Salvador, Bahamas, pp. 36–57, 1999.

Table 2.4.6-201
Characteristics of Landslides on the U.S. Atlantic Margin

Dimension	Minimum	Maximum	Mean	Median
Area (square kilometer)	9	15,241	1,880	424
Length (kilometer)	2.7	>291	85	51
Width (kilometer)	2.1	151	21	12
Source Depth (meter)	92	3,263	1,630	1,785
Toe Depth (meter)	2,126	4,735	3,101	2,991
Scarp Height (meter)	3	410	90	63

Source: Reference 202

Table 2.4.6-202 (Sheet 1 of 2)
Summary of Historical Tsunami Run-Up Events in the East Coast of U.S.

Date[(a)]	Time (Hours)	Validity Code[(b)]	Cause Code[(c)]	Source Location (latitude, longitude)	Run-Up Location Along U.S. East Coast (lat, long)	Run-Up Type[(d)]	Run-Up Height (meters)
11/01/1755	08:50	4	1	Lisbon, Portugal (36.0°N 11.0°W)	—[(e)]	—	—
09/24/1848		3	8	Fishing Ships Harbor, Newfoundland, Canada (52.616°N 55.766°W)	—	—	—
06/27/1864	22:30	3	1	SW Avalon Peninsula, Newfoundland, Canada (46.5°N 53.7°W)	—	—	—
09/01/1886	02:51	4	1	Charleston, SC (32.9°N 80.0°W)	Jacksonville, FL (30.317°N 81.65°W) Mayport, FL (30.39°N 81.43°W) Copper River, SC (32.87°N 79.93°W)	1 1 1	—
09/01/1895	11:09	3	1	High Bridge, NJ (40.667°N 74.883°W)	Long Island, NY (40.591°N 73.796°W)	1	—
10/11/1918	14:14	4	1	Puerto Rico, Mona Passage (18.5°N 67.5°W)	Atlantic City, NJ (39.364°N 74.423°W)	2	0.06
11/18/1929	20:32	4	3	Grand Banks[(f)], Newfoundland, Canada (44.69°N 56.0°W)	Ocean City, MD (38.333°N 75.083°W) Atlantic City, NJ (39.35°N 74.417°W) Charleston, SC (32.75°N 79.916°W)	2 2 2	0.30 0.68 0.12
08/04/1946	17:51	4	1	Northeastern Cost, Dominican Republic (19.3°N 68.9°W)	Daytona Beach, FL (29.20°N 81.017°W) Atlantic City, NJ (39.364°N 74.423°W)	2 2	—
08/08/1946	13:28	4	1	Northeastern Cost, Dominican Republic (19.71°N 69.51°W)	Daytona Beach, FL (29.21°N 81.02°W) Atlantic City, NJ (39.364°N 74.423°W)	2 2	—
05/19/1964	00:00	3	8	Long Island, NY[(f)] (40.8°N 73.10°W)	Montauk, NY (41.033°N 71.950°W) Plum Island, NY (41.181°N 72.194°W) Willetts Point, NY (40.683°N 73.283°W) Newport, RI (41.493°N 71.327°W)	2 2 2 2	0.10 0.28 0.10 0.10
12/26/2004	00:58	4	1	Off Sumatra, Indonesia (3.295°N 95.982°E)	Trident Pier, FL (28.415°N 80.593°W) Atlantic City, NJ (39.35°N 74.417°W) Cape May, NJ (38.97°N 74.96°W)	2 2 2	0.17 0.11 0.06

Table 2.4.6-202 (Sheet 2 of 2)
Summary of Historical Tsunami Run-Up Events in the East Coast of U.S.

(a) Date and time given in Universal Coordinated Time (also known as Greenwich Mean Time).
(b) Tsunami event validity:
Valid values: 0 to 4
Validity of the actual tsunami occurrence is indicated by a numerical rating of the reports of that event:
0 = Erroneous entry
1 = Very doubtful tsunami
2 = Questionable tsunami
3 = Probable tsunami
4 = Definite tsunami
(c) Tsunami cause code:
Valid values: 0 to 11
The source of the tsunami:
0 = Unknown cause
1 = Earthquake
2 = Questionable earthquake
3 = Earthquake and landslide
4 = Volcano and earthquake
5 = Volcano, earthquake, and landslide
6 = Volcano
7 = Volcano and landslide
8 = Landslide
9 = Meteorological
10 = Explosion
11 = Astronomical tide
(d) Type of run-up measurement:
Valid values: 1 to 7
1 = Water height measurement
2 = Tide-gage measurement
3 = Deep ocean gage
4 = Paleodeposit
5 = Computer modeled
6 = Atmospheric pressure wave
7 = Seiche
(e) Data not available
(f) Only locations with measured run-up values are presented

Source: Reference 214

Table 2.4.6-203
Grid Resolution and Sizes of the Subdomains

	Grid Resolution (m)	Grid Spacing along M[(a)] Axis (m)	Grid Spacing along N(a) Axis (m)
SITE	450 - 540	260 – 410	620 – 800
ISLANDS	1,240 – 3,710	970 – 3,010	950 – 7,050
DEEP	3,120 – 22,320	1,850 – 24,080	2,630 – 27,340

(a) M and N are the principal axes of the model curvilinear grid system

Table 2.4.6-204
Horizontal and Vertical Resolutions of Depth Data

	Biscayne Bay Sounding	LiDAR	Coastal Relief	ETOPO1
Horizontal Resolution	30 m	0.1 m[(a)]	3 arc-seconds (90 m)	1 arc-minute (1,800 m)
Vertical Resolution	0.01 m	0.01 m	1 m for land 0.1 m for sea	1 m

(a) ~ 1 meter resolution for about 10 percent of the data

Table 2.4.6-205
Nested Grids in FUNWAVE-TVD for Cape Fear Tsunami

	Coordinates of SW Corner		Grid Spacing (Δx = Δy)	Number of Grid Cells
	x	**y**		
Grid	**degrees**	**degrees**	**seconds**	**cells**
A	-82.0	23.0	60	780 x 900
B	-80.75	23.0	15	480 x 1260
C	-80.517	25.322	3	592 x 768

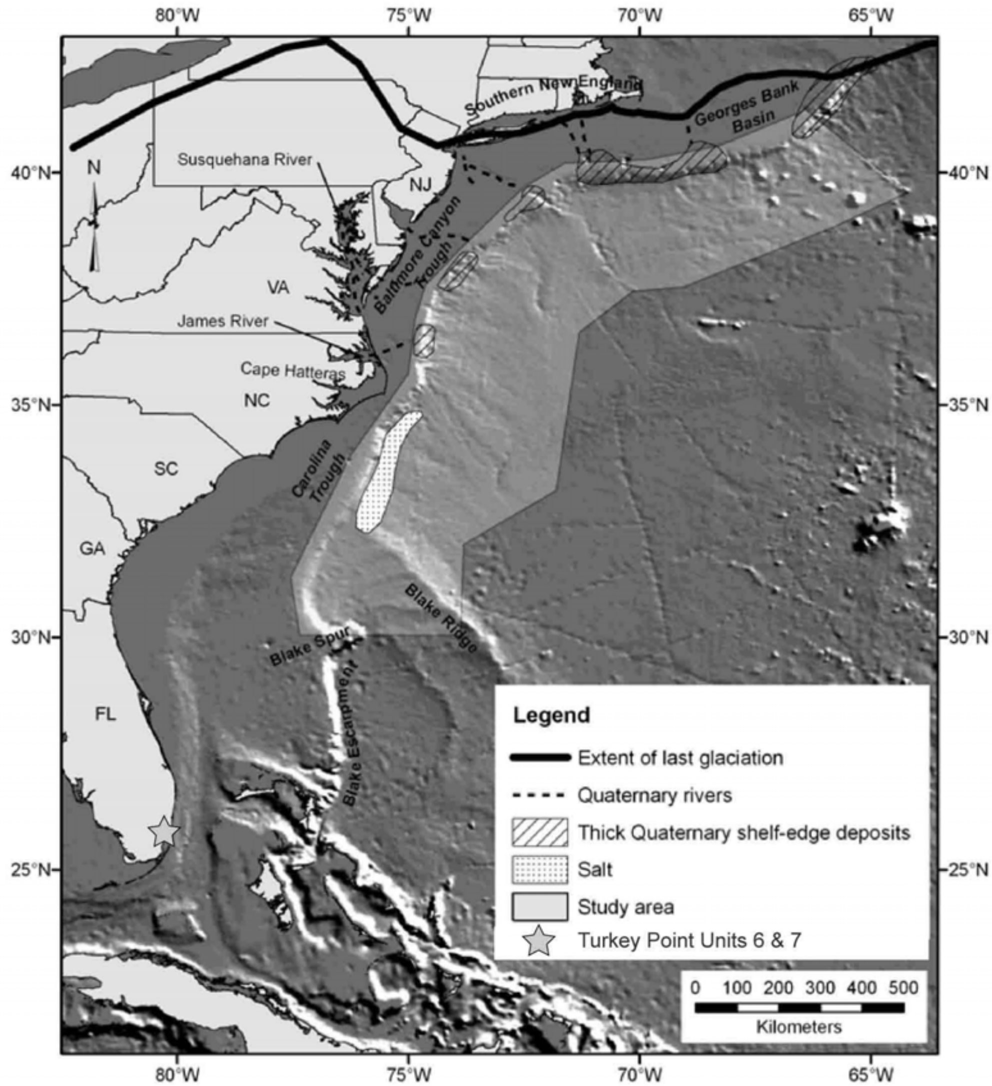
Table 2.4.6-206
Nested Grids in FUNWAVE-TVD for Florida Escarpment Tsunami

	Coordinates of SW Corner		Grid Spacing (Δx = Δy)	Number of Grid Cells
	x	**y**		
Grid	**degrees**	**degrees**	**seconds**	**cells**
A	-89.0	22.0	60	780 x 420
B	-80.75	23.0	15	480 x 1260
C	-80.517	25.156	3	592 x 768

Table 2.4.6-207
Nested Grids in FUNWAVE-TVD for Great Bahama Bank Tsunami

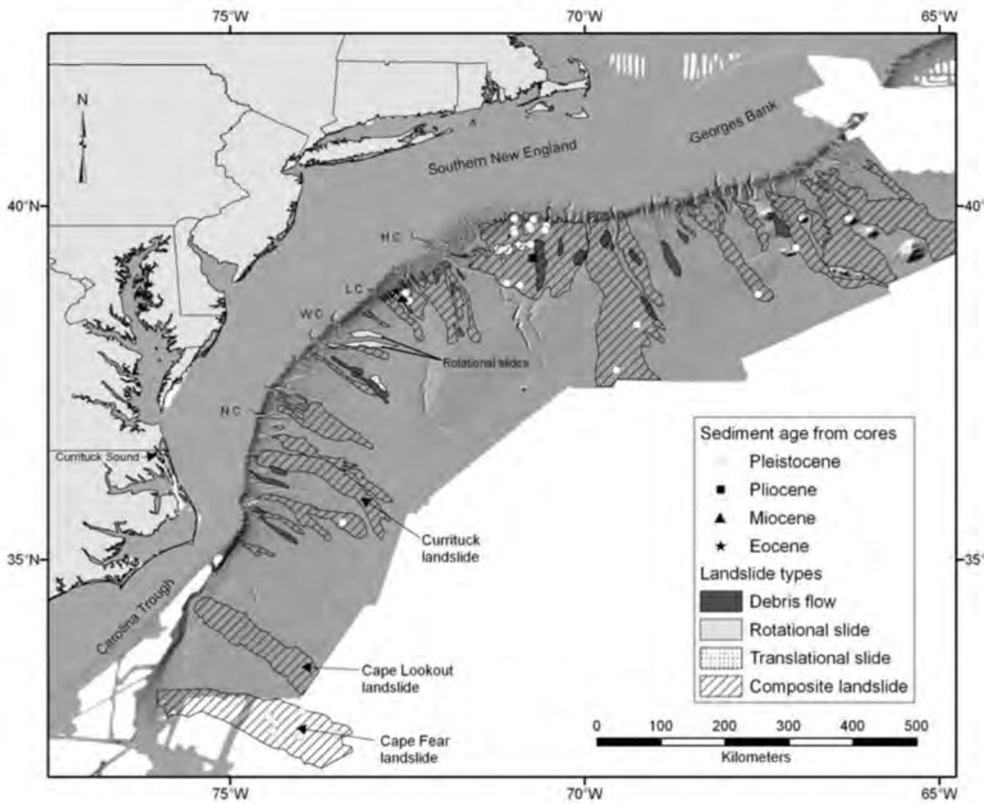
	Coordinates of SW Corner		Grid Spacing (Δx = Δy)	Number of Grid Cells
	x	**y**		
Grid	**degrees**	**degrees**	**seconds**	**cells**
B	-80.75	23.0	15	480 x 1260
C	-80.517	25.156	3	592 x 768

Figure 2.4.6-201 Location Map Showing the Extent of the AGMTHAG Study Area and Geologic Features That May Influence Landslide Distribution Along the U.S. Atlantic Margin



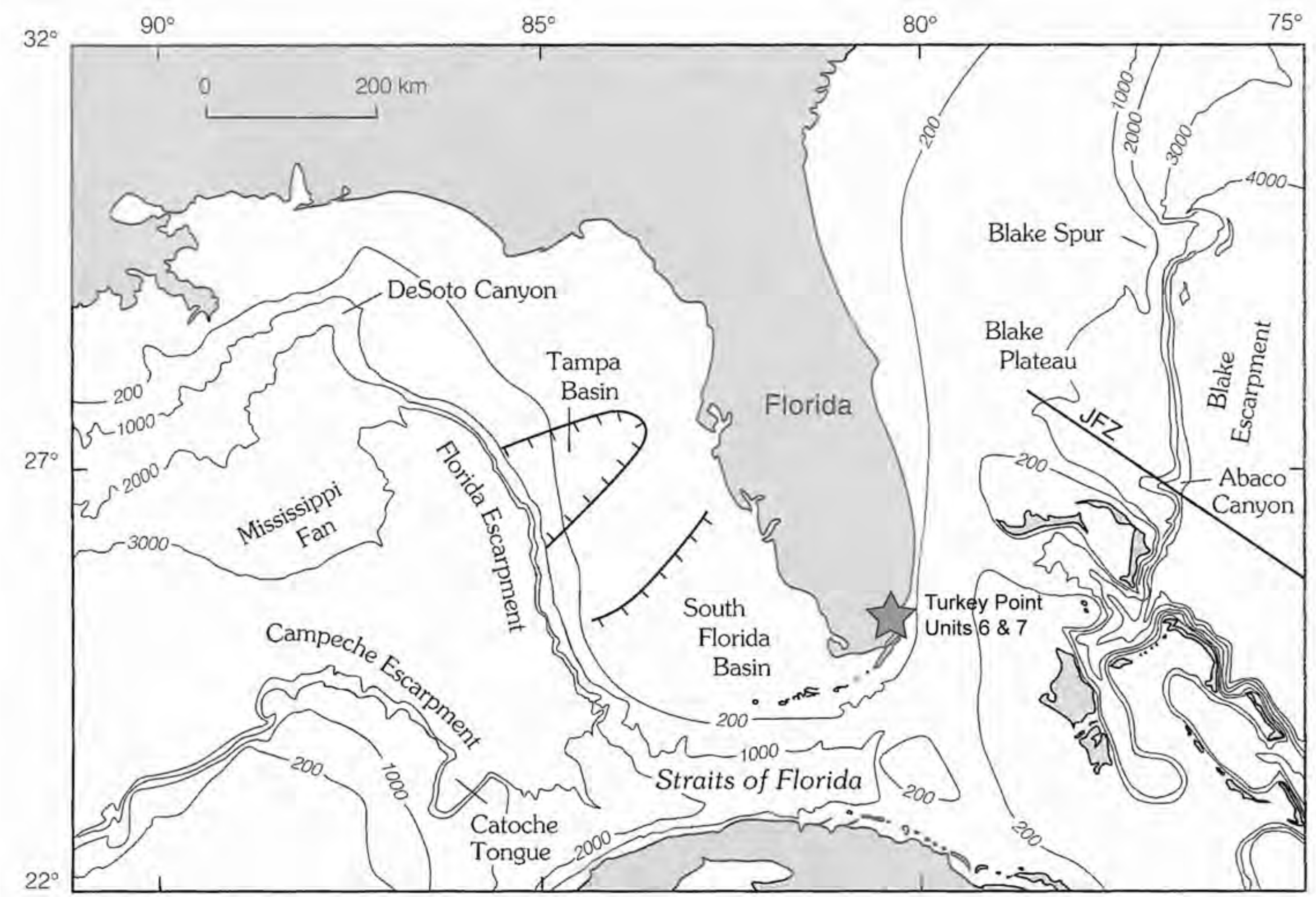
Modified from Reference 202

Figure 2.4.6-202 Distribution of Different Landslide Types Along the U.S. Atlantic Margin



Notes: HC = Hudson Canyon; LC = Lindenkohl Canyon; WC = Wilmington Canyon; NC = Norfolk Canyon
Source: Reference 202

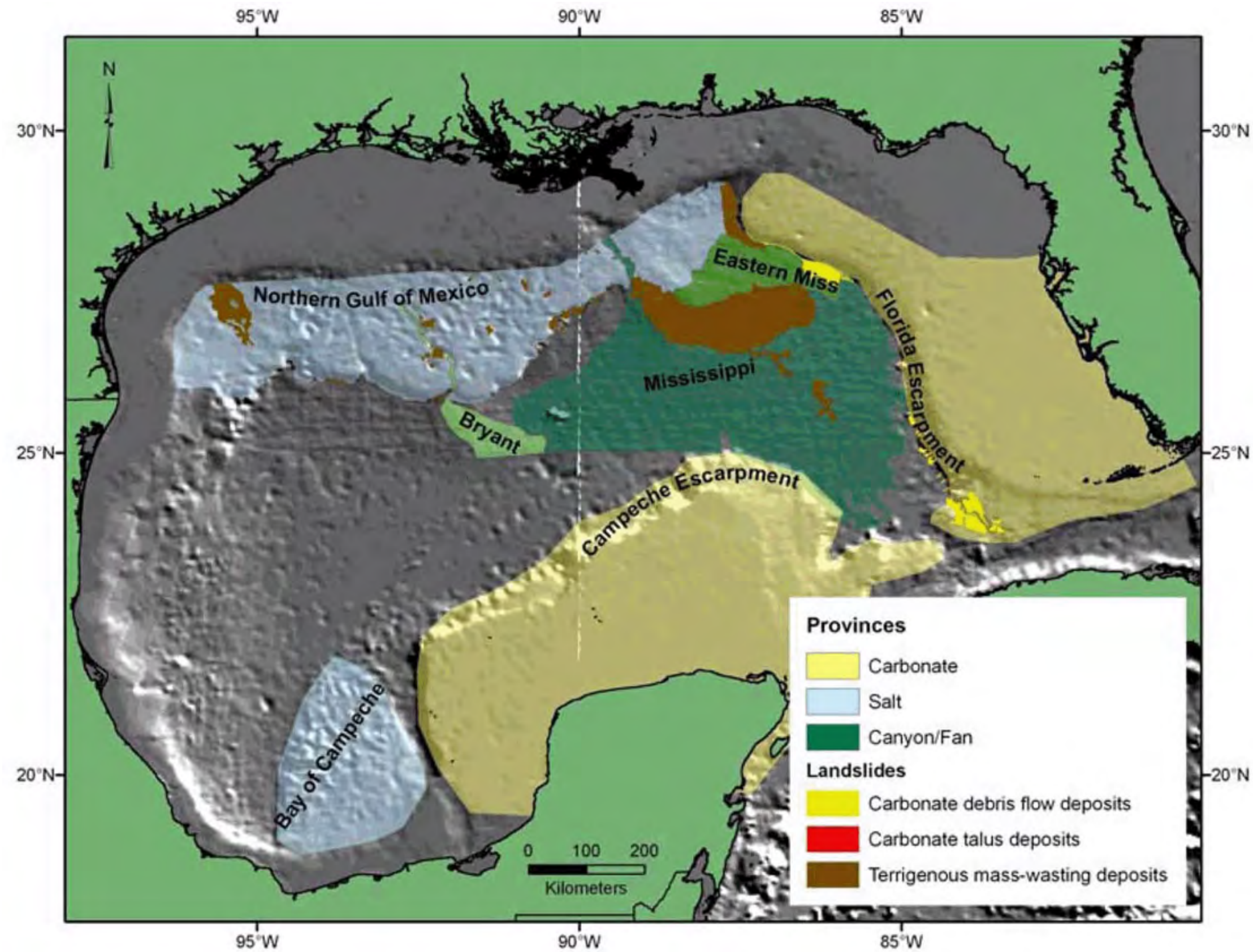
Figure 2.4.6-203 Location of Blake Escarpment Offshore of the Florida Coast



JFZ = Jacksonville fracture zone from Klitgord and Schouten (1986)

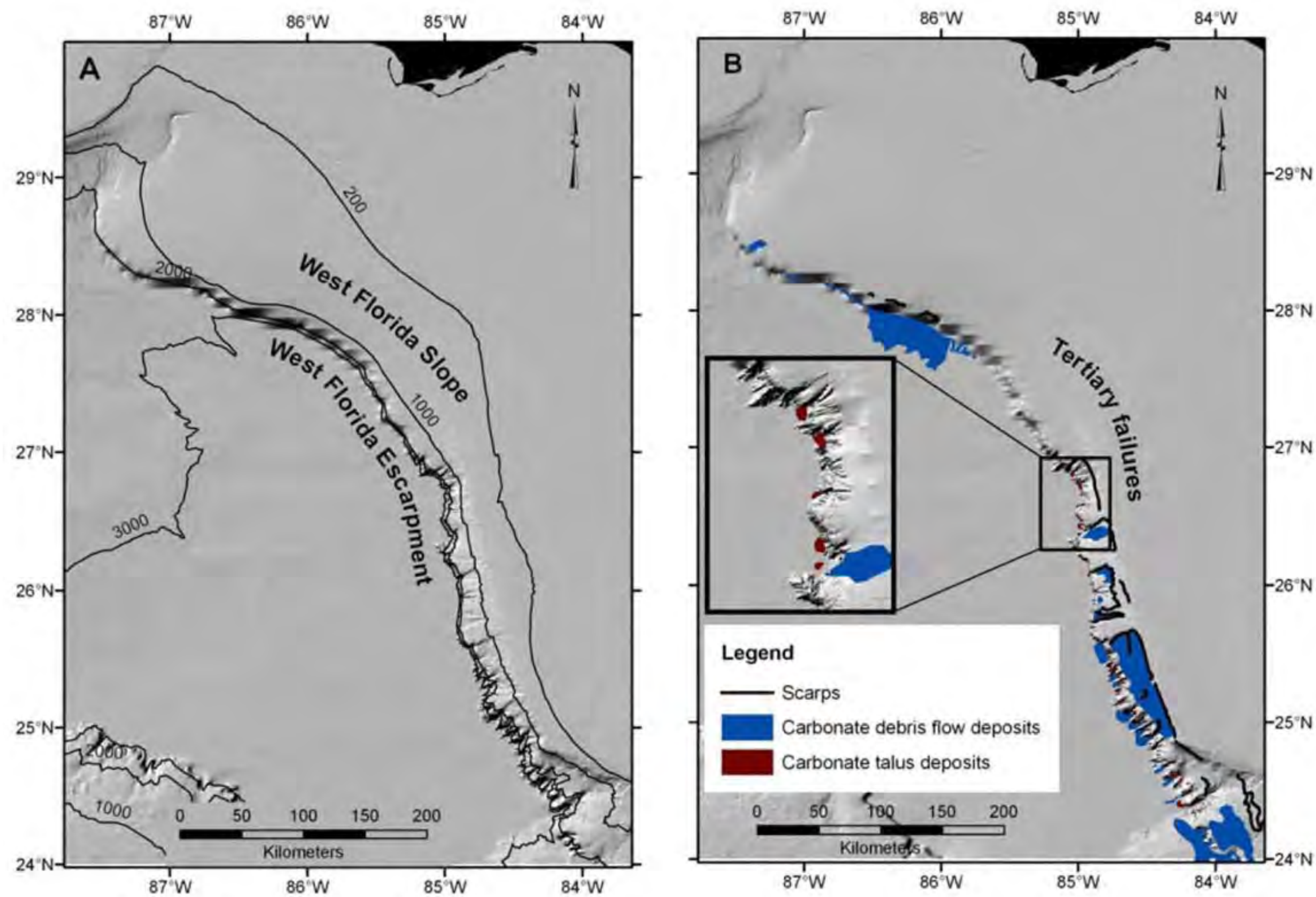
Note: Depth contours are in meters.
Modified from Reference 203

Figure 2.4.6-204 Location Map Showing the Extent of the Physiographic Features in the Gulf of Mexico Basin



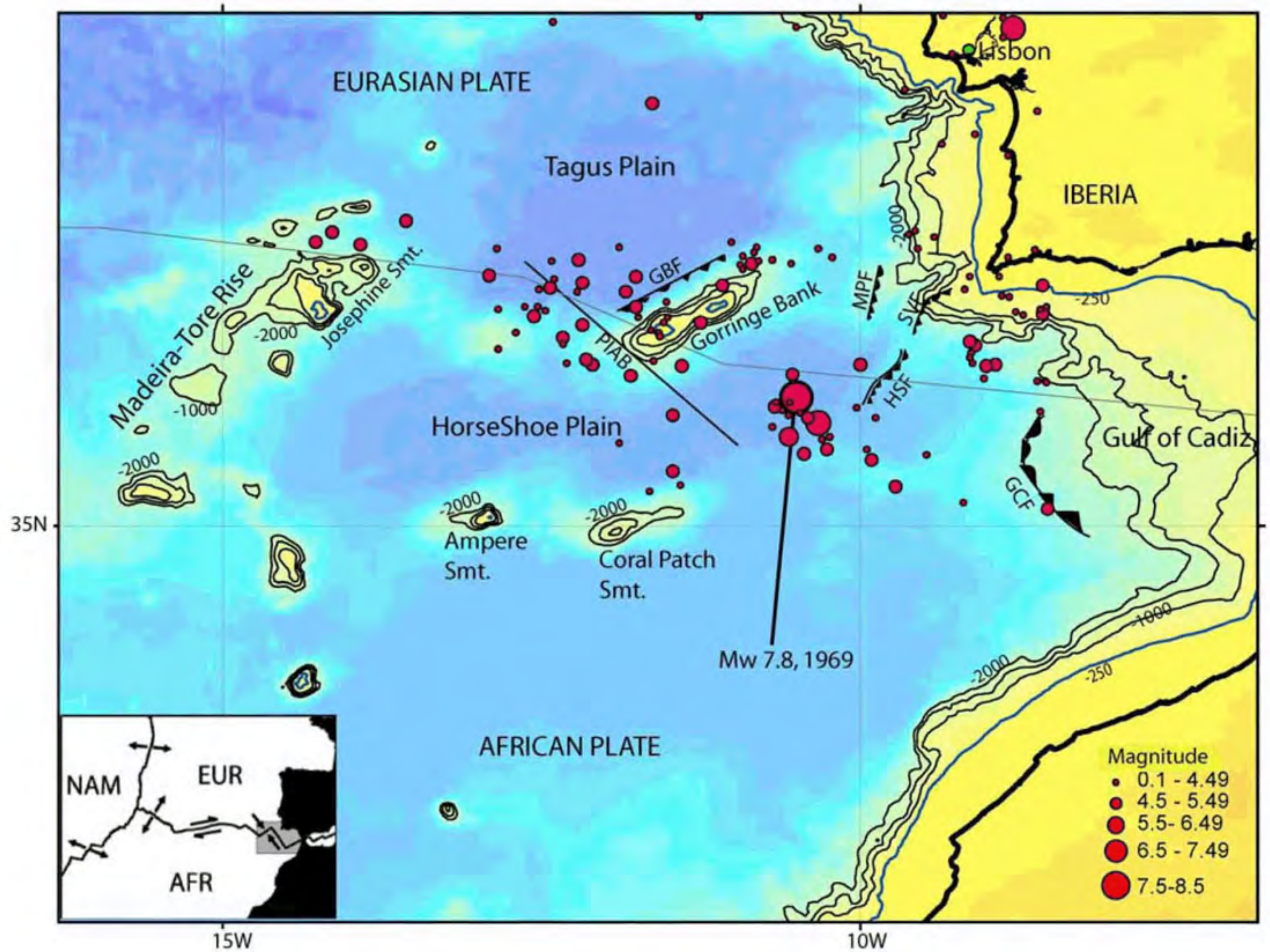
Source: Reference 202

Figure 2.4.6-205 (A) Morphology of the Florida Escarpment and the West Florida Slope, and (B) the Extent and Distribution of Carbonate Debris Flow Deposits and Talus Deposits



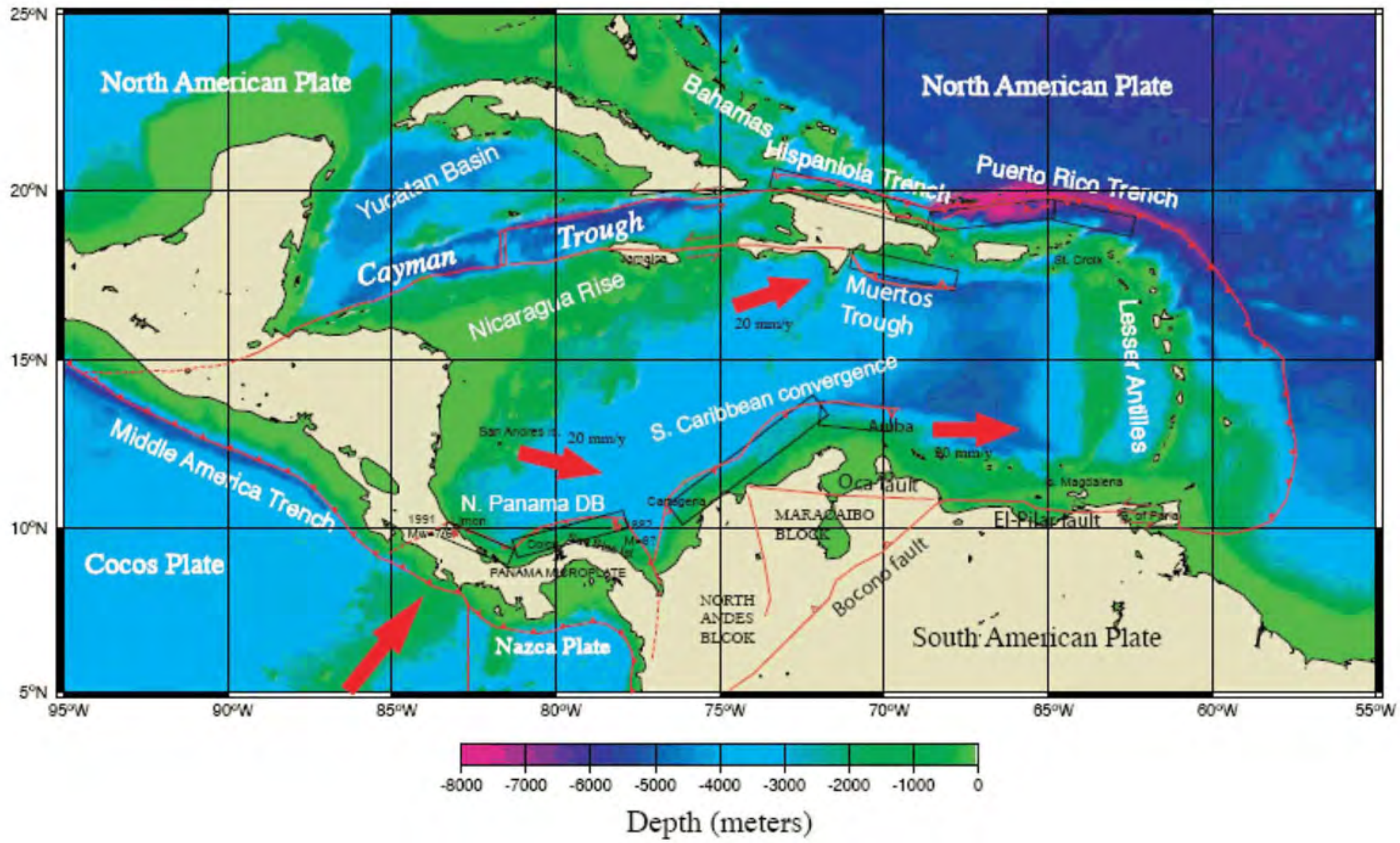
Note: Depth contours are in meters.
Modified from Reference 202

Figure 2.4.6-206 Plate Tectonic Setting and Bathymetry of the Eastern Azores-Gibraltar Region



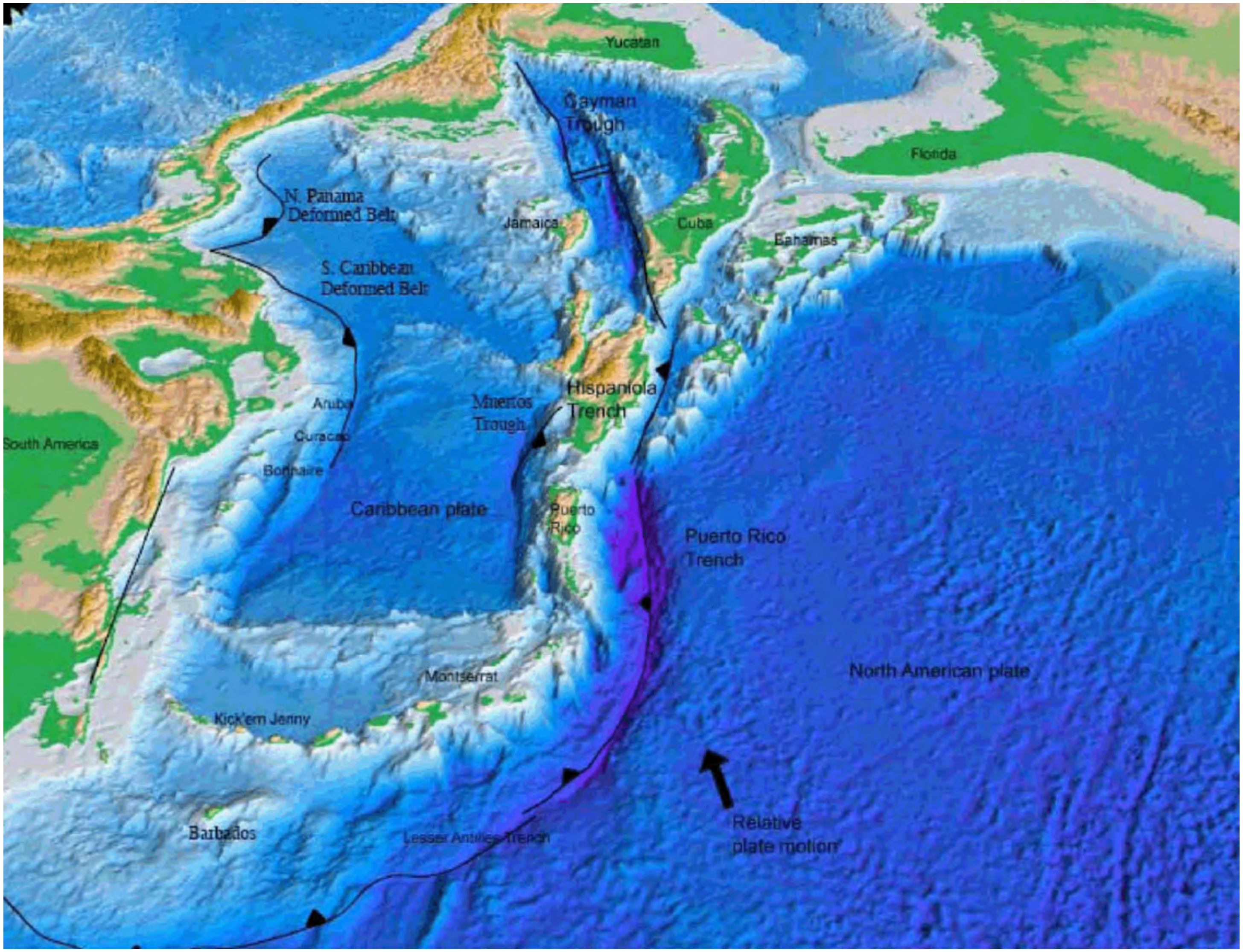
Note: Barbed lines show faults proposed in various past studies, GBF — Gorringe Bank Fault; MPF —- Marqués de Pombal Fault; SVF — St. Vicente Fault; HSF — Horseshoe Fault; GCF — Gulf of Cádiz Fault; PIAB - Paleo Iberia-Africa Plate Boundary. Inset plates: NAM - North American Plate; EUR — Eurasian Plate; AFR — African Plate. Depth contours are in meters (only contours from –250 to –2000 meters are shown).
Source: Reference 202

Figure 2.4.6-207 The Caribbean Plate Boundary and its Tectonic Elements



Note: Red lines are plate boundaries and red arrows indicate relative plate movement
Source: Reference 202

Figure 2.4.6-208 Perspective (Schematic) View of the Tectonic Elements in the Caribbean Plate and Seafloor Topography



Source: Reference 202

Figure 2.4.6-209 Geophysical Setting and Seafloor Topography East of Southeast U.S. Coast and North of the Caribbean

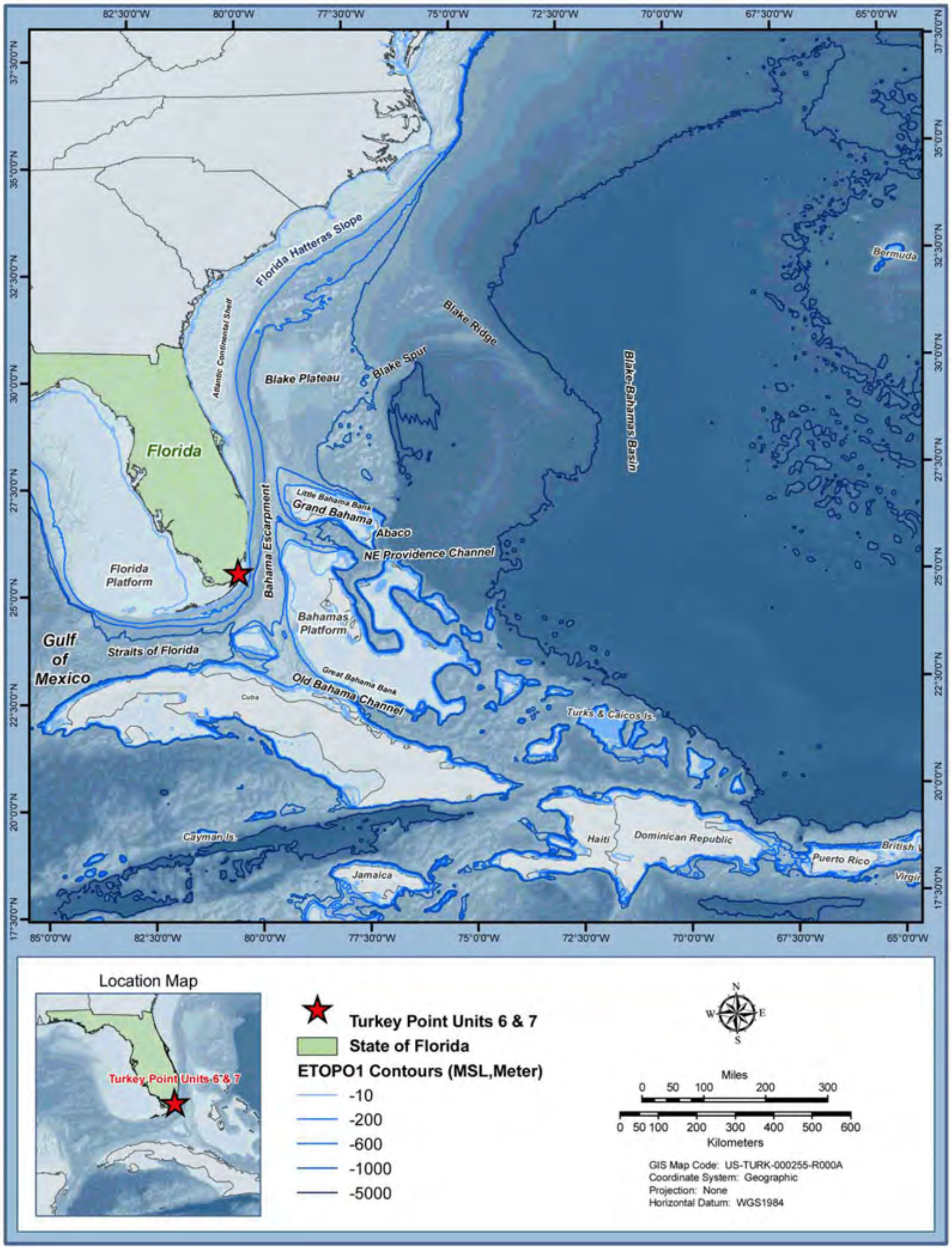


Figure 2.4.6-210 Extent of Selected Tsunami Model Domain and Subdomains SITE, ISLANDS, and DEEP

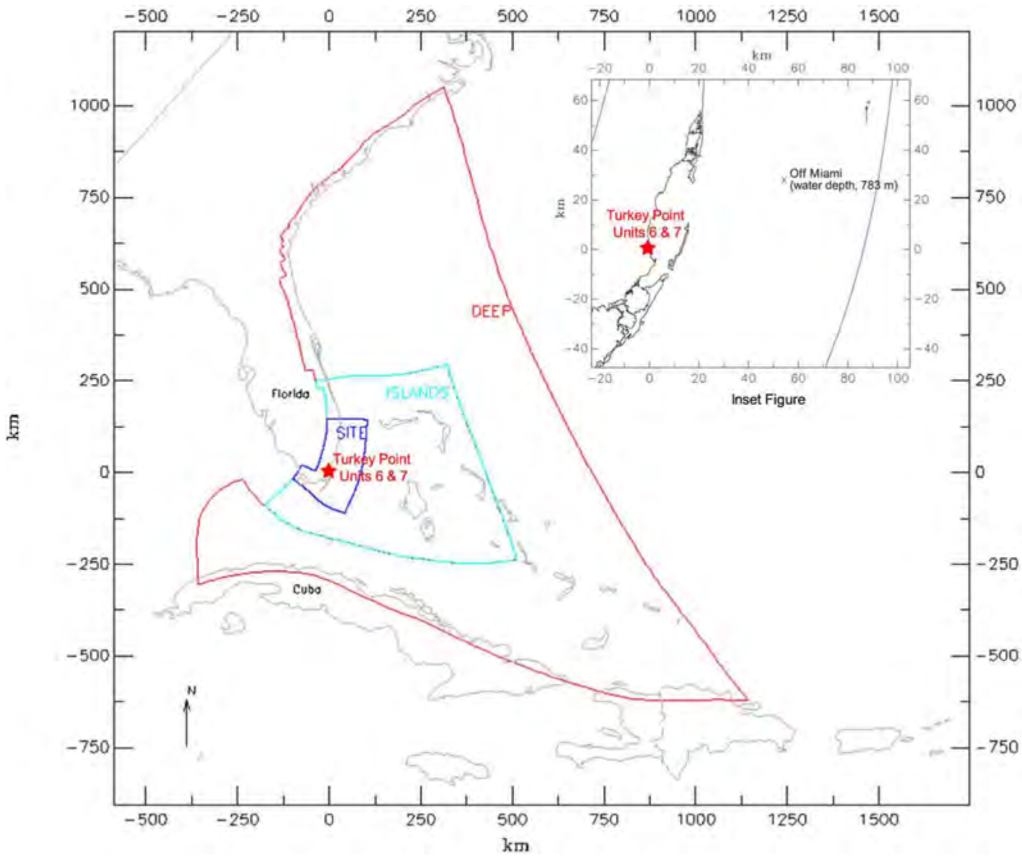


Figure 2.4.6-211 Model Grids of the DEEP Subdomain

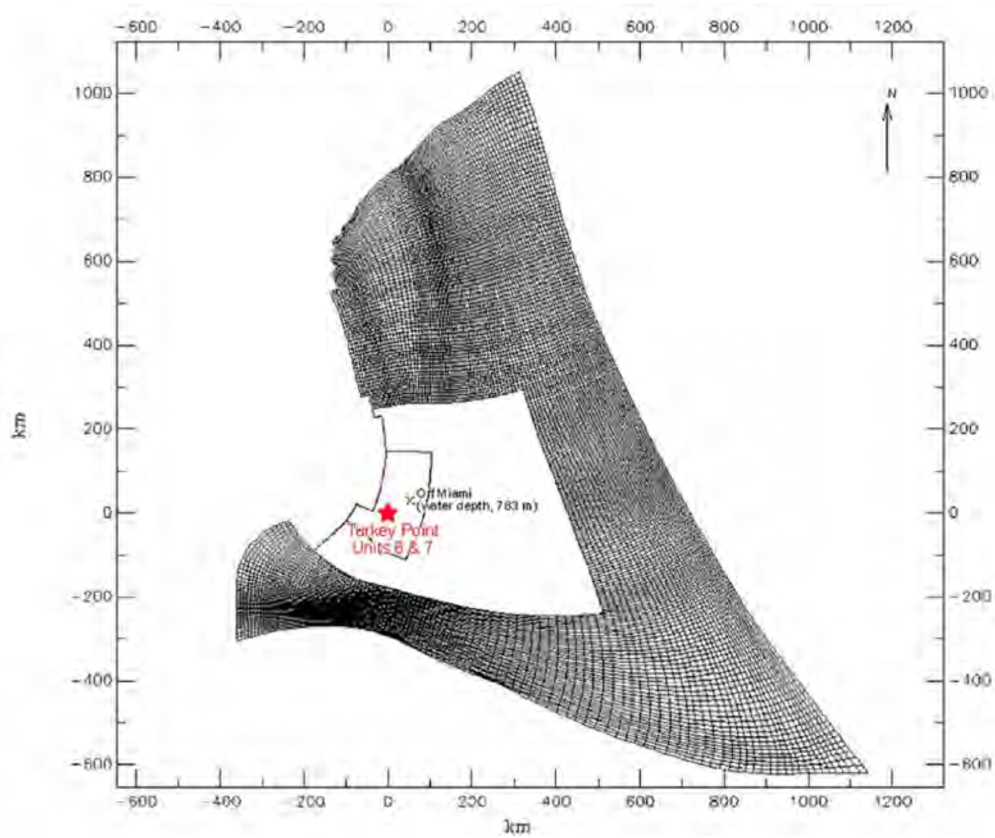


Figure 2.4.6-212 Model Grids of the ISLANDS Subdomain

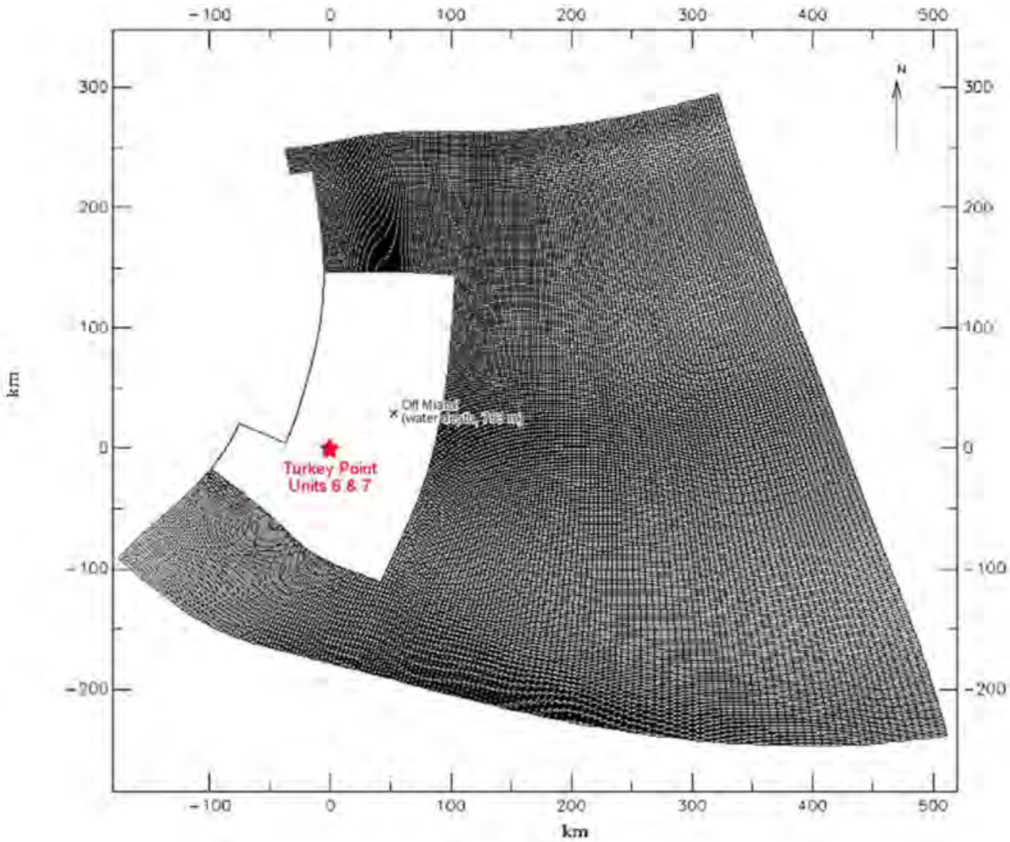


Figure 2.4.6-213 Model Grids of the SITE Subdomain near Units 6 & 7

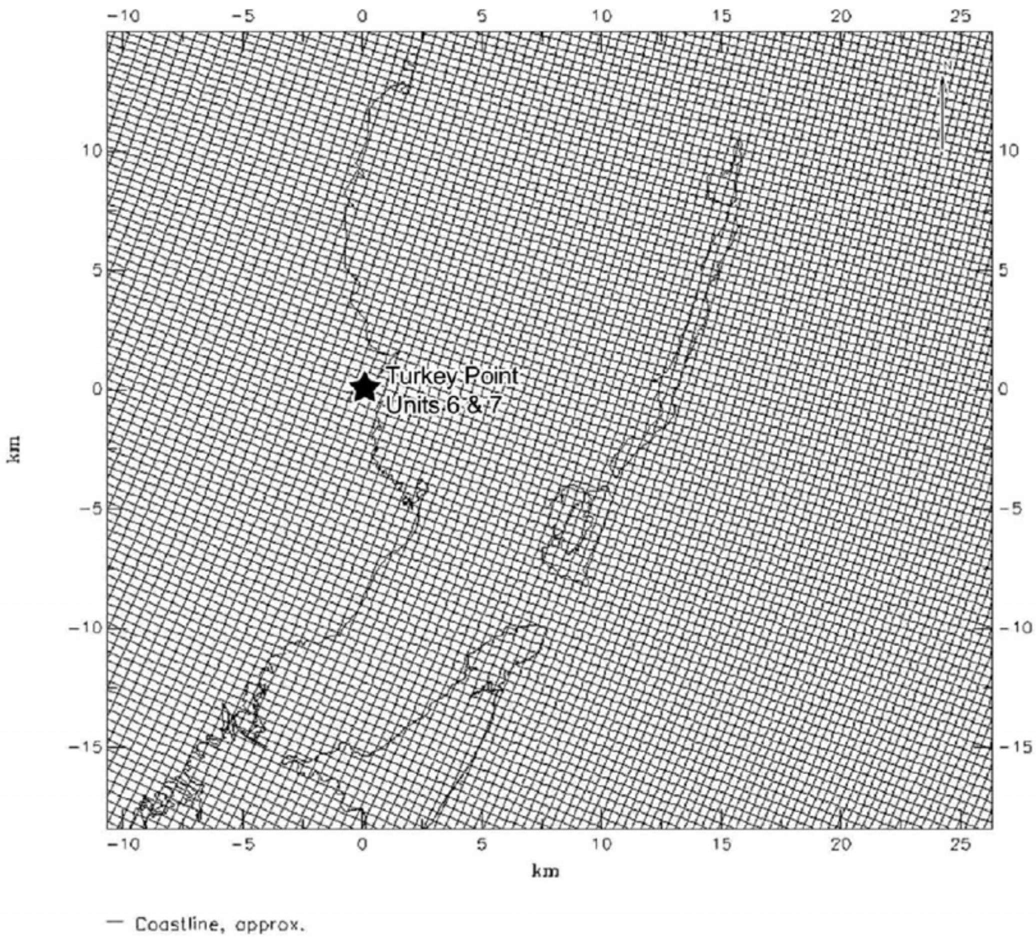
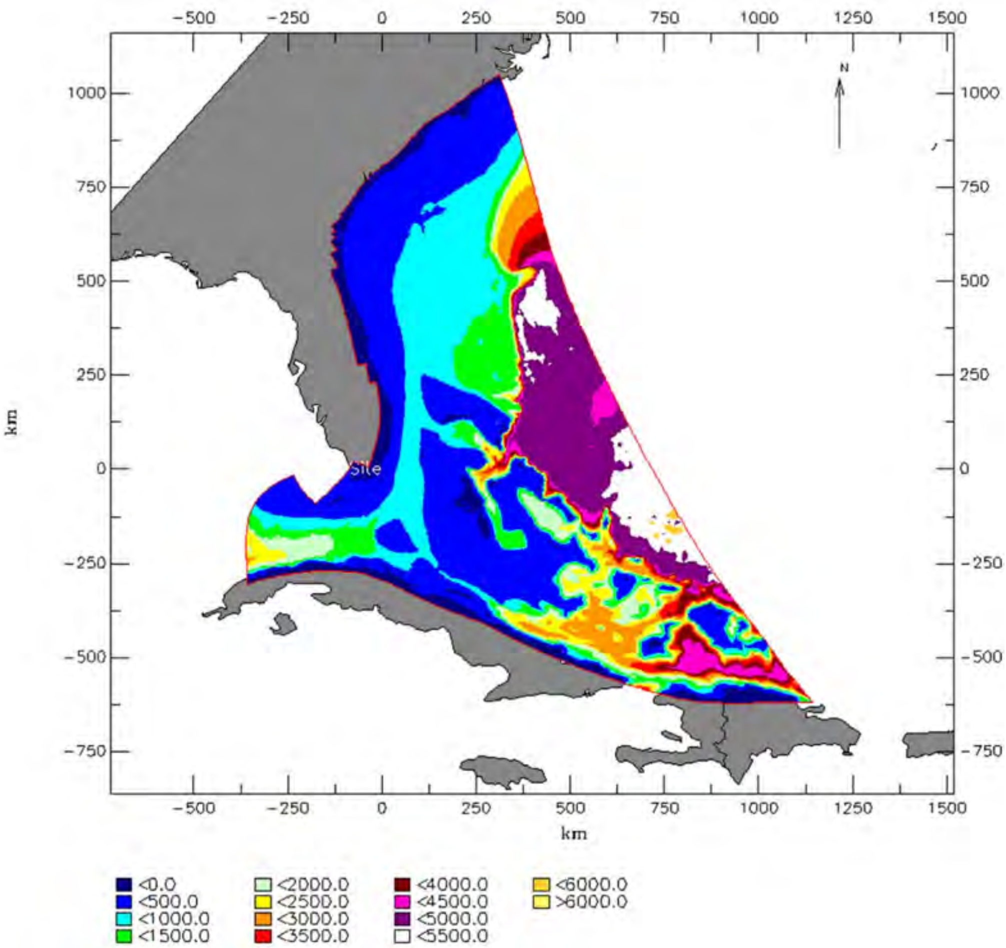
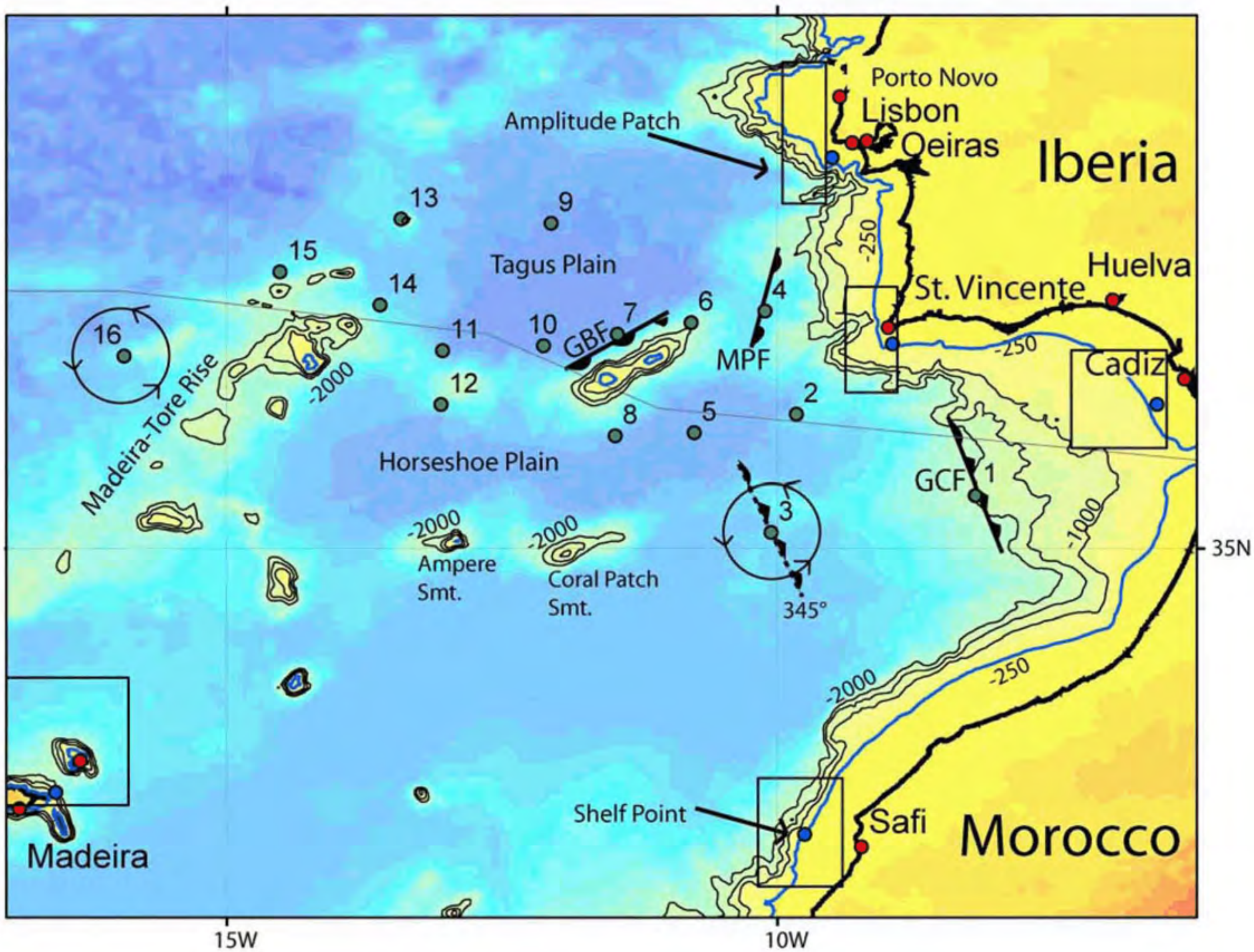


Figure 2.4.6-214 Contours of Model Bathymetry



Note: Depths to the seabed are in meters relative to MSL

Figure 2.4.6-215 Postulated Epicenter Locations for the 1755 Lisbon Earthquake by AGMTHAG



Note: Fault orientation for source locations 3 and 16 were rotated 360° at 15° to test the optimal str ke angle generating maximum tsunami amplitude in the Caribbean.
Depth contours are in meters.
Source: Reference 202

Figure 2.4.6-216 Input Tsunami Marigrams at the Model Open Boundary for Conditions with Single Wave, Continuous Wave Train, and Two Consecutive Waves

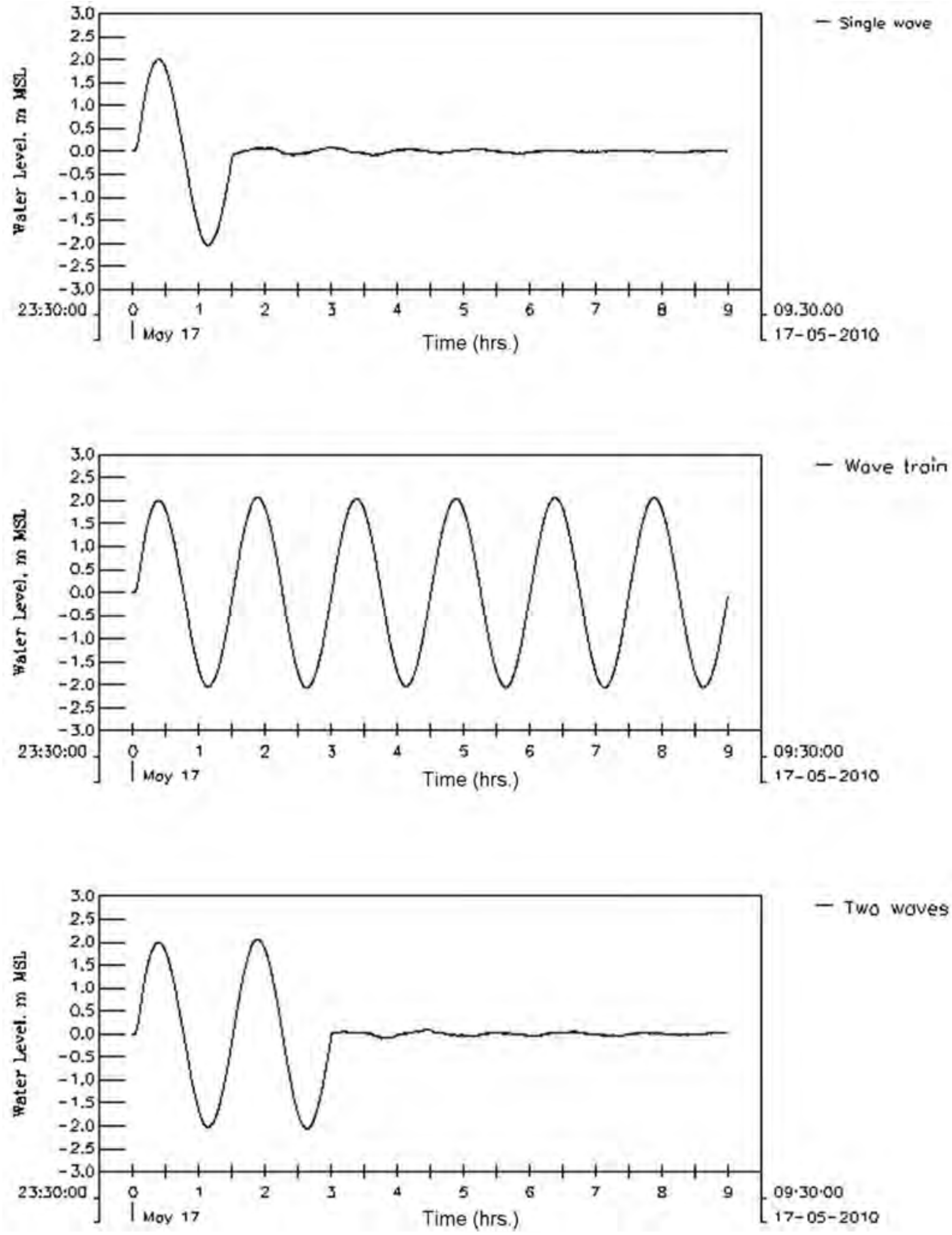
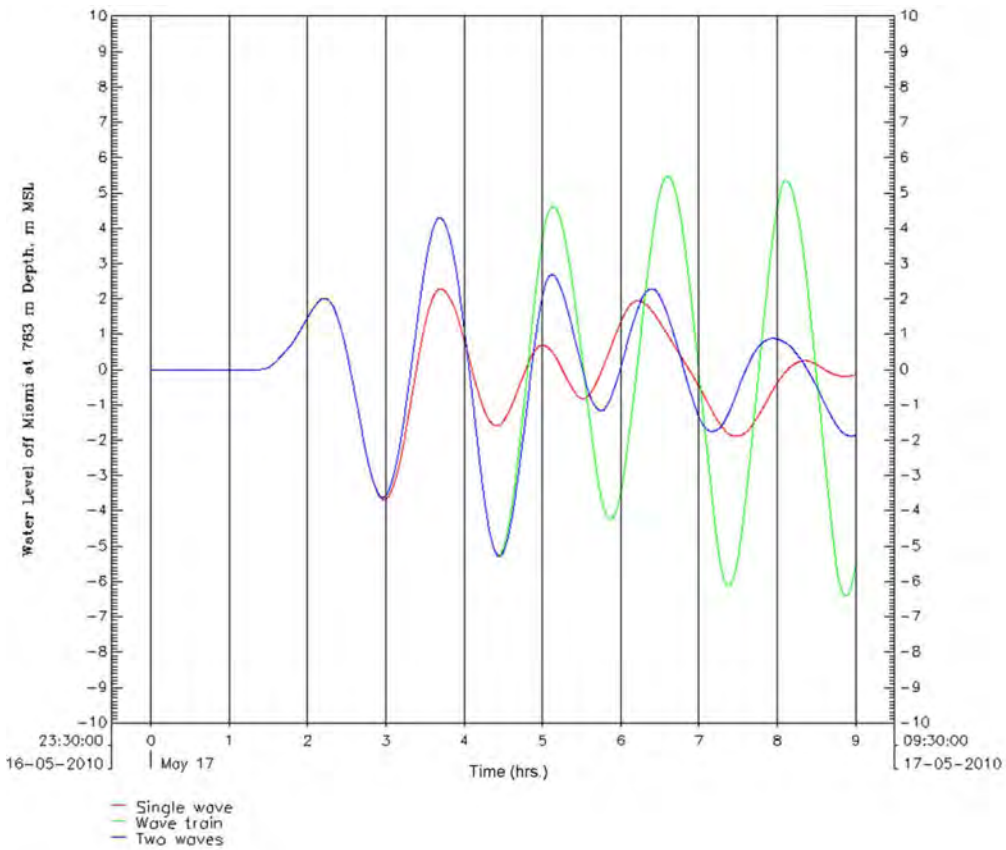
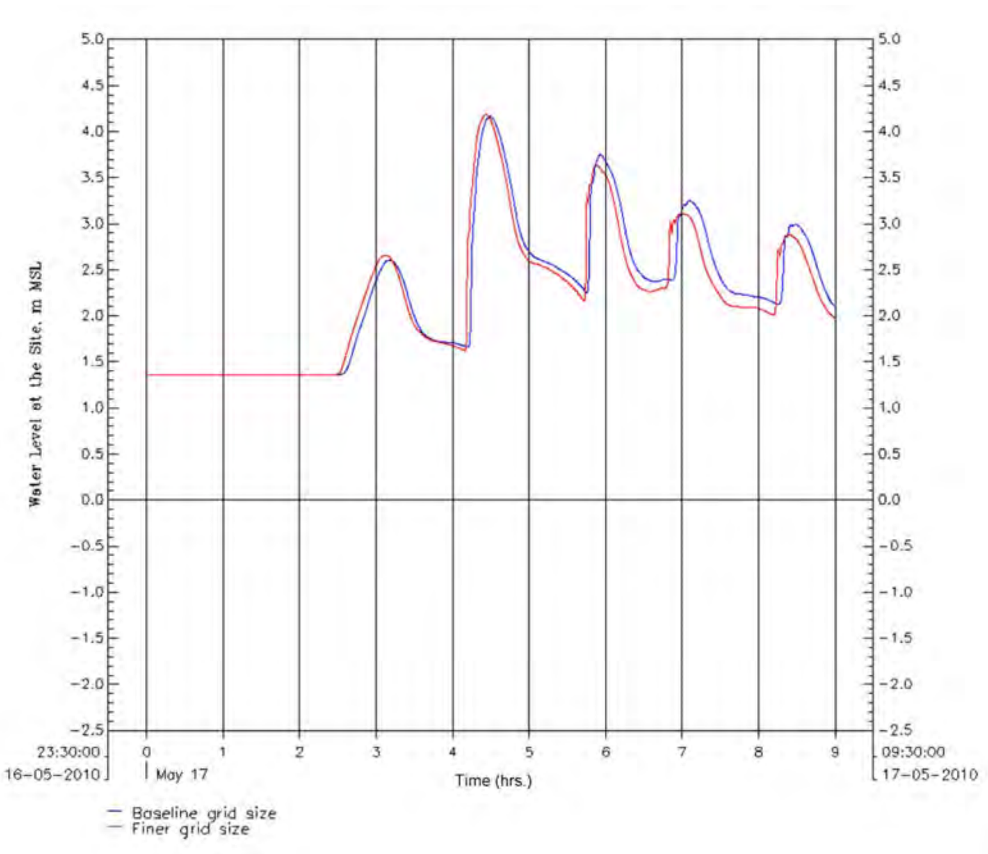


Figure 2.4.6-217 Simulated Tsunami Marigrams at 783 meters (2569 feet) Water Depth off Miami, Florida



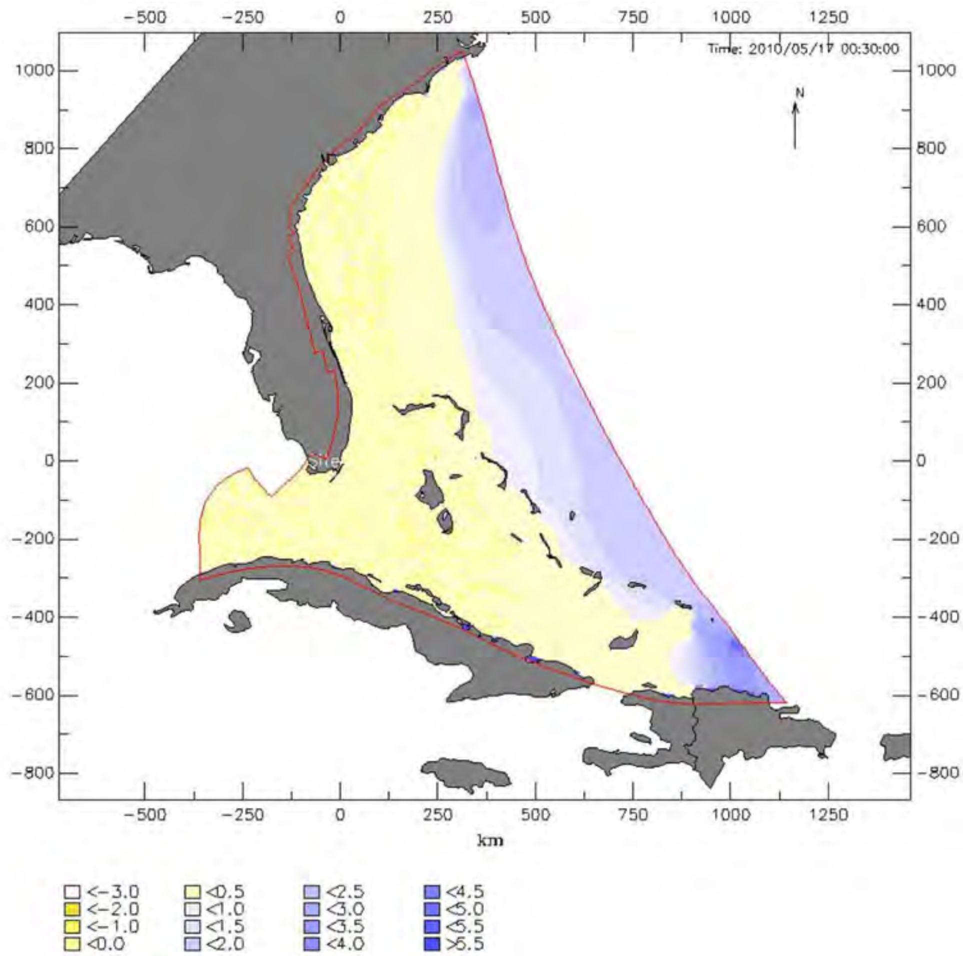
Note: Initial water level at MSL.

Figure 2.4.6-218 Simulated Tsunami Water Levels at the Units 6 & 7 Site for the Selected (Baseline) and Finer Grid Sizes



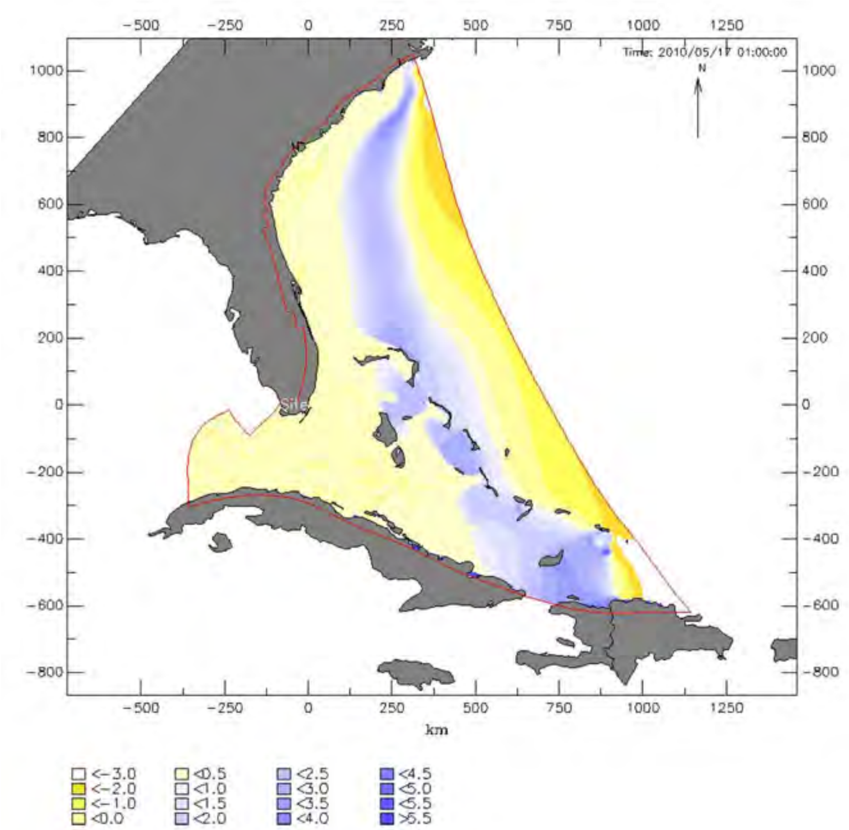
Note: Initial water level at 1.36 meters (4.46 feet) MSL.

Figure 2.4.6-219a Tsunami Water Level Contours 30 Minutes into the Model Simulation (with Manning's n of 0.02 and non-reflective boundaries)



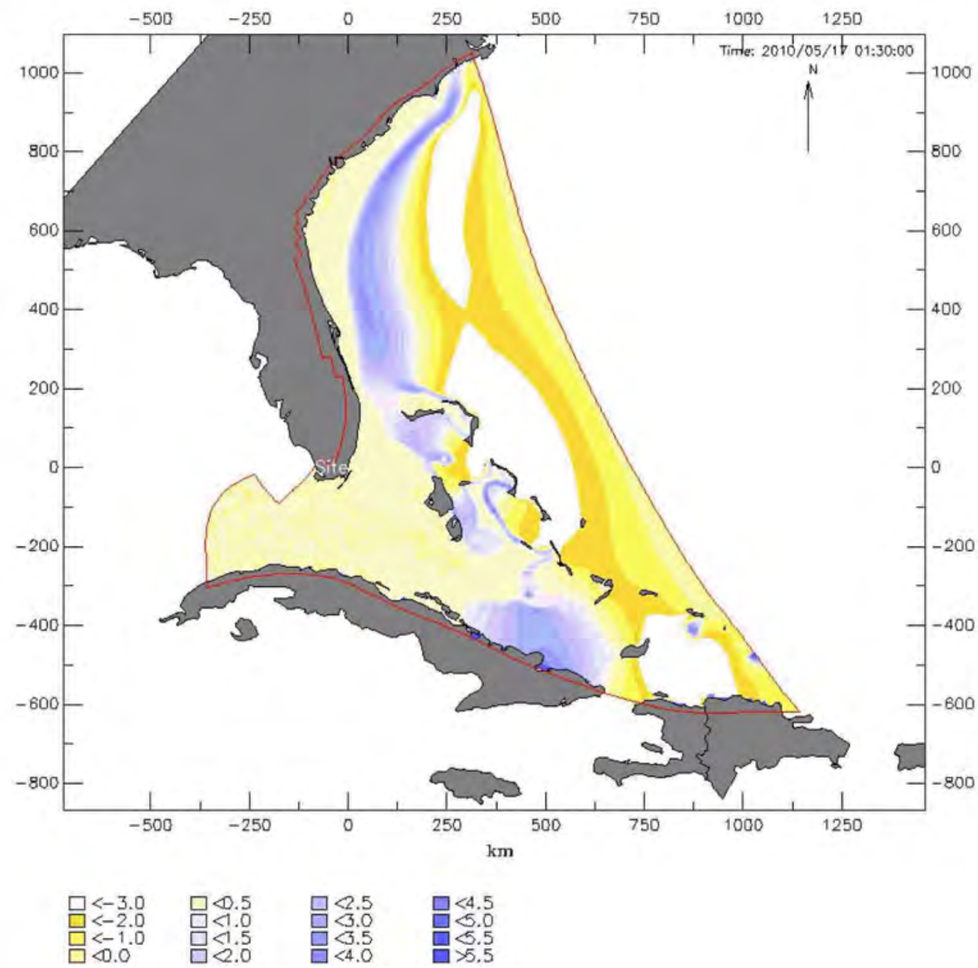
Note: Water levels are in meters **relative to 1.36 m** MSL.

Figure 2.4.6-219b Tsunami Water Level Contours 1.0 hour into the Model Simulation (with Manning's n of 0.02 and non-reflective boundaries)



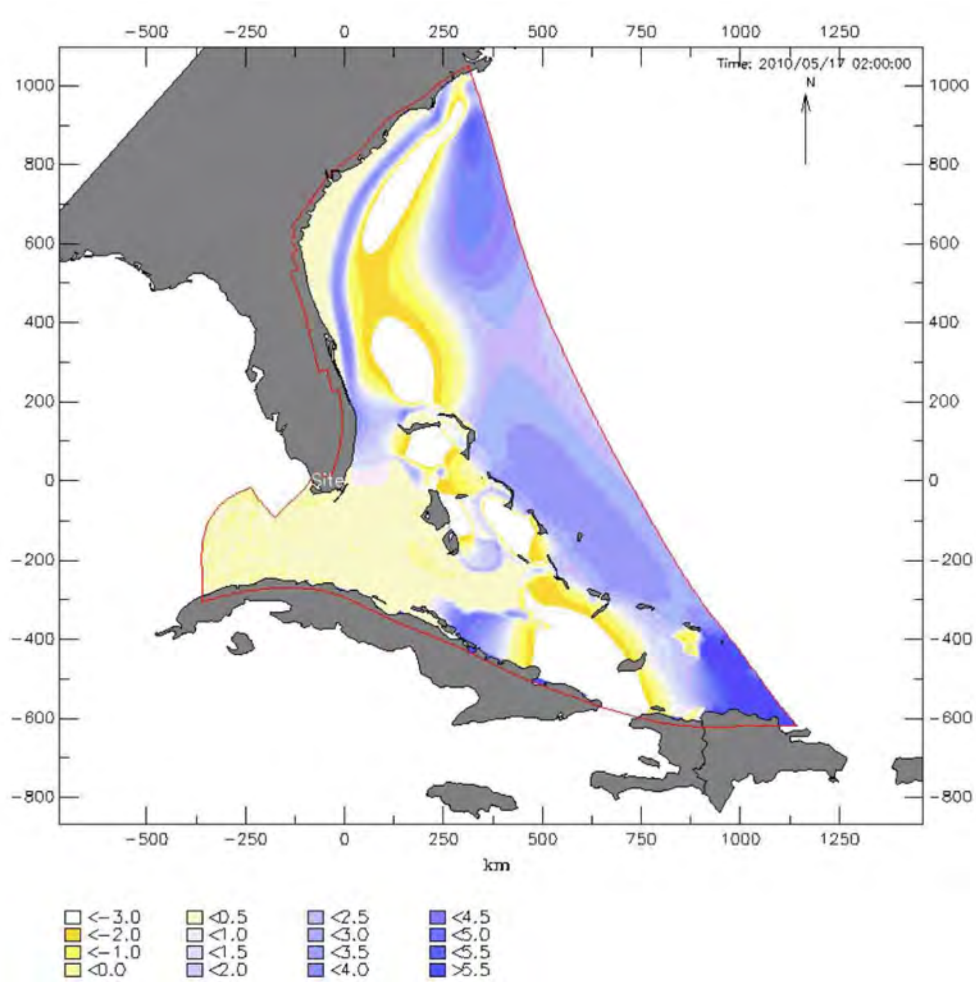
Note: Water levels are in meters **relative to 1.36 m** MSL.

Figure 2.4.6-219c Tsunami Water Level Contours 1.5 hours into the Model Simulation (with Manning's n of 0.02 and non-reflective boundaries)



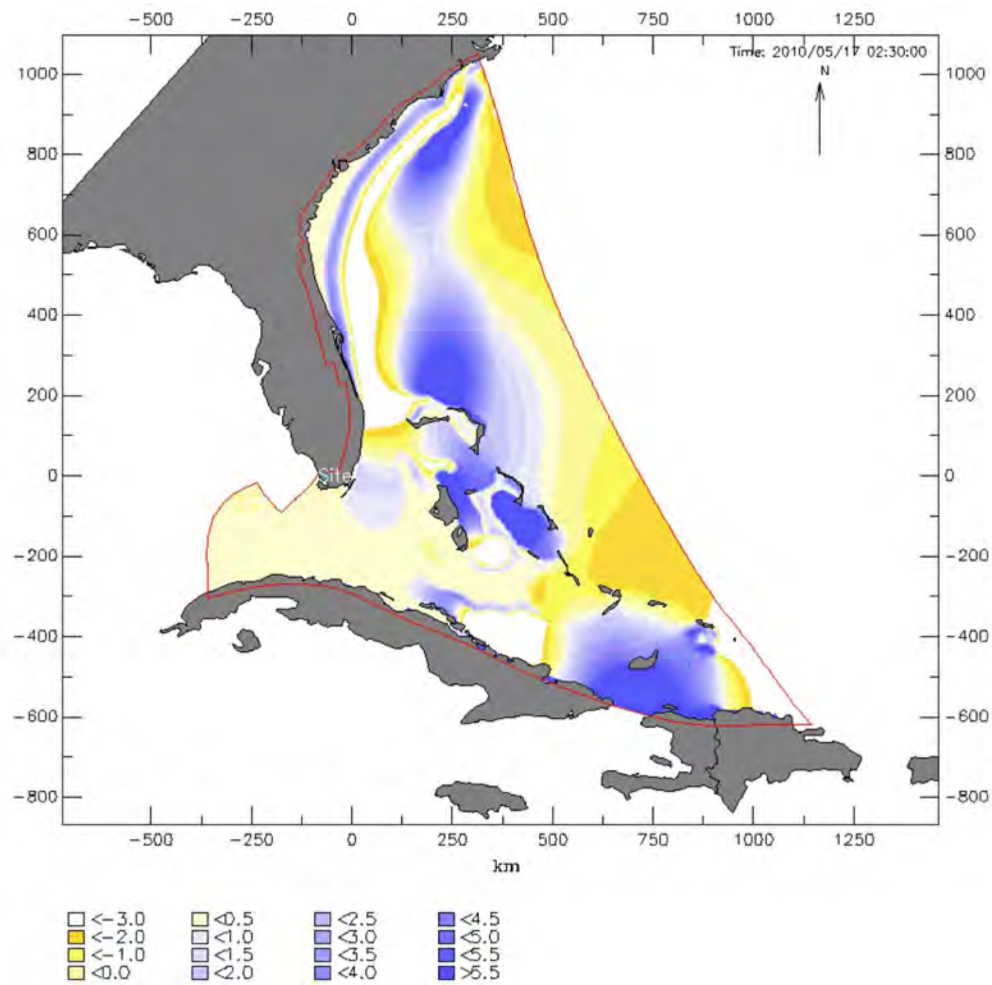
Note: Water levels are in meters **relative to 1.36 m** MSL.

Figure 2.4.6-219d Tsunami Water Level Contours 2.0 hours into the Model Simulation (with Manning's n of 0.02 and non-reflective boundaries)



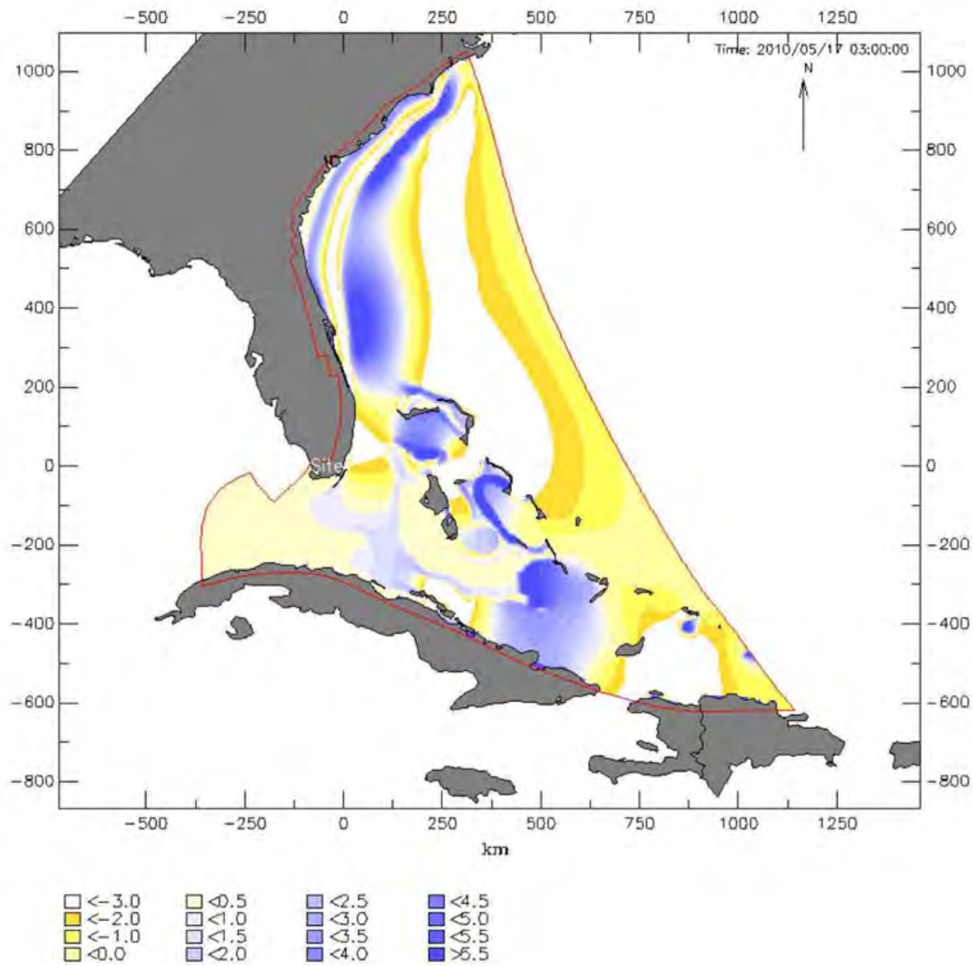
Note: Water levels are in meters **relative to 1.36 m** MSL.

Figure 2.4.6-219e Tsunami Water Level Contours 2.5 hours into the Model Simulation (with Manning's n of 0.02 and non-reflective boundaries)



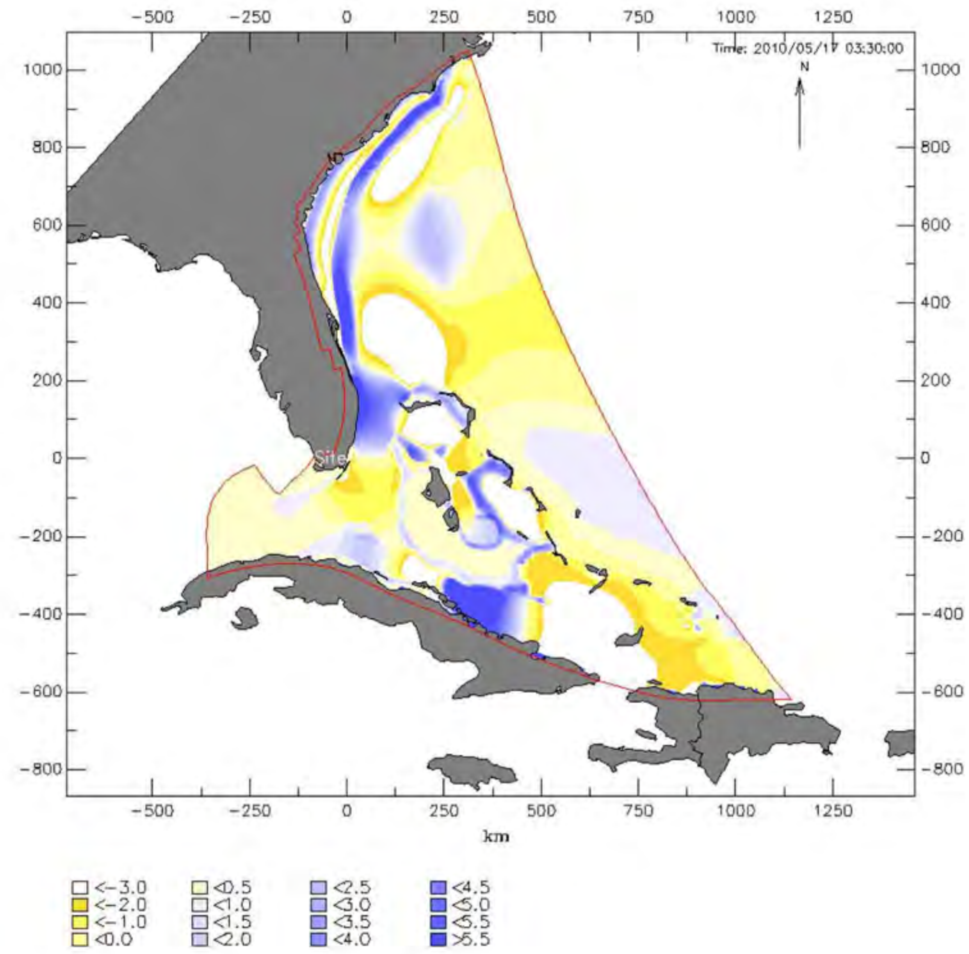
Note: Water levels are in meters **relative to 1.36 m** MSL.

Figure 2.4.6-219f Tsunami Water Level Contours 3.0 hours into the Model Simulation (with Manning's n of 0.02 and non-reflective boundaries)



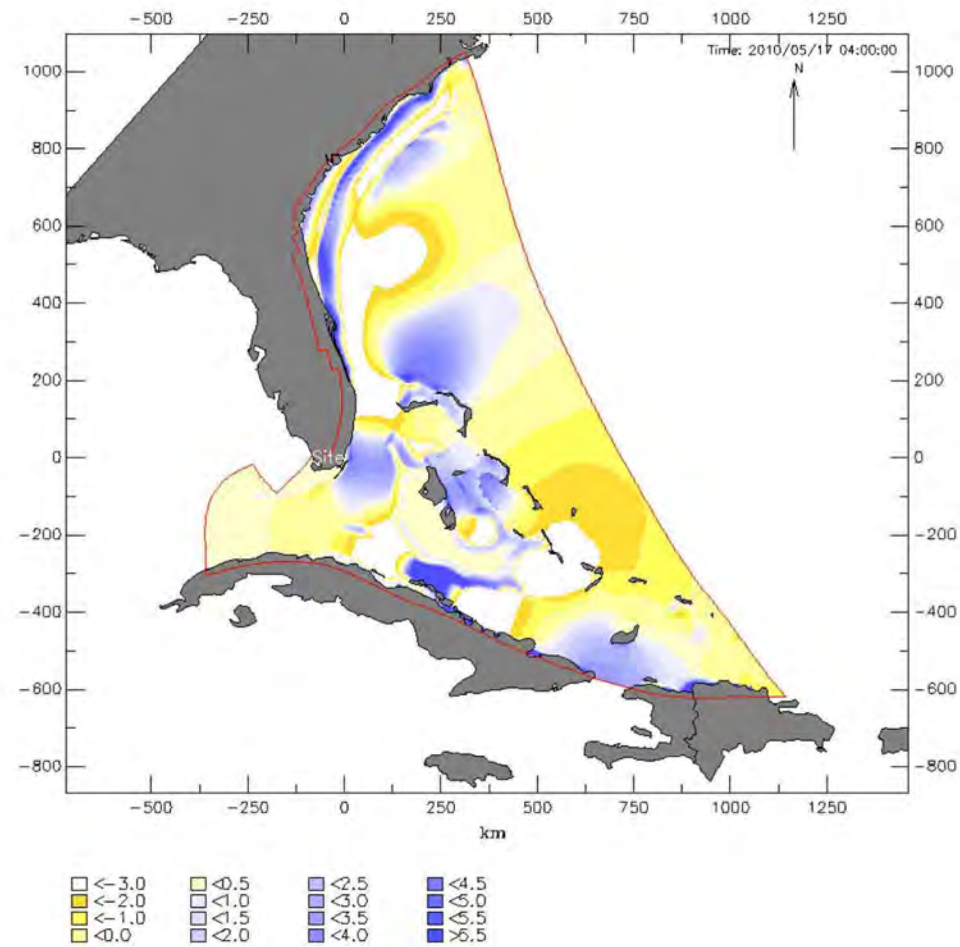
Note: Water levels are in meters **relative to 1.36 m** MSL.

Figure 2.4.6-219g Tsunami Water Level Contours 3.5 hours into the Model Simulation (with Manning's n of 0.02 and non-reflective boundaries)



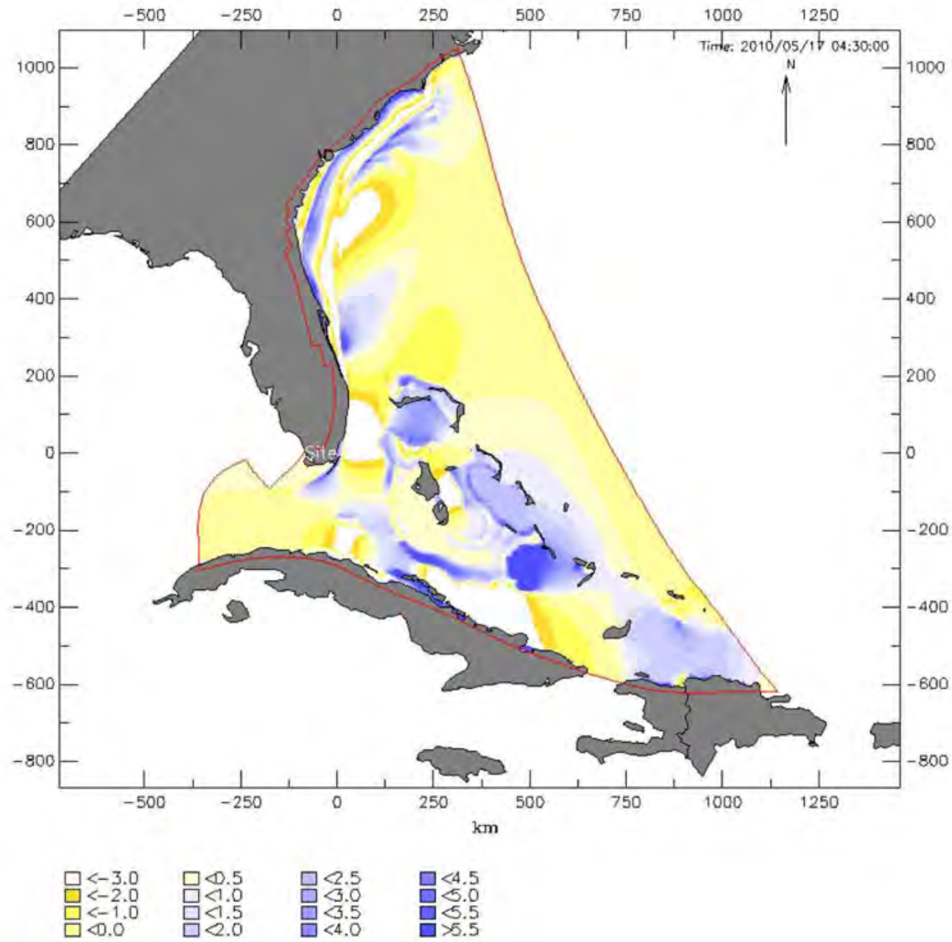
Note: Water levels are in meters **relative to 1.36 m** MSL.

Figure 2.4.6-219h Tsunami Water Level Contours 4.0 hours into the Model Simulation (with Manning's n of 0.02 and non-reflective boundaries)



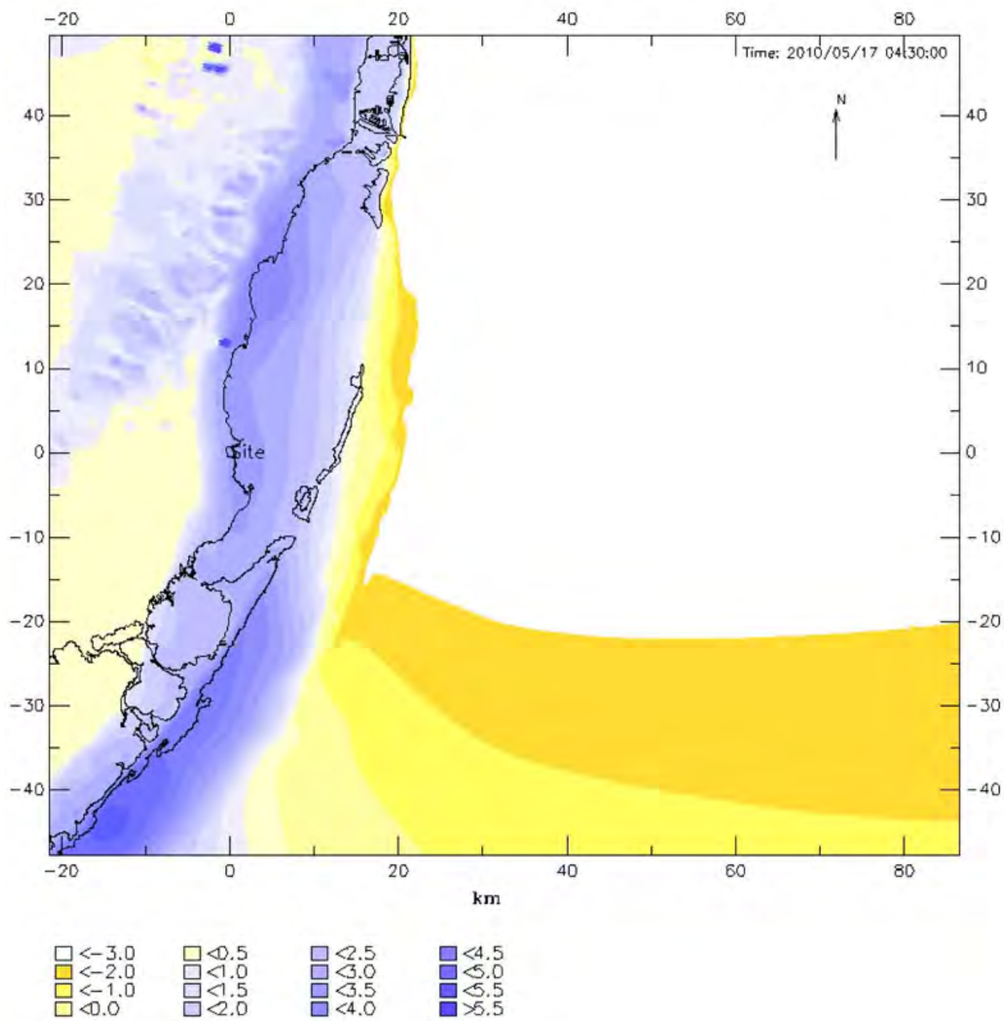
Note: Water levels are in meters **relative to 1.36 m** MSL.

Figure 2.4.6-219i Tsunami Water Level Contours 4.5 hours into the Model Simulation (with Manning's n of 0.02 and non-reflective boundaries)



Note: Water levels are in meters **relative to 1.36 m** MSL.

Figure 2.4.6-220 Tsunami Water Level Contours near the Units 6 & 7 Site 4.5 Hours into the Model Simulation Corresponding to the Time Close to the Maximum Water Level at Site (with Manning's n of 0.02 and non-reflective boundaries)



Note: Water levels are in meters **relative to 1.36 m** MSL; some (dry) land elevations are shown as flood water levels according to designation in Delft3D-FLOW.

Figure 2.4.6-221a Location of Simulated Water Level Monitoring Points along Track 1

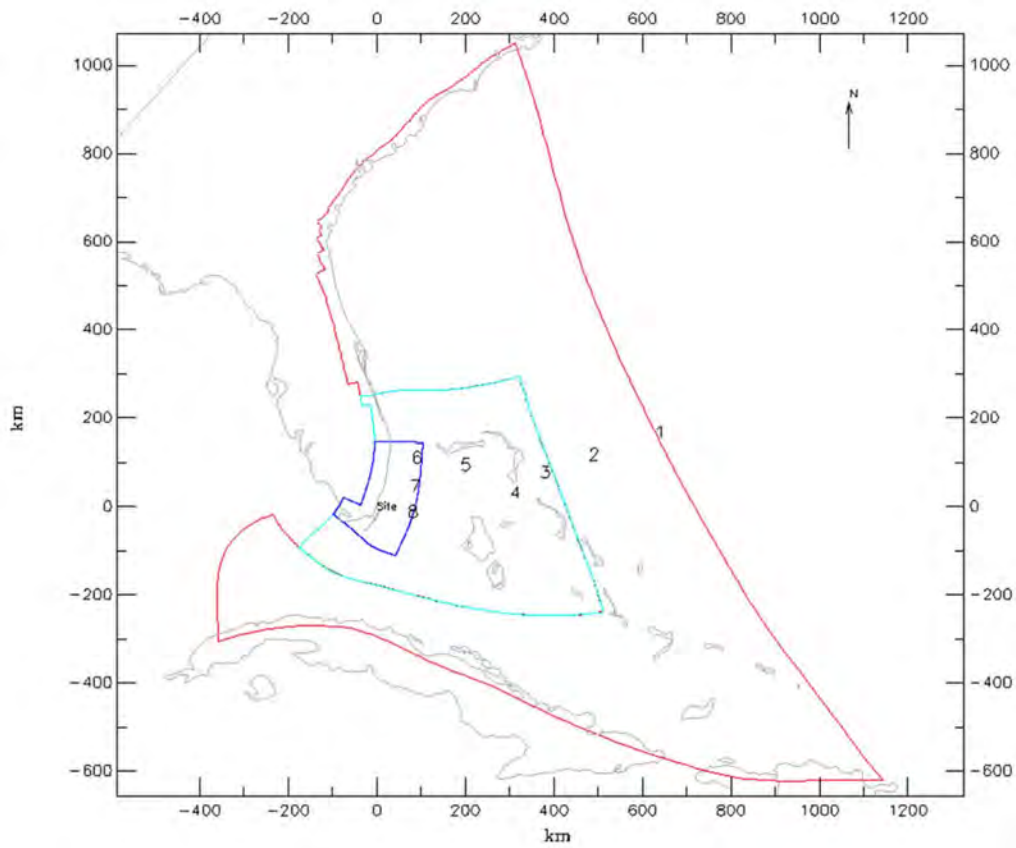


Figure 2.4.6-221b Location of Simulated Water Level Monitoring Points along Track 2

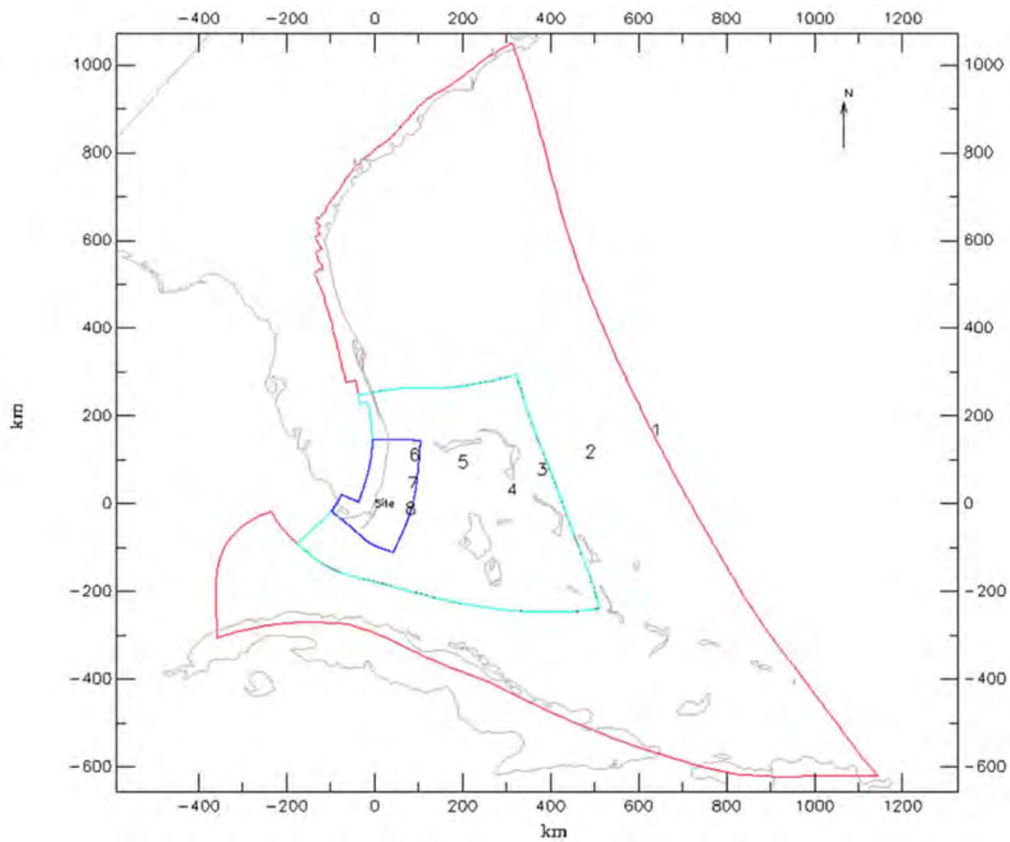


Figure 2.4.6-221c Location of Simulated Water Level Monitoring Points along Track 3

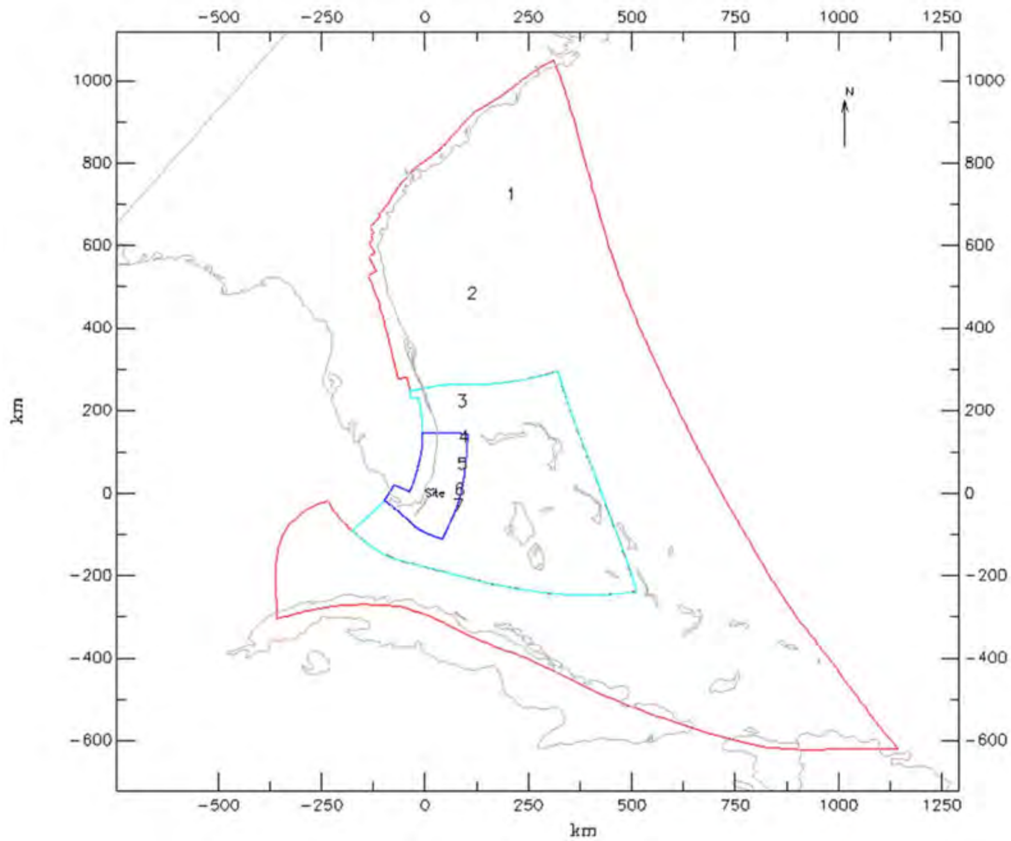
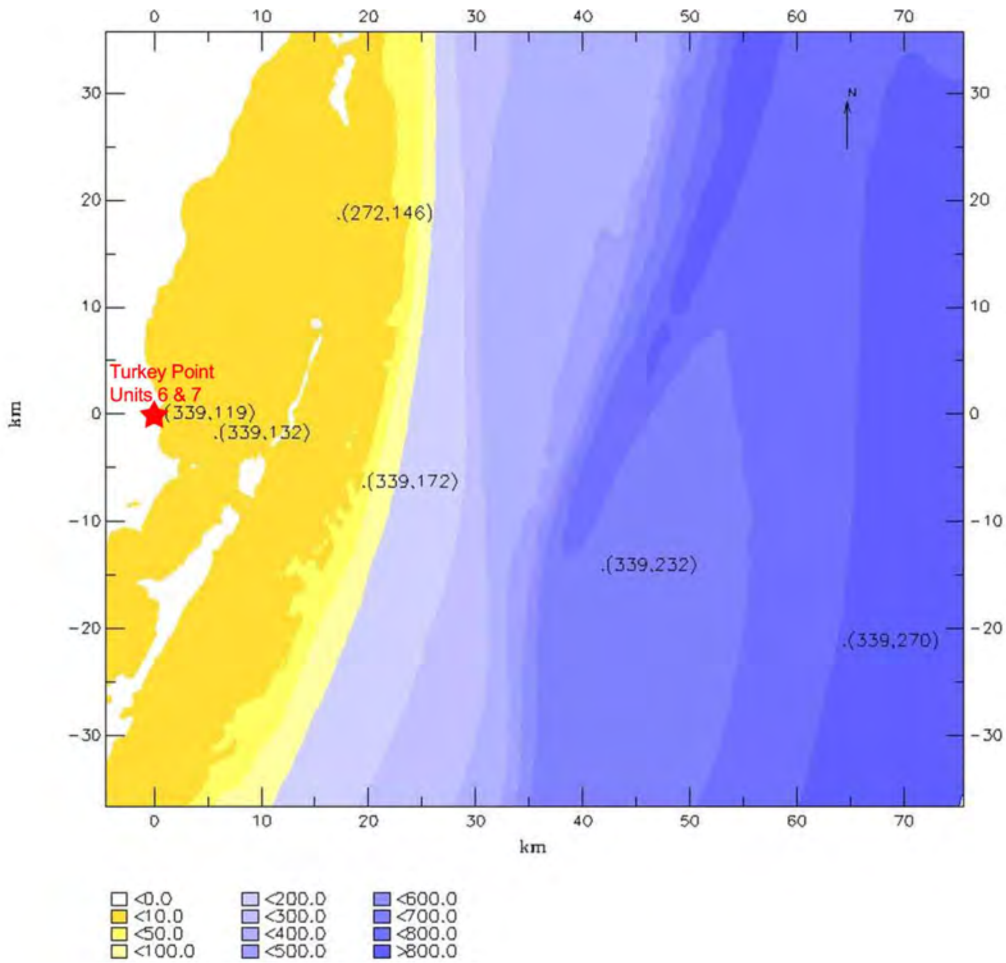


Figure 2.4.6-221d Location of Simulated Water Level Monitoring Points in Biscayne Bay and Vicinity (along with water depth contours)



Note: Depths to the seabed are in meters relative to MSL.

Figure 2.4.6-222 Tsunami Marigrams at Monitoring Points along Track 1, relative to 1.36 m MSL (with Manning's n of 0.02 and non-reflective boundaries)

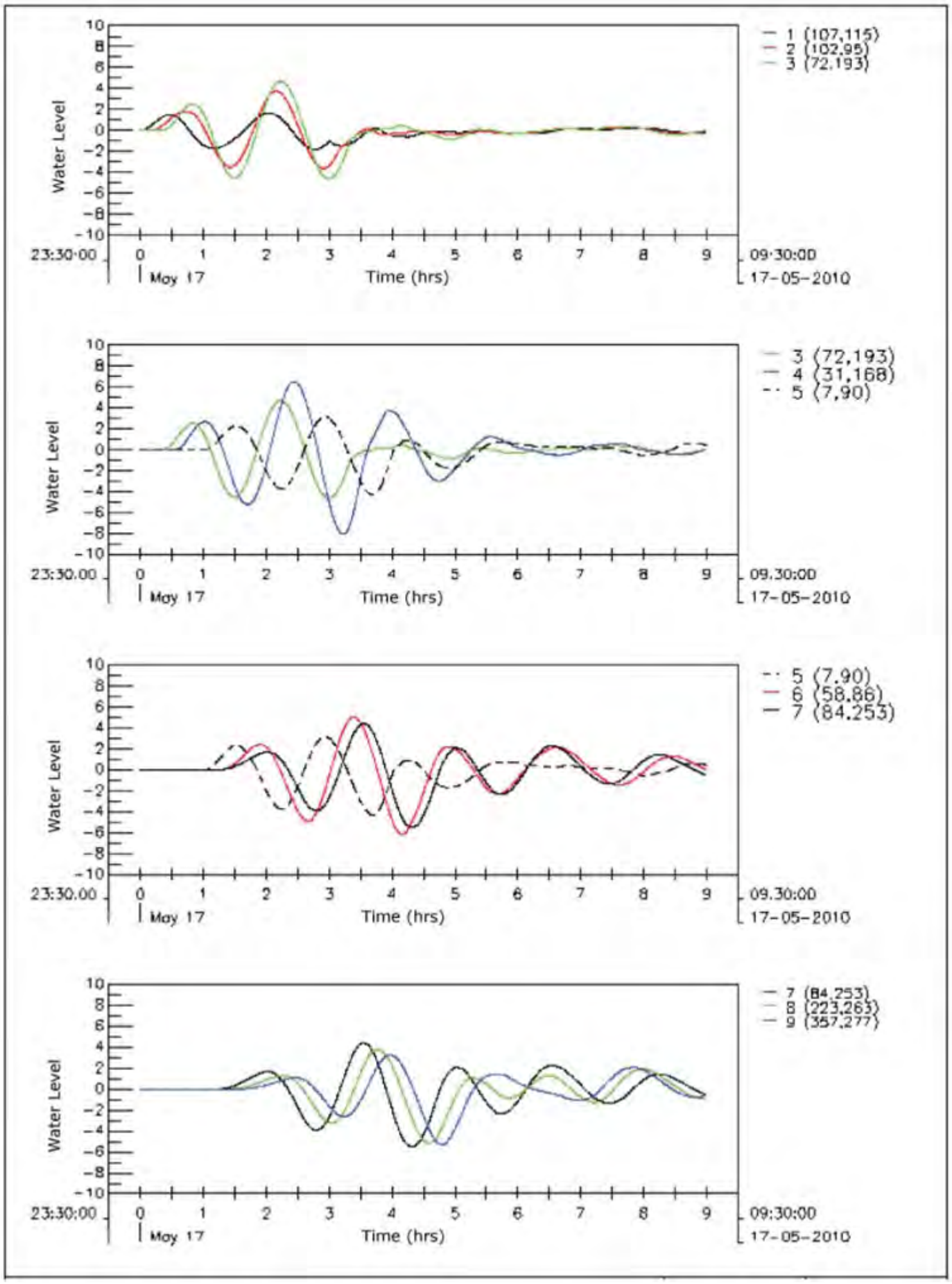


Figure 2.4.6-223 Tsunami Marigrams at Monitoring Points along Track 2, relative to 1.36 m MSL (with Manning's n of 0.02 and non-reflective boundaries)

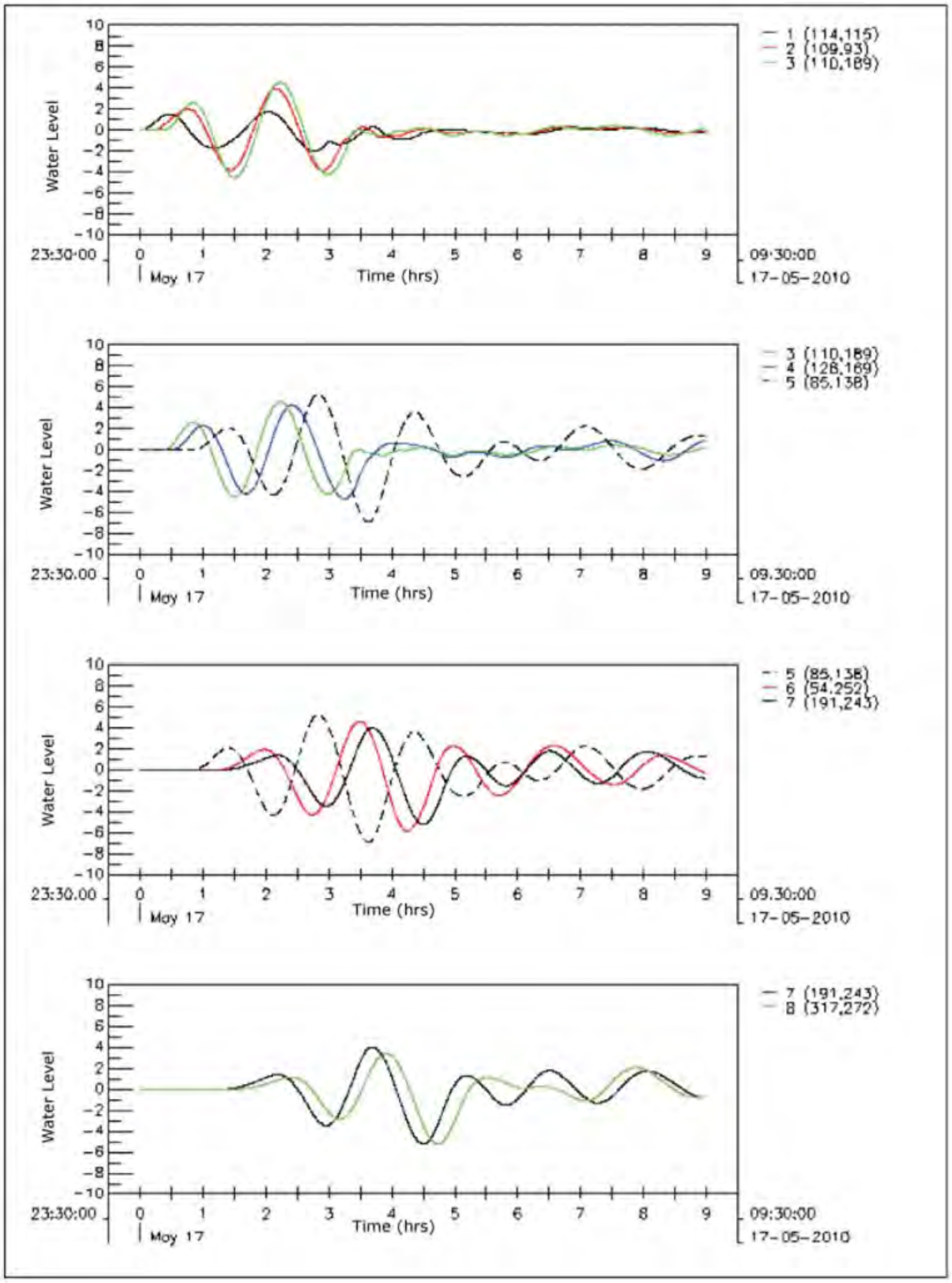


Figure 2.4.6-224 Tsunami Marigrams at Monitoring Points along Track 3, relative to 1.36 m MSL (with Manning's n of 0.02 and non-reflective boundaries)

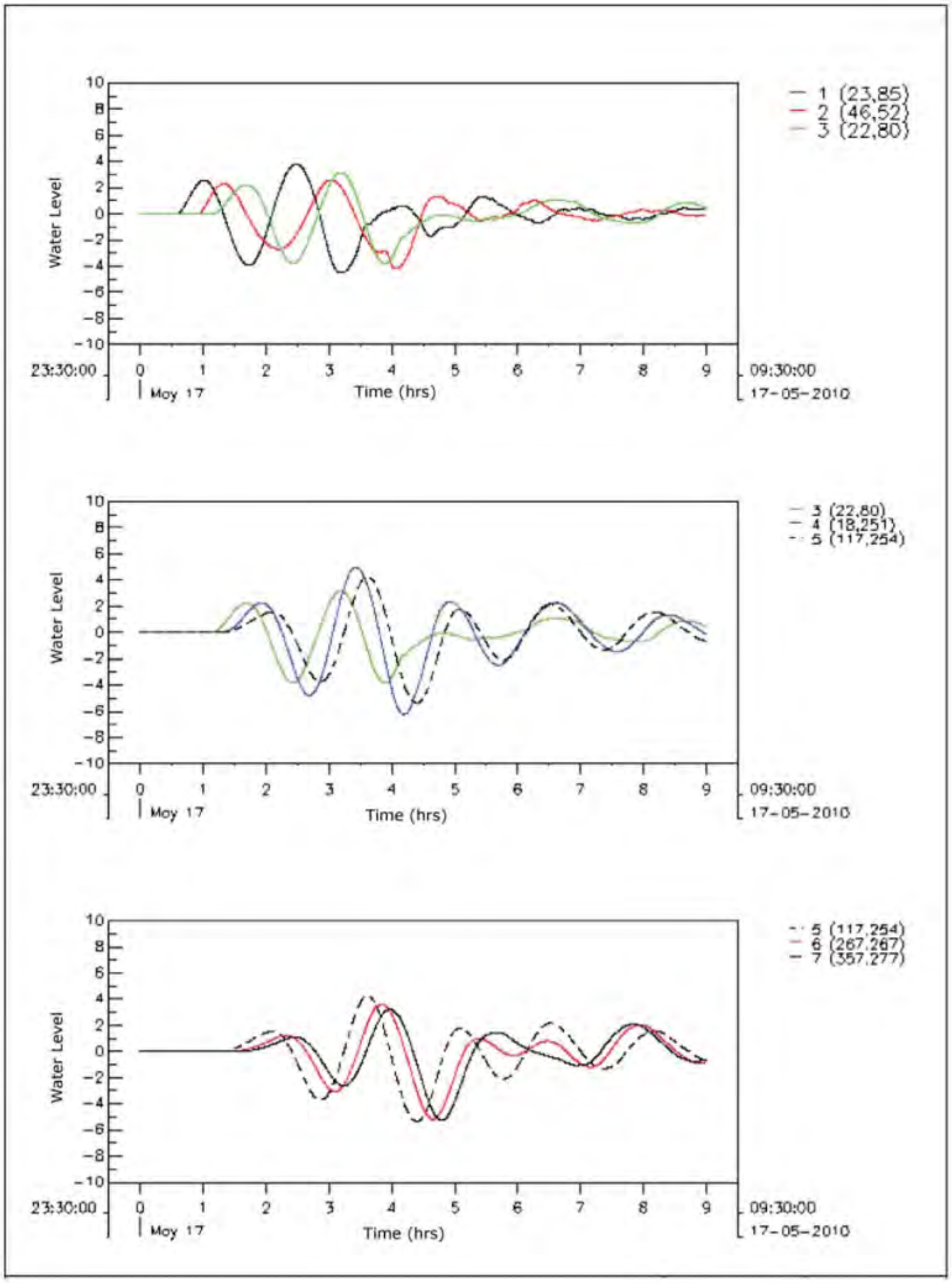


Figure 2.4.6-225 Tsunami Marigrams at Monitoring Points in Biscayne Bay and Vicinity, relative to 1.36 m MSL (with Manning's n of 0.02 and non-reflective boundaries)

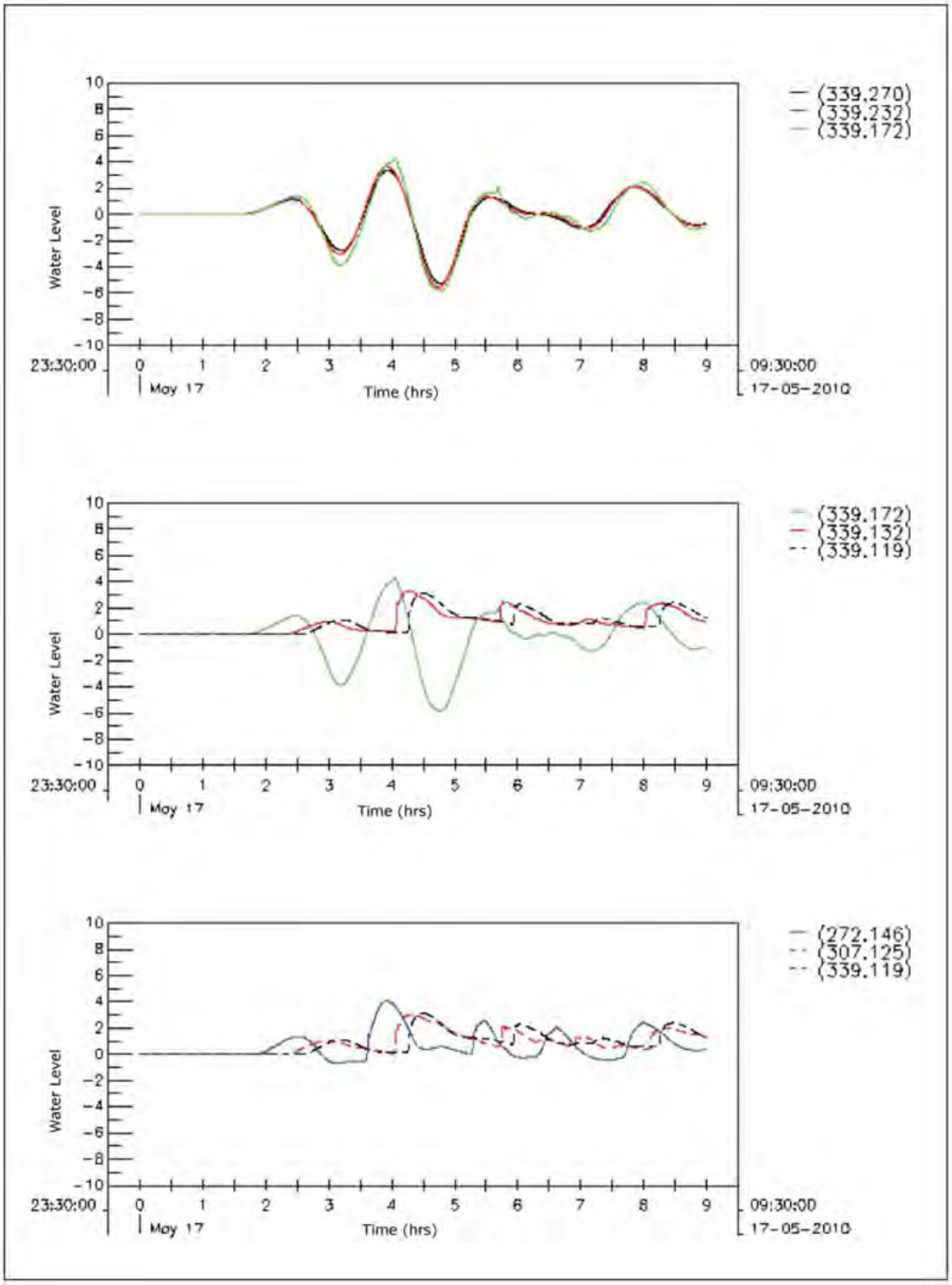


Figure 2.4.6-226 Simulated Tsunami Marigram at the Units 6 & 7 Site (with Manning's n of 0.02 and non-reflective boundaries)

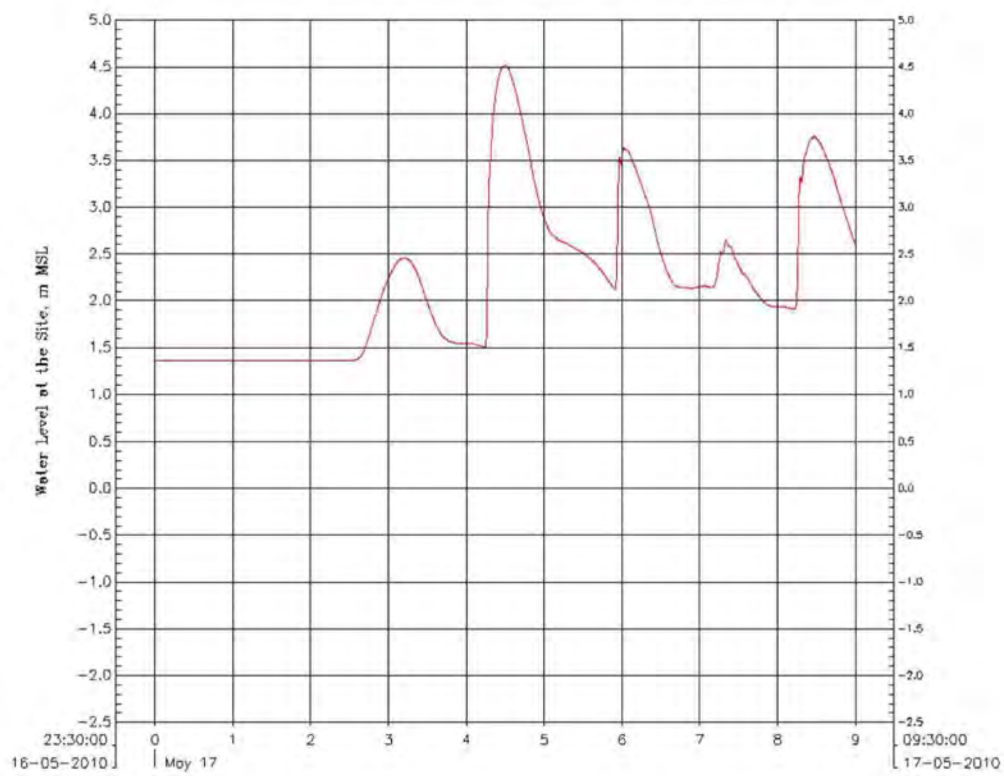
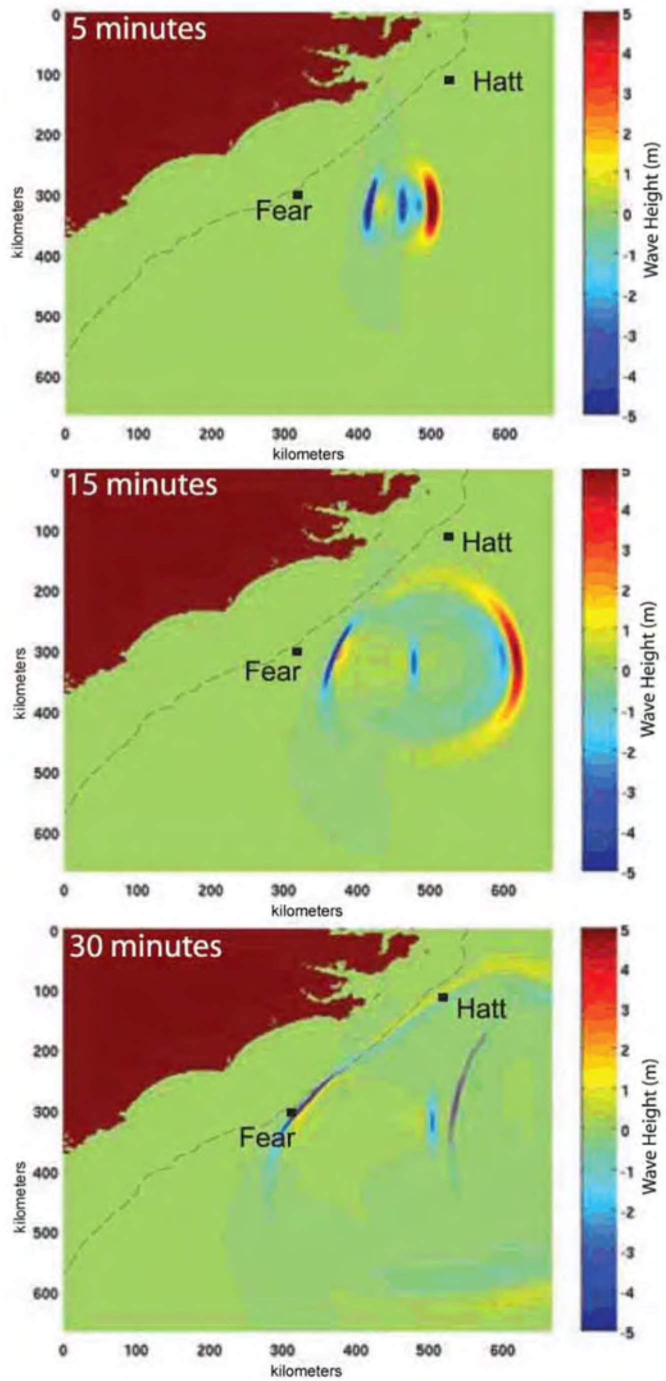
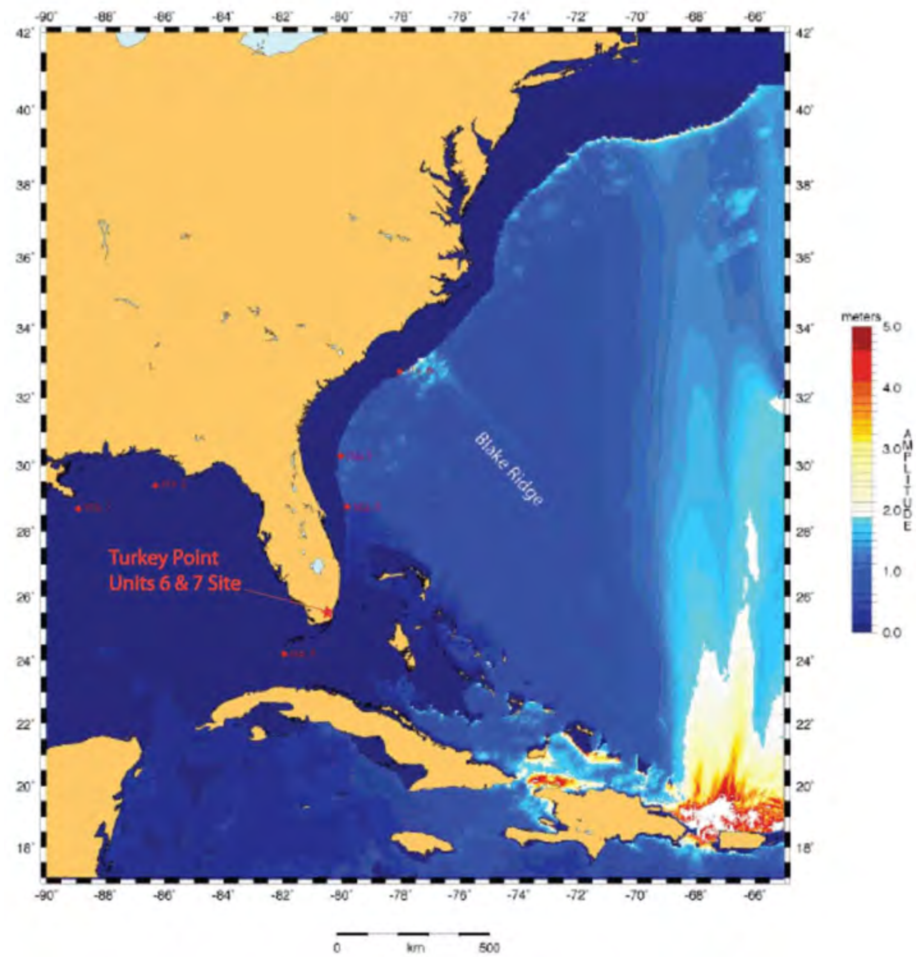


Figure 2.4.6-227 Tsunami Wave Amplitude Results for 5, 15, and 30 Min. After Slide Initiation of the Largest Landslide Within Cape Fear Slide Complex



Source: Reference 223

Figure 2.4.6-228 A Simulation Result of Maximum Open-Ocean Tsunami Amplitude Over 4.4 Hours of Propagation Time for North Puerto Rico/Lesser Antilles Subduction Zone



Source: Reference 202

Figure 2.4.6-229 Water Levels at the Site for Incoming Tsunami Sine-Wave With and Without Riemann BC

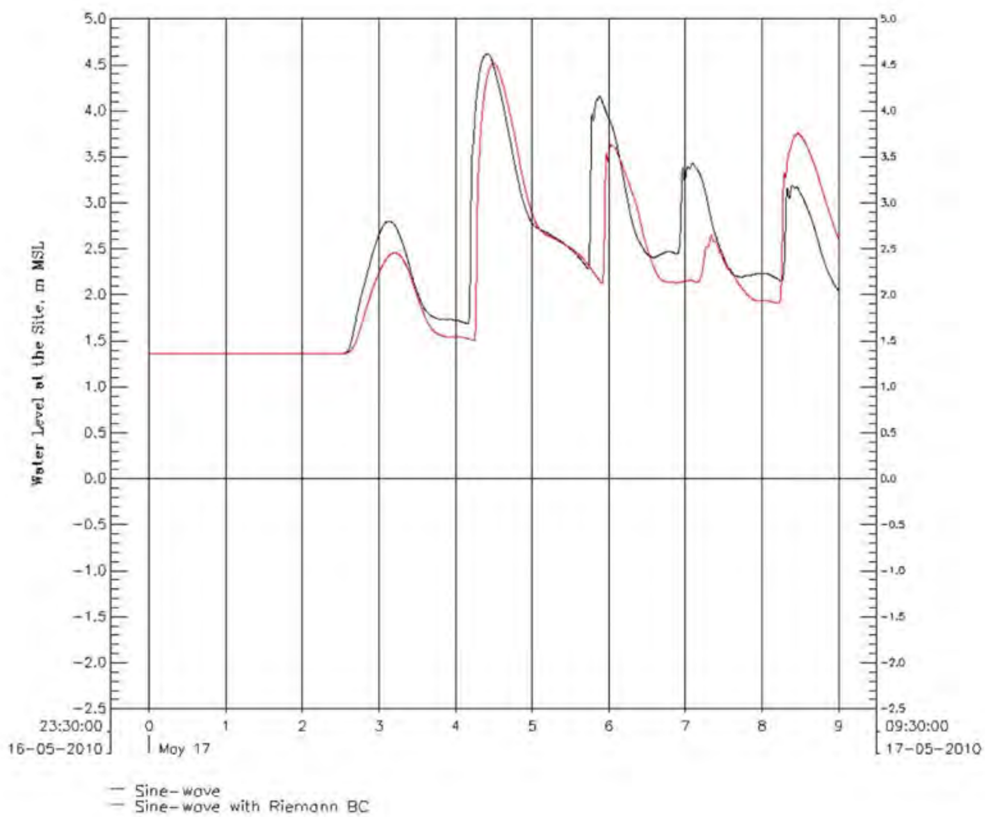


Figure 2.4.6-230 Isosceles N-Wave Form in Comparison with a Sine-Wave Form

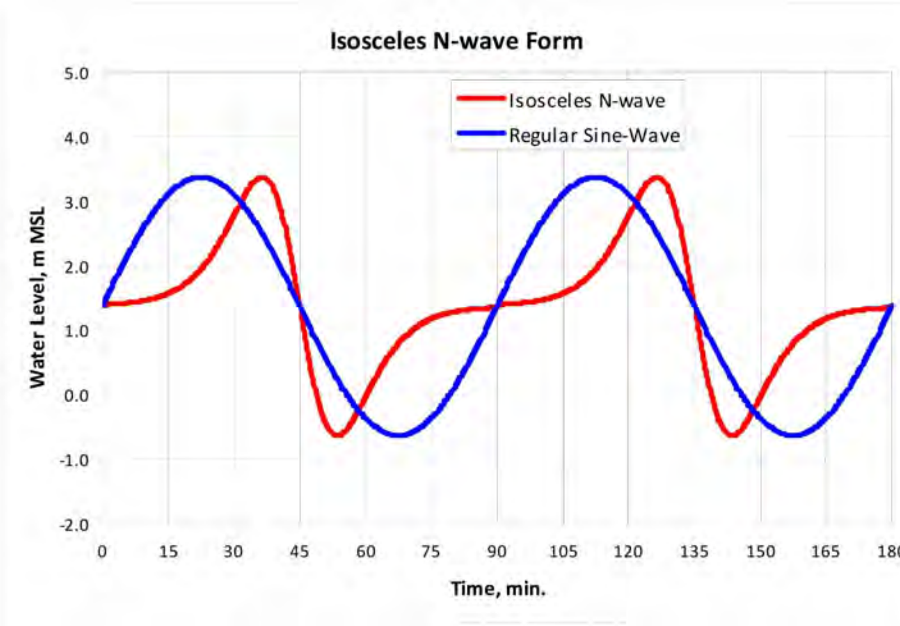


Figure 2.4.6-231 Steepened Sine-Wave Form in Comparison with a Regular Sine-Wave Form

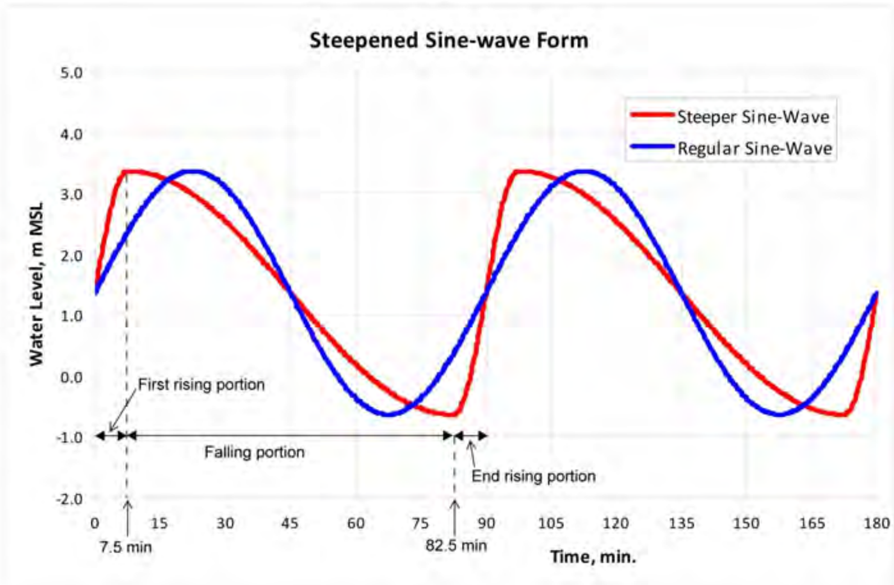


Figure 2.4.6-232 Time History of Water Level at the Forcing Boundary for Steepened Sine-Wave Form

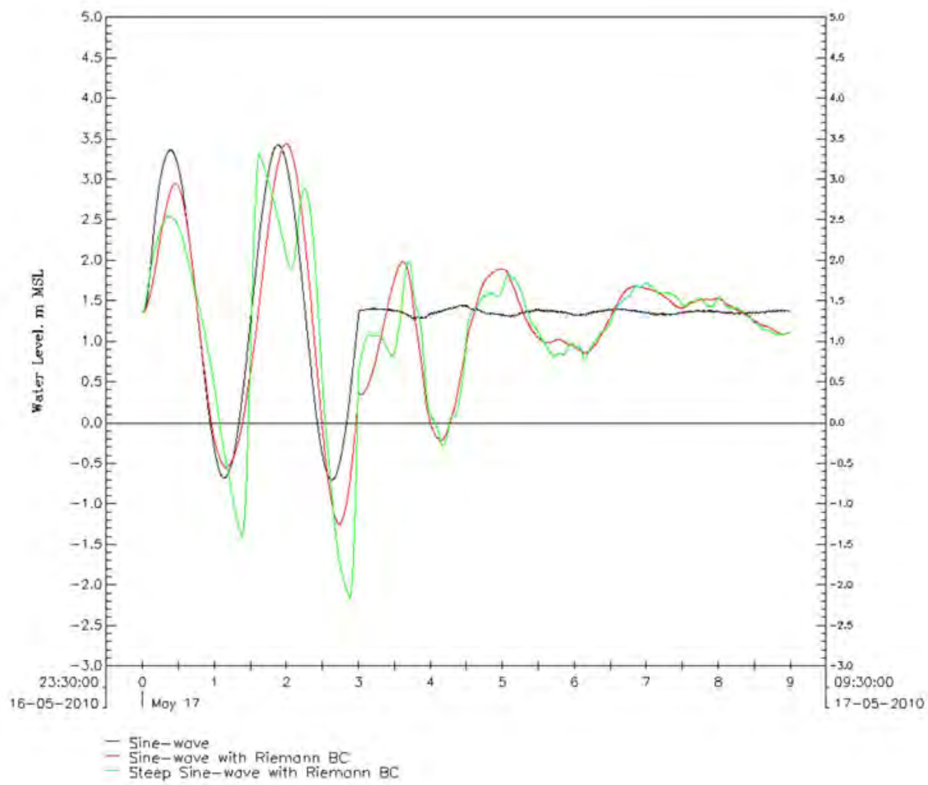


Figure 2.4.6-233 Time History of Water Level Off Miami at Water Depth of 783 Meters (2569 Feet) for Steepened Sine-Wave Form

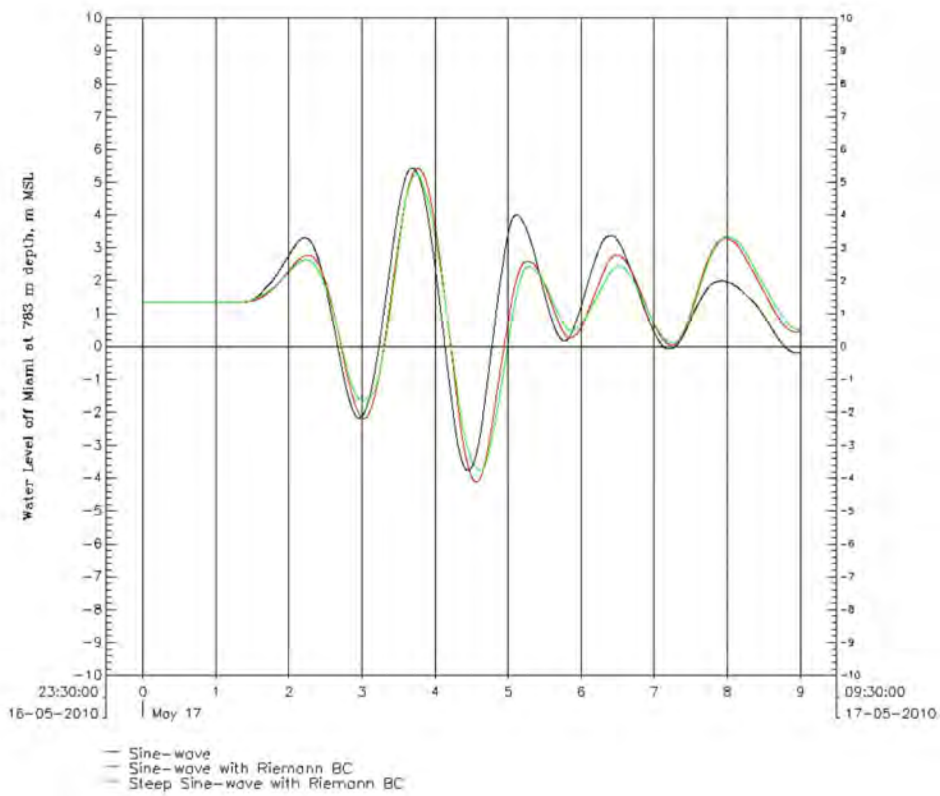


Figure 2.4.6-234 Time History of Water Level at the Site for Steepened Sine-Wave Form

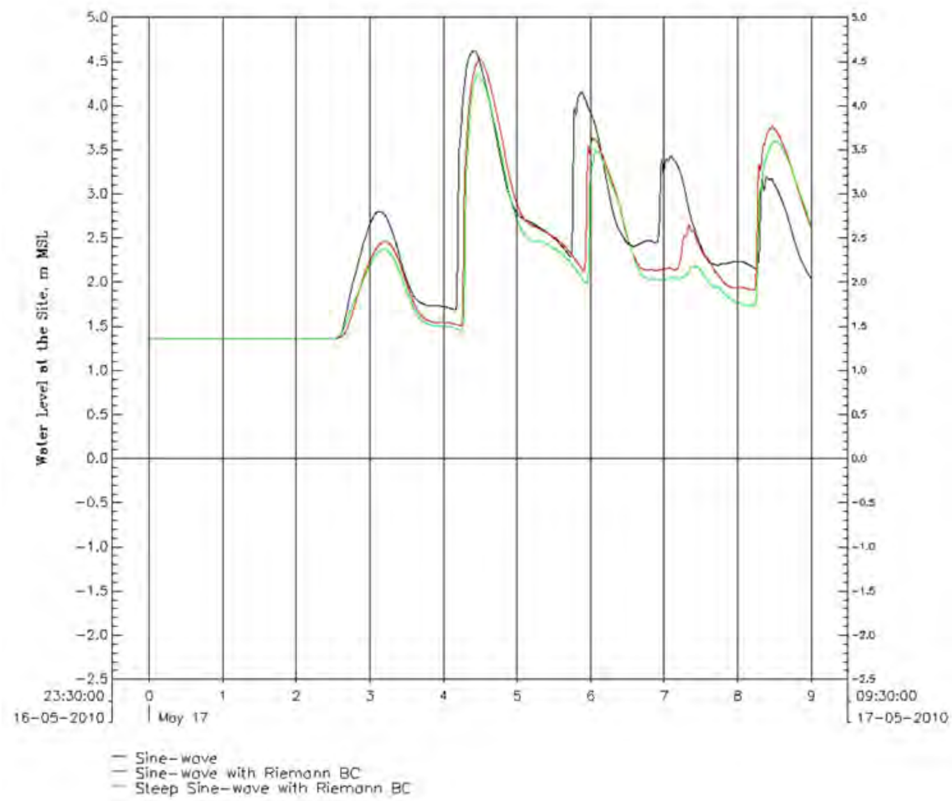


Figure 2.4.6-235 Time History of Water Level at the Forcing Boundary for Isosceles N-Wave Form

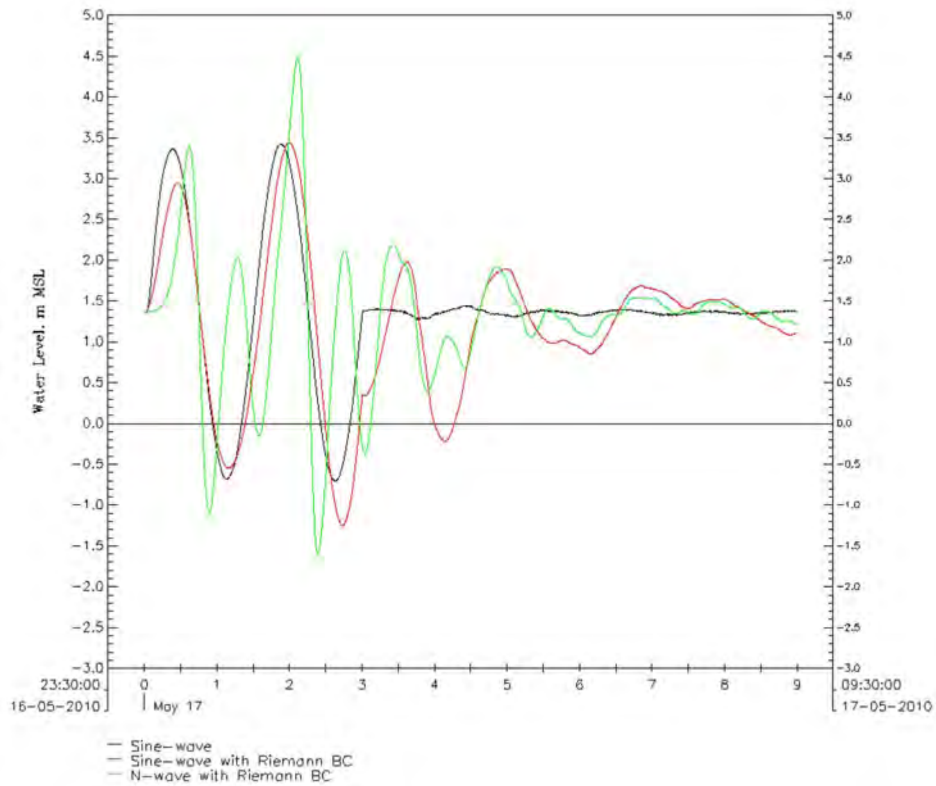


Figure 2.4.6-236 Time History of Water Level Off Miami at Water Depth of 783 Meters (2569 Feet) for Isosceles N-Wave Form

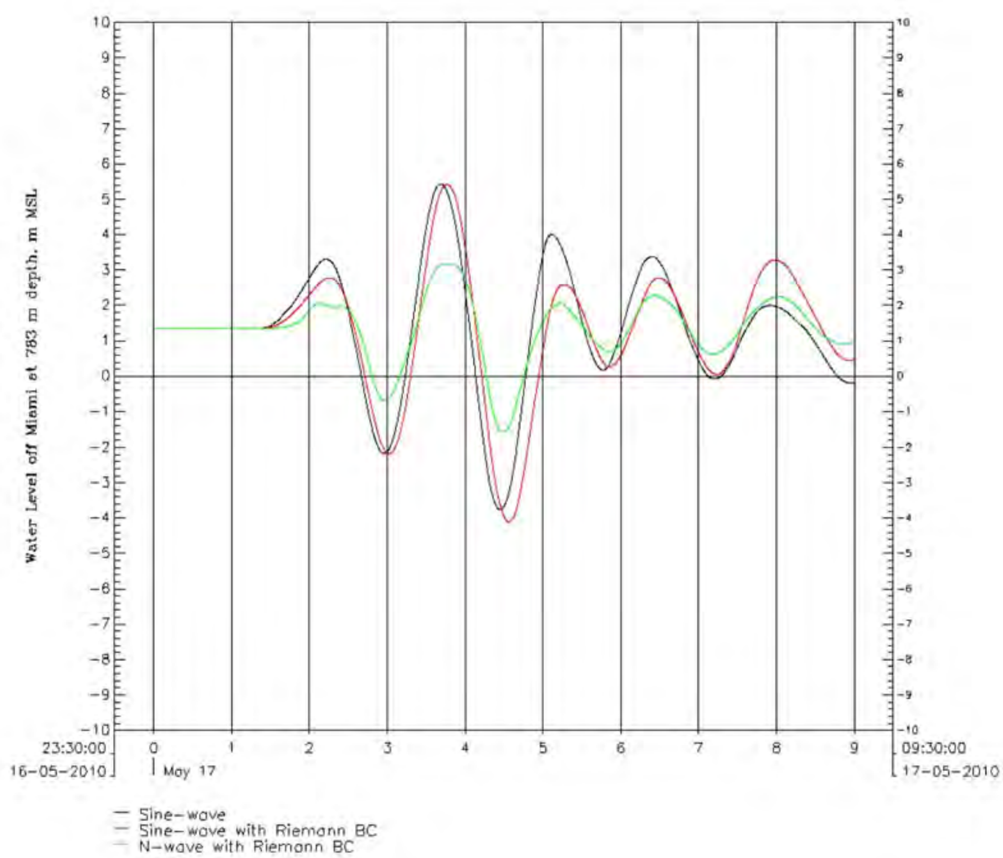


Figure 2.4.6-237 Time History of Water Level at the Site for Isosceles N-Wave Form

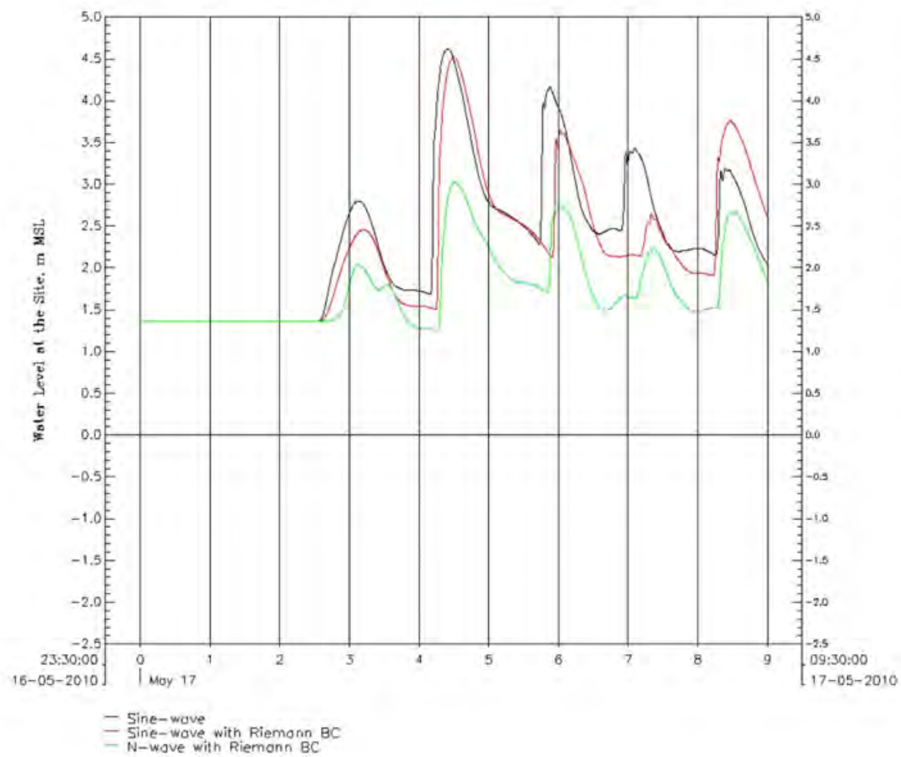
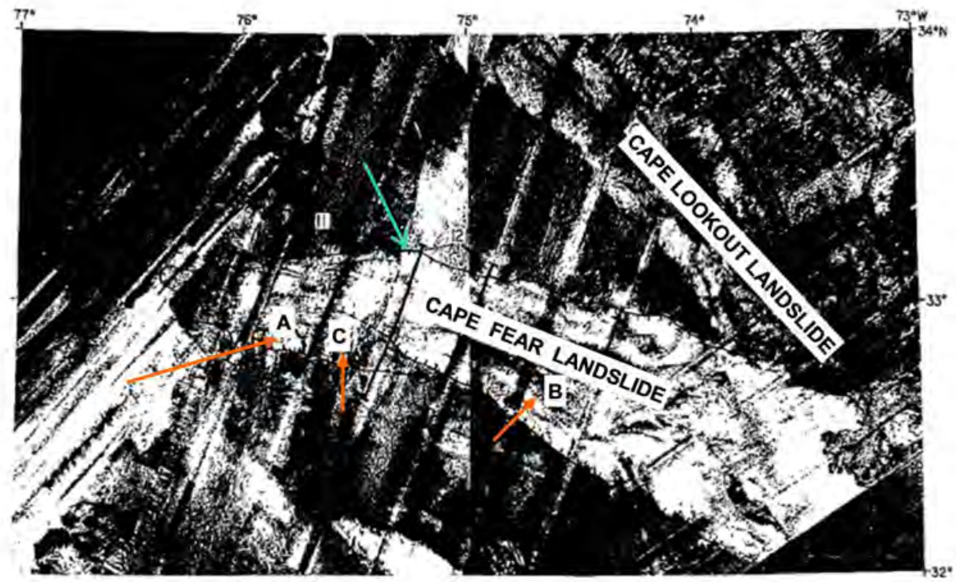


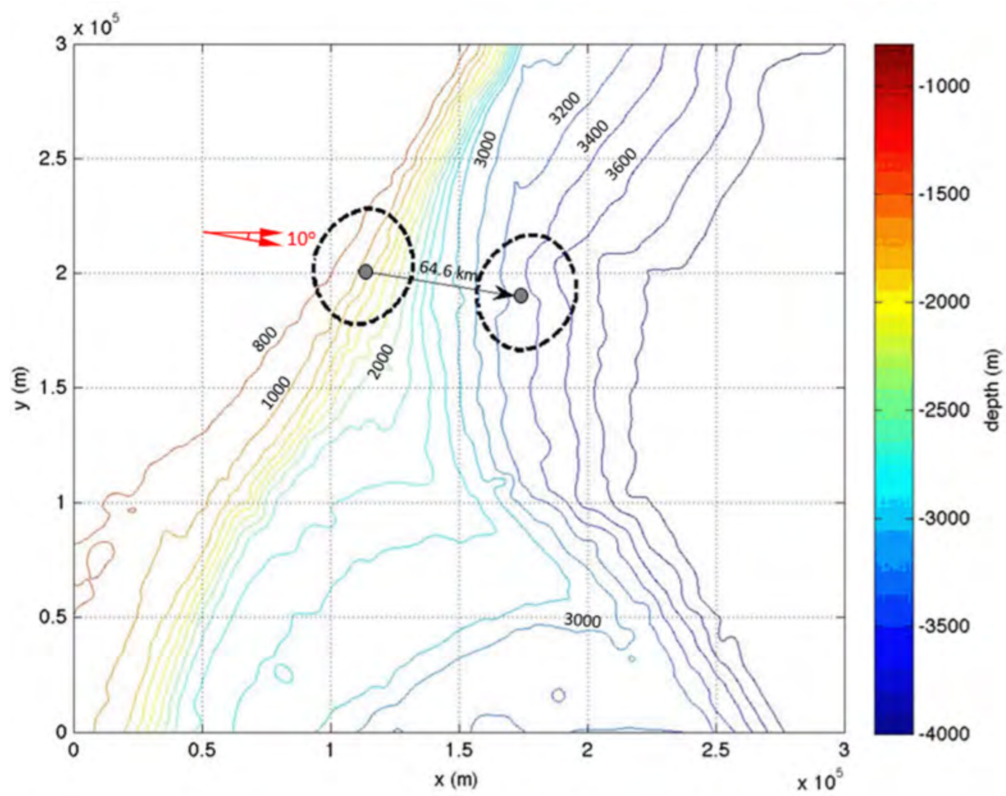
Figure 2.4.6-238 GLORIA sidescan-sonar image of the Cape Fear Slide



Source: Reference 225.

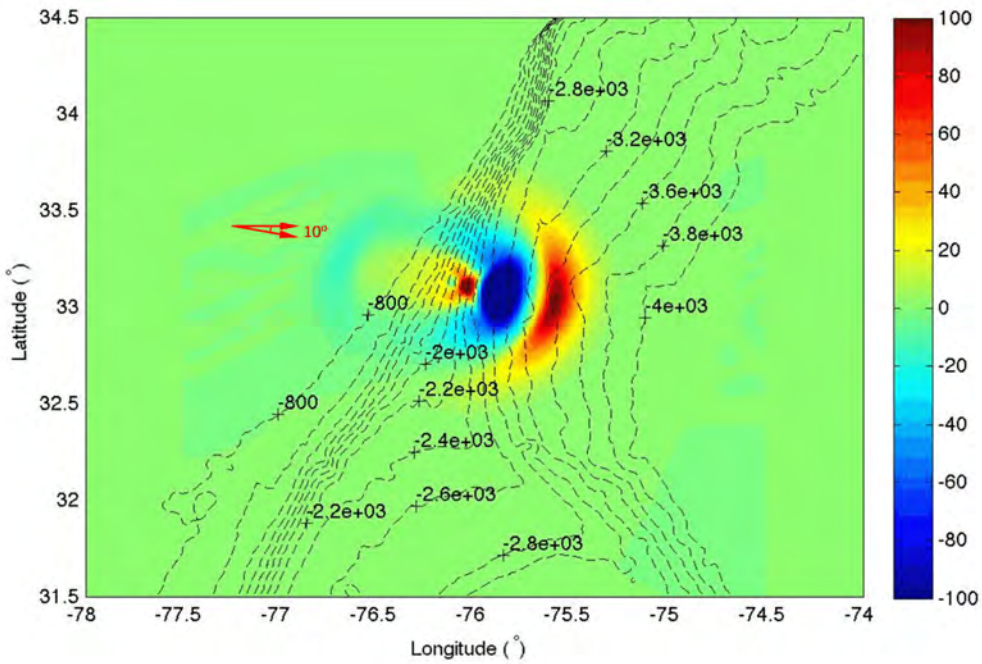
Note: Hachures pointing downslope represents scarps. The lighter acoustic return seen in the image represent mass movement deposits and the dark return are the undisturbed sedimentary deposits. The location (A) is the longitudinal lines representing both debris chutes between the salt diapirs at the head of the landslide area, and flow paths of debris further down slope, which is shown with location (B). Location (C) is an area of irregular, hummocky sea floor that has been crumpled and buckled by mass movement near the head of the slide. The blue arrow indicates the northern limit of the Cape Fear landslide.

Figure 2.4.6-239 Location and Lateral Extent of the Postulated Submarine Mass Failure for the Cape Fear Simulations and Local Bathymetry



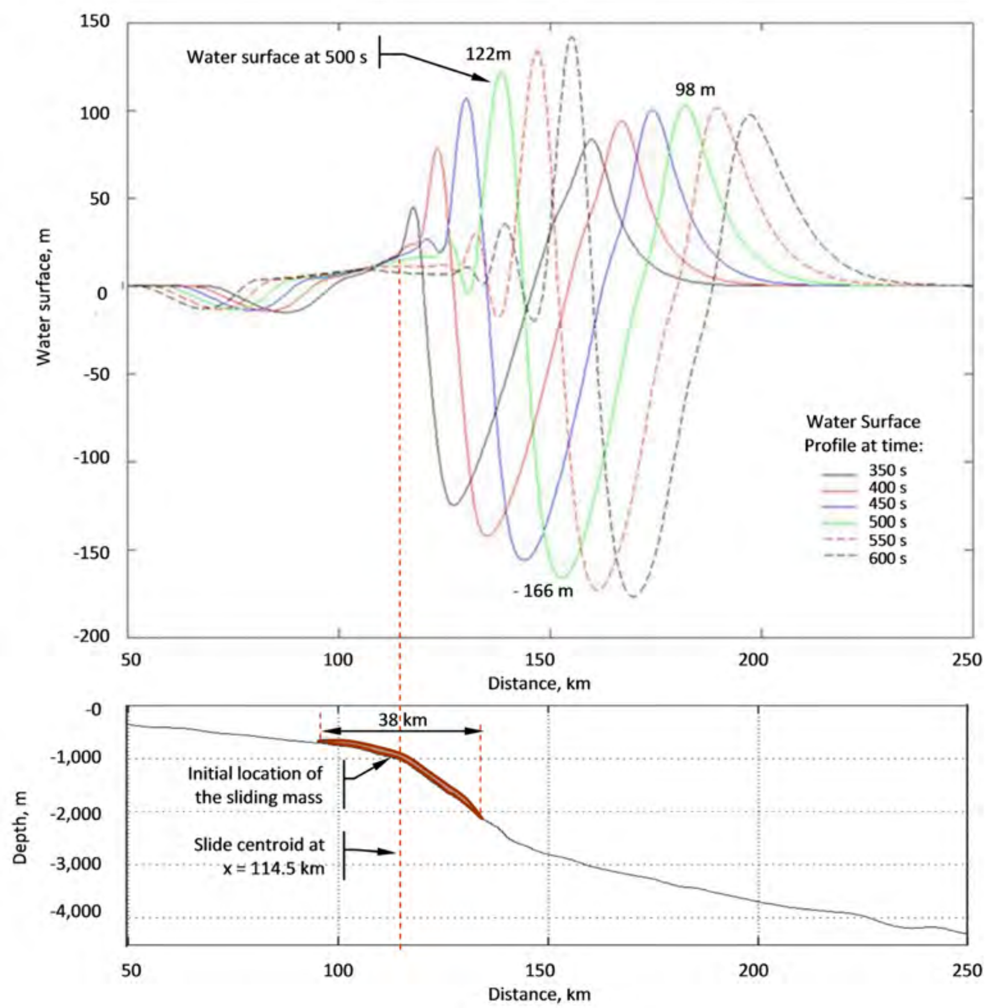
Note: Bathymetry contours indicate water depths (MSL).

Figure 2.4.6-240 Initial Wave Generated by NHWAVE (Dynamic Source) for the Cape Fear Submarine Failure Shown in Figure 2.4.6-239



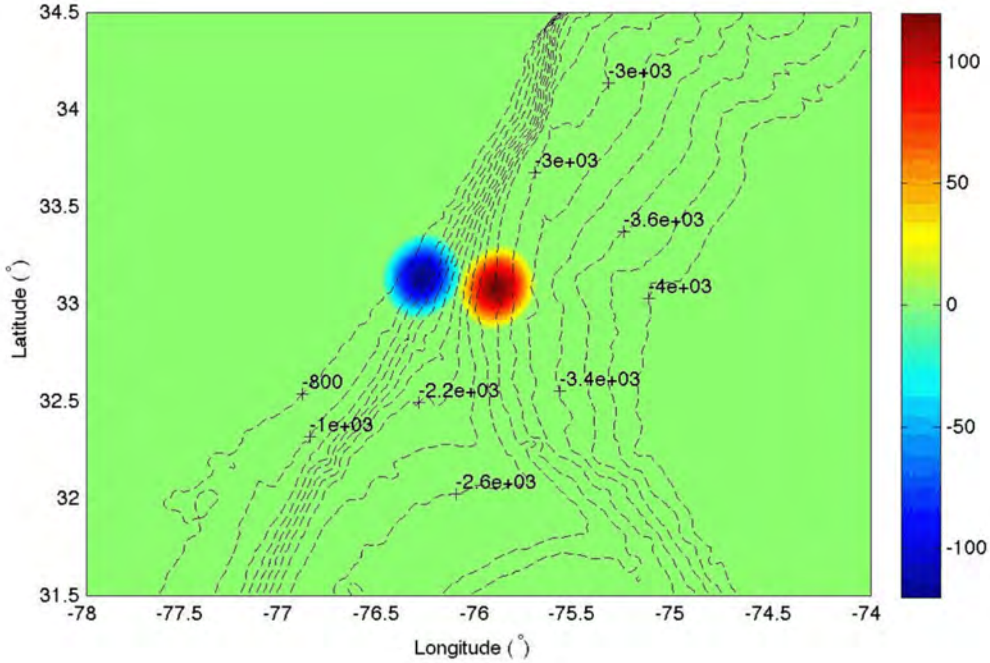
Note: Colors in elevation legend indicate water surface elevation (MSL) in meters. Bathymetry contours indicate water depths (m MSL).

Figure 2.4.6-241 Water Surface Profile in the Direction of the Slide Motion at Different Times after the Initiation of the Slide (Upper Panel) and Ocean Floor Profile (Lower Panel)



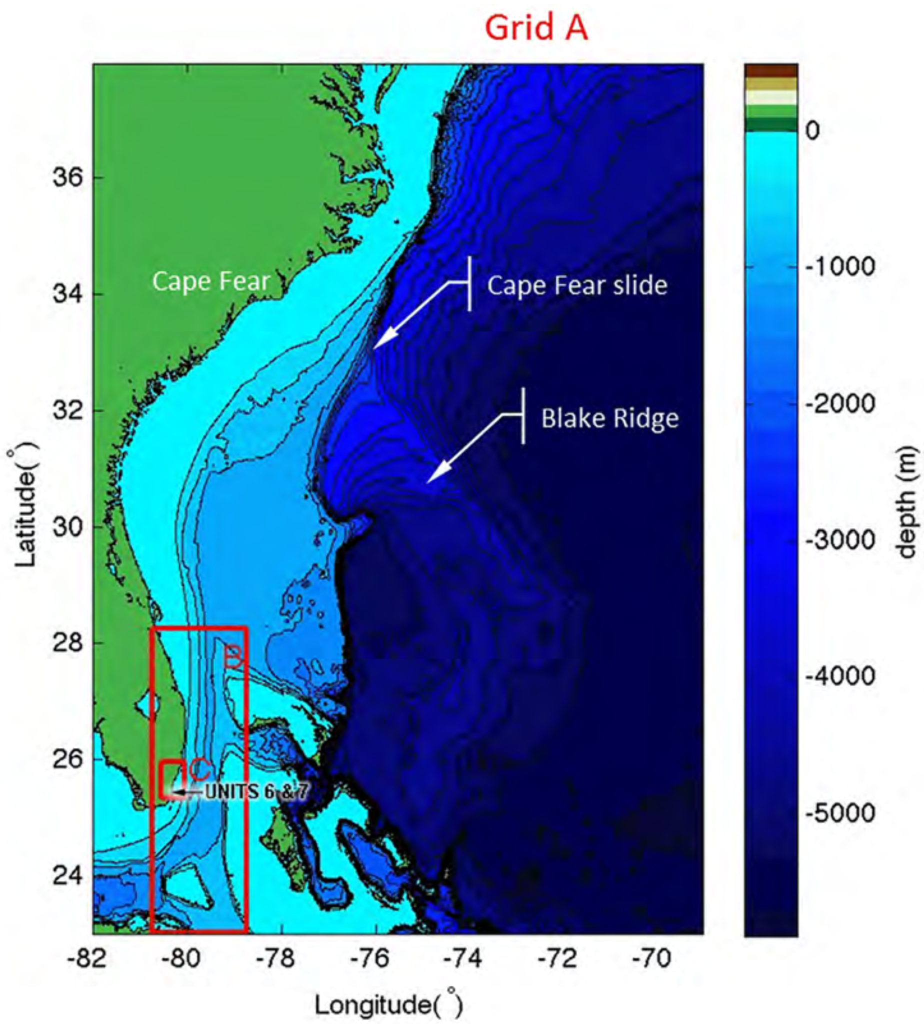
Note: Water surface elevations (upper panel) and water depths (lower panel) are relative to MSL.

Figure 2.4.6-242 Initial Wave for a Static Source Representation of the Cape Fear Submarine Failure Shown in Figure 2.4.6-239



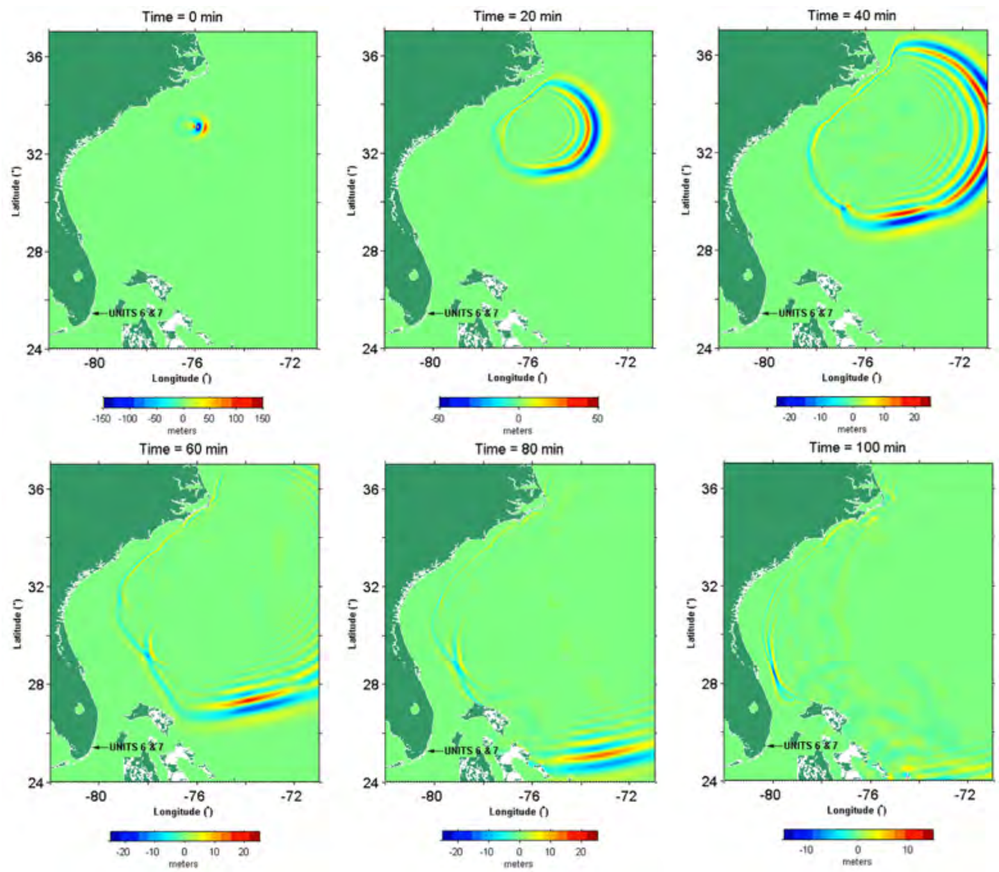
Note: Colors in elevation legend indicate water surface elevation (MSL) in meters. Bathymetry contours indicate water depths (MSL).

Figure 2.4.6-243 Model Domain And Bathymetry in the Three Nested Grids Used in the FUNWAVE-TVD Simulations



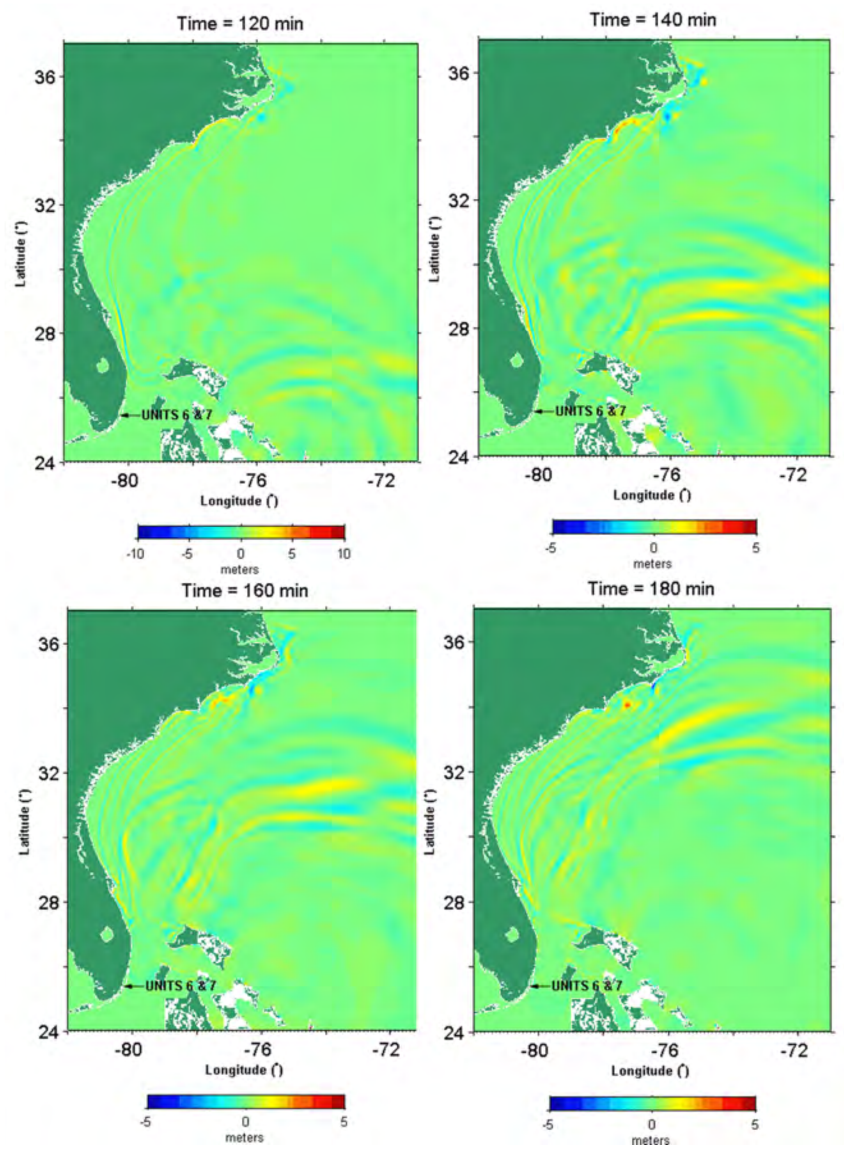
Note: Colors in elevation legend represent water surface elevations relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Figure 2.4.6-244 Simulated Propagation of the Cape Fear Tsunami (Dynamic Source) in Grid A at 0, 20, 40, 60, 80, and 100 Minutes after the Submarine Failure



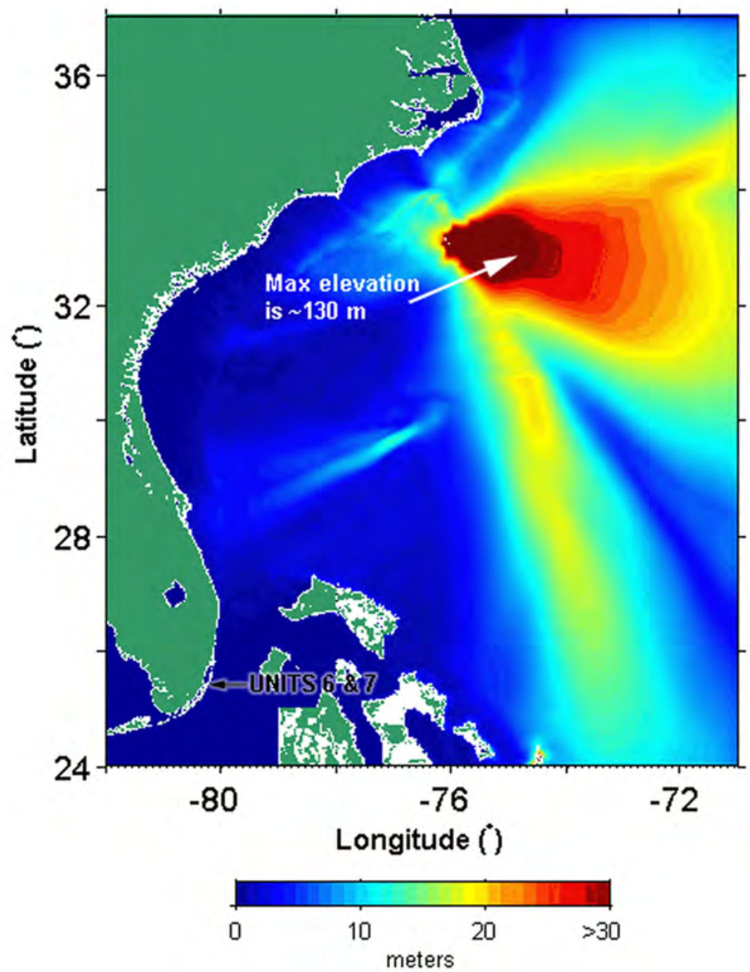
Note: Colors in elevation legend represent water surface elevations relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Figure 2.4.6-245 Simulated Propagation of the Cape Fear Tsunami (Dynamic Source) in Grid A at 120, 140, 160, and 180 Minutes after the Submarine Failure



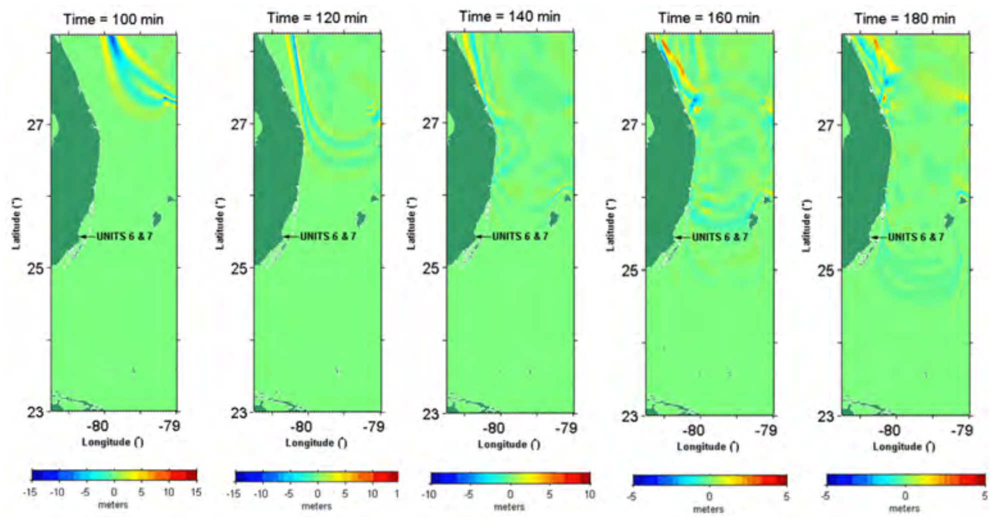
Note: Colors in elevation legend represent water surface elevations relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Figure 2.4.6-246 Simulated Maximum Water Surface Elevation during the Propagation of the Cape Fear Tsunami (Dynamic Source) in Grid A



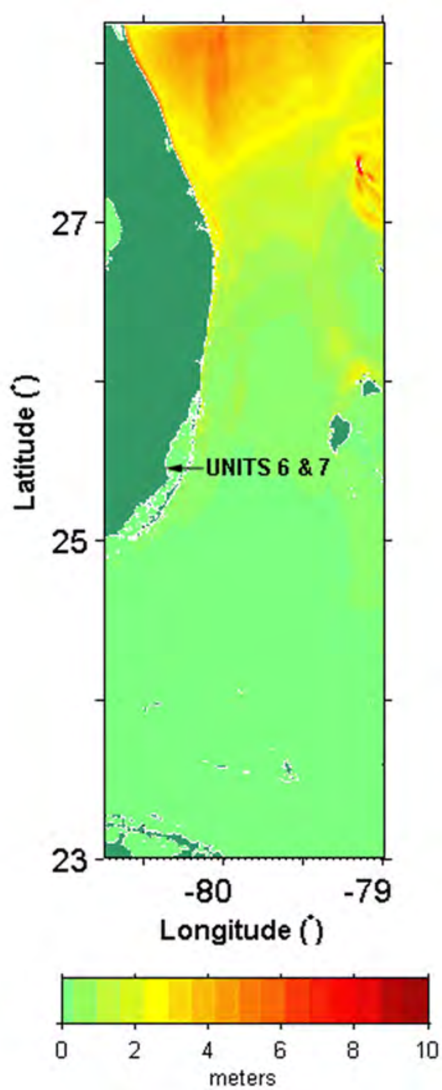
Note: Colors in elevation legend represent water surface elevations relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Figure 2.4.6-247 Simulated Propagation of the Cape Fear Tsunami (Dynamic Source) in Grid B at 100, 120, 140, 160, and 180 Minutes after the Submarine Failure



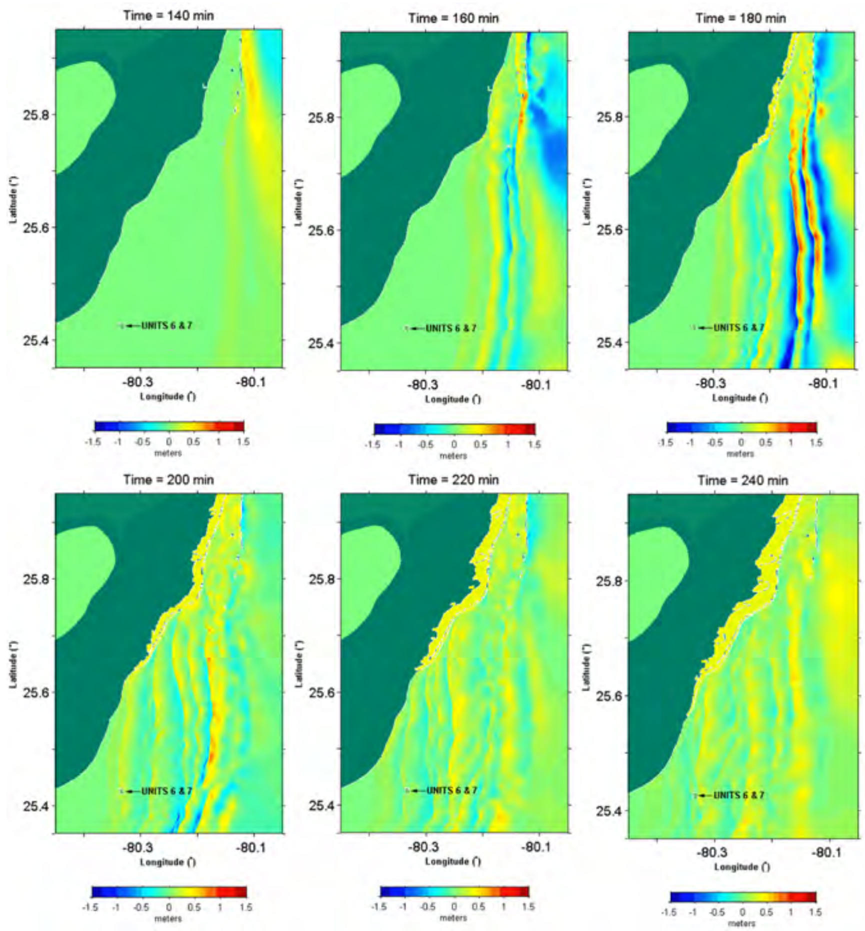
Note: Colors in elevation legend represent water surface elevations relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Figure 2.4.6-248 Simulated Maximum Water Surface Elevation during the Propagation of the Cape Fear Tsunami (Dynamic Source) In Grid B



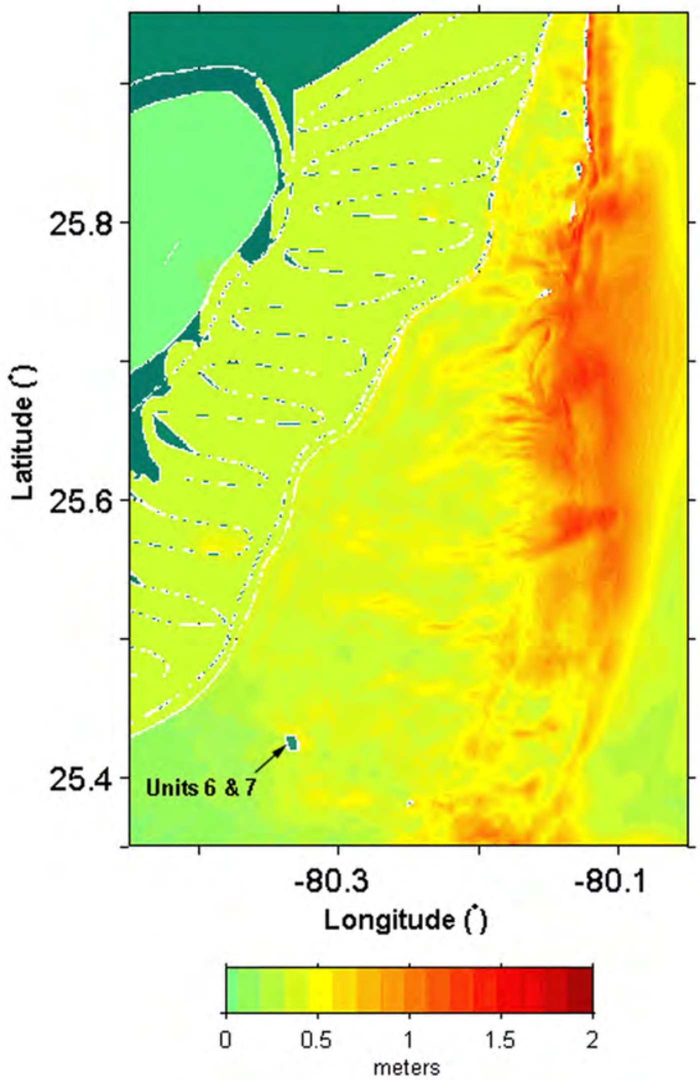
Note: Colors in elevation legend represent water surface elevations relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Figure 2.4.6-249 Simulated Propagation of the Cape Fear Tsunami (Dynamic Source) in Grid C at 140, 160, 180, 200, 220, and 240 Minutes after the Submarine Failure



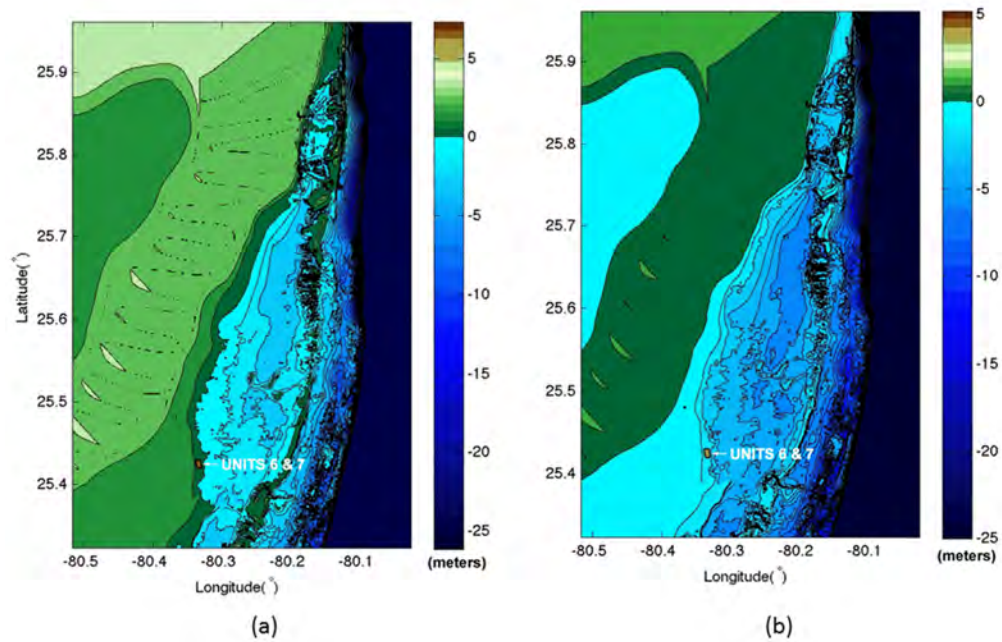
Note: Colors in elevation legend represent water surface elevations relative to MLW.

Figure 2.4.6-250 Simulated Maximum Water Surface Elevation during the Propagation of the Cape Fear Tsunami (Dynamic Source) In Grid C



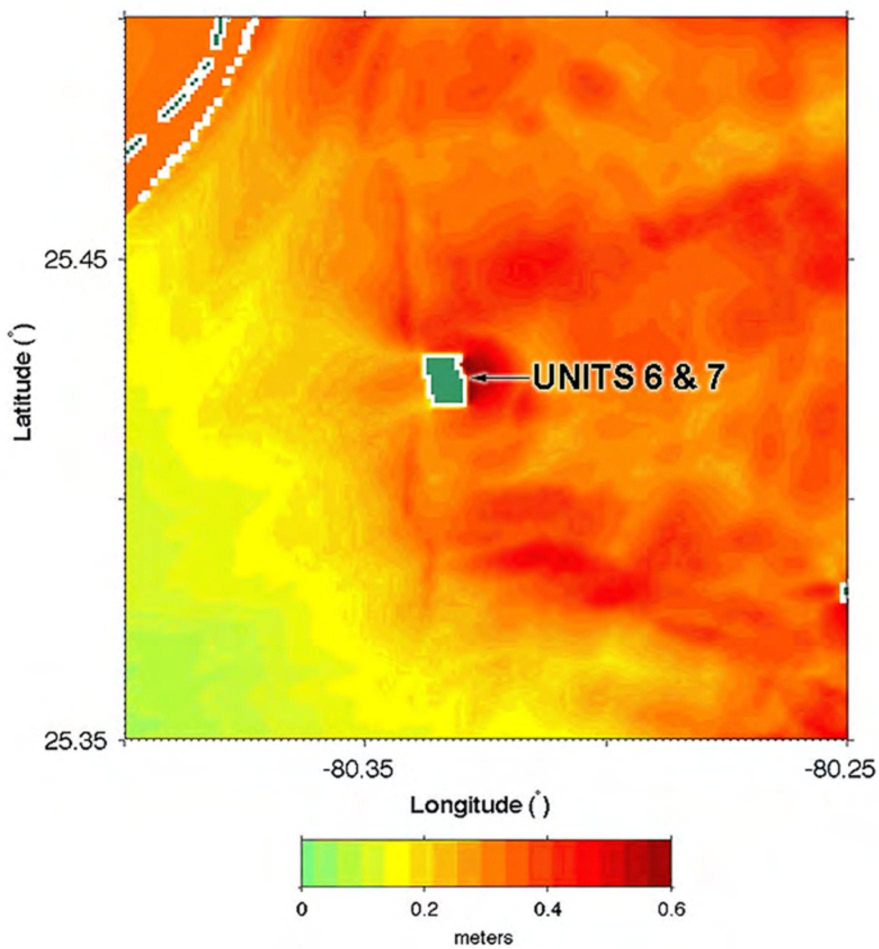
Note: Colors in elevation legend represent water surface elevations relative to MLW.

Figure 2.4.6-251 (a) Water Depth Relative to MLW over the Area of Grid C; and (b) Water Depth Relative to the Assumed Initial Water Surface in the Cape Fear Tsunami Simulations



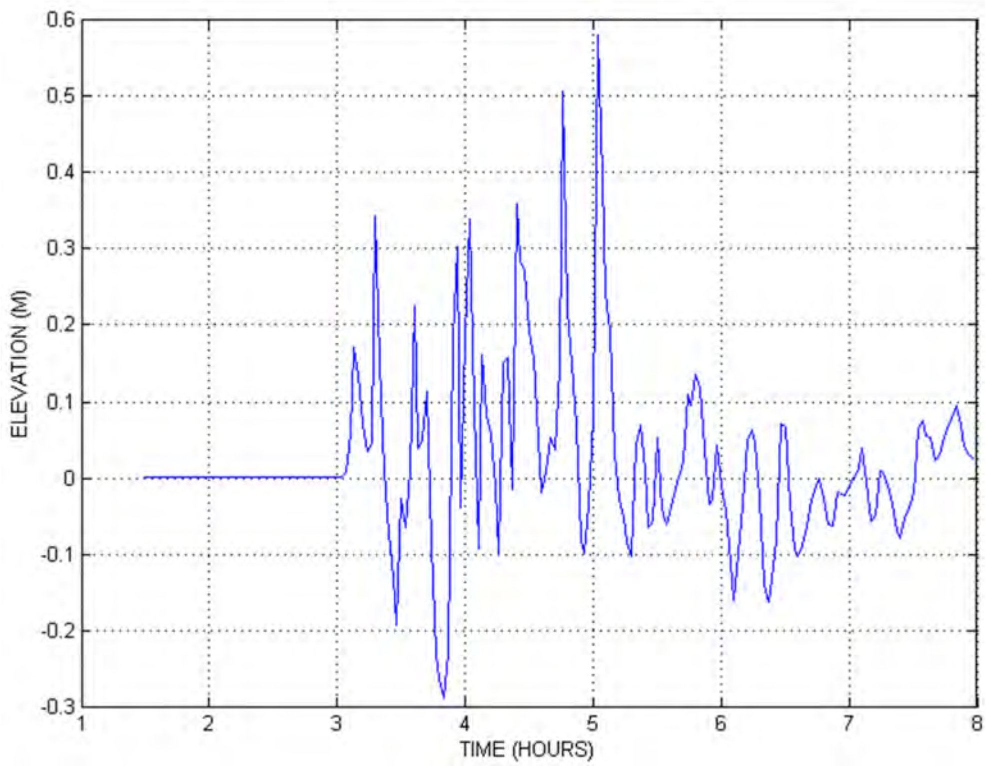
Note: Colors in elevation legend represent water surface elevations relative to MLW.

Figure 2.4.6-252 Simulated Maximum Water Surface Rise, Relative to the Initial Sea Water Level, during the Propagation of the Cape Fear Tsunami (Dynamic Source) in the Vicinity of Units 6 & 7



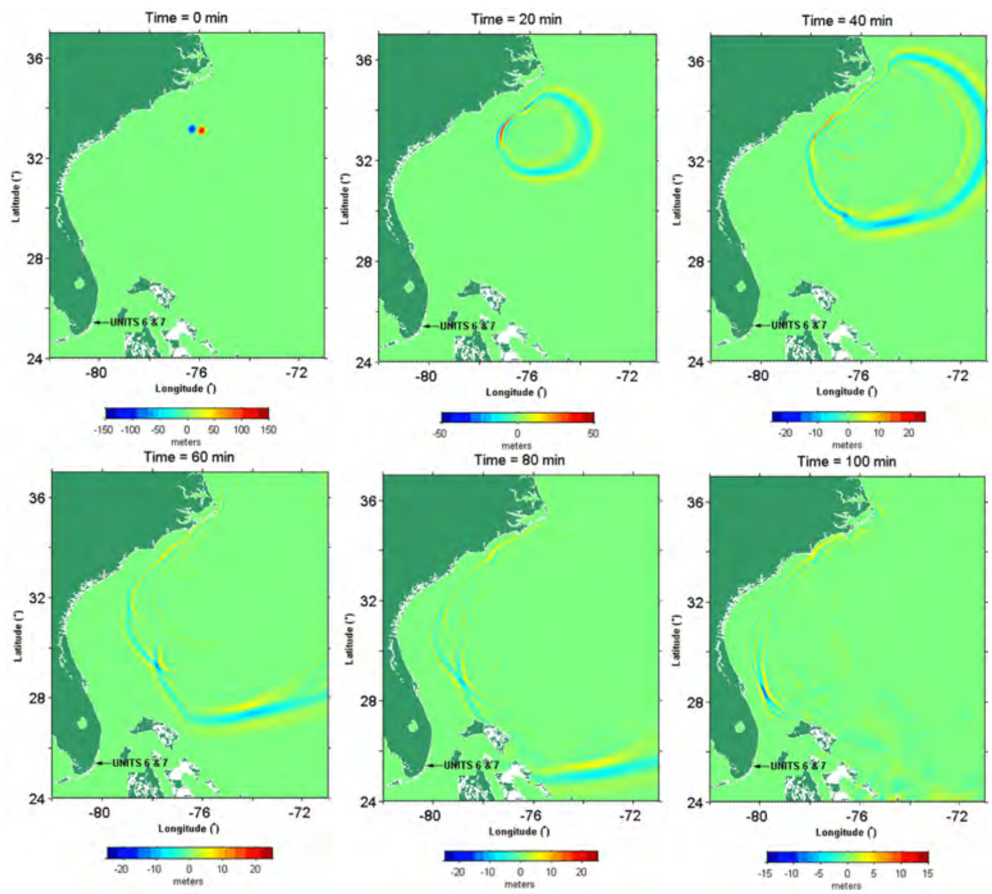
Note: Colors in elevation legend represent water surface elevations relative to MLW.

Figure 2.4.6-253 Water Surface Elevation Near Units 6 & 7 as a Function of Time Following the Cape Fear Tsunami (Dynamic Source)



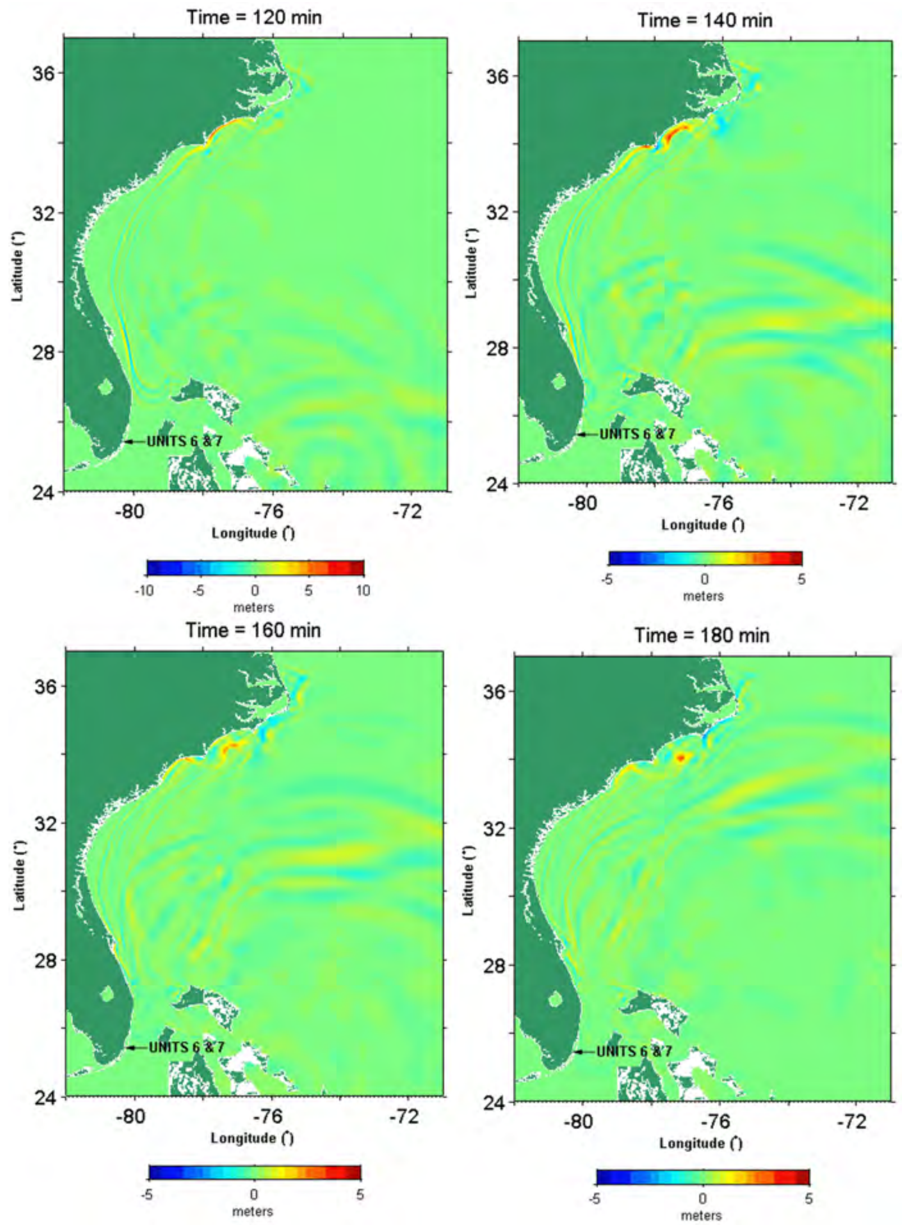
Note: Water surface elevations are relative to the initial water level.

Figure 2.4.6-254 Simulated Propagation of the Cape Fear Tsunami (Static Source) in Grid A at 0, 20, 40, 60, 80, and 100 Minutes after the Submarine Failure



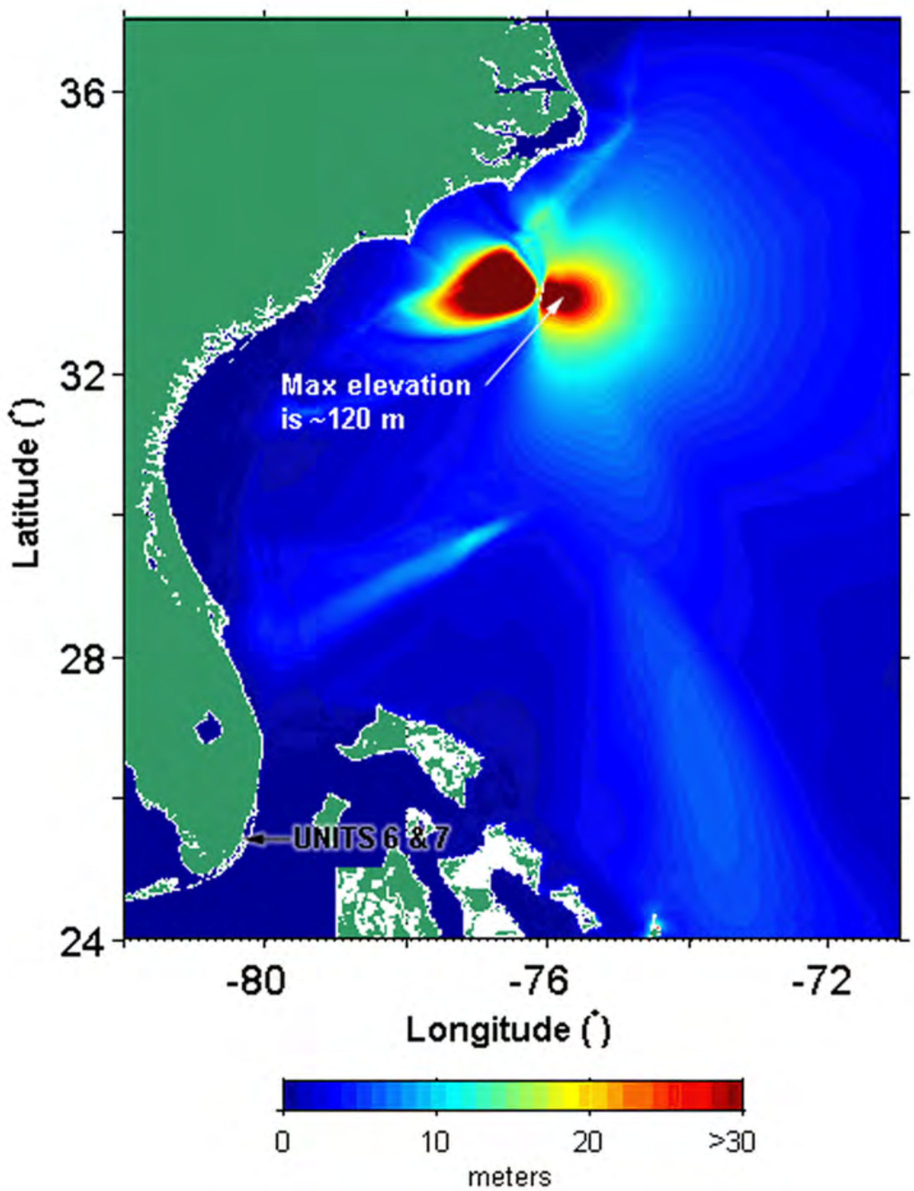
Note: Colors in elevation legend represent water surface elevations relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Figure 2.4.6-255 Simulated Propagation of the Cape Fear Tsunami (Static Source) in Grid A at 120, 140, 160, and 180 Minutes after the Submarine Failure



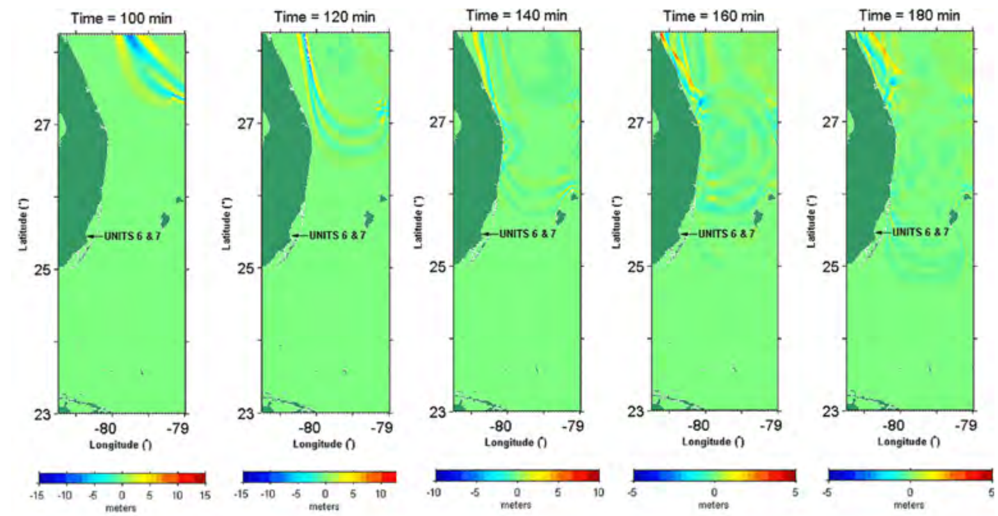
Note: Colors in elevation legend represent water surface elevations relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Figure 2.4.6-256 Simulated maximum water surface elevation during the Propagation of the Cape Fear Tsunami (static source) in Grid A



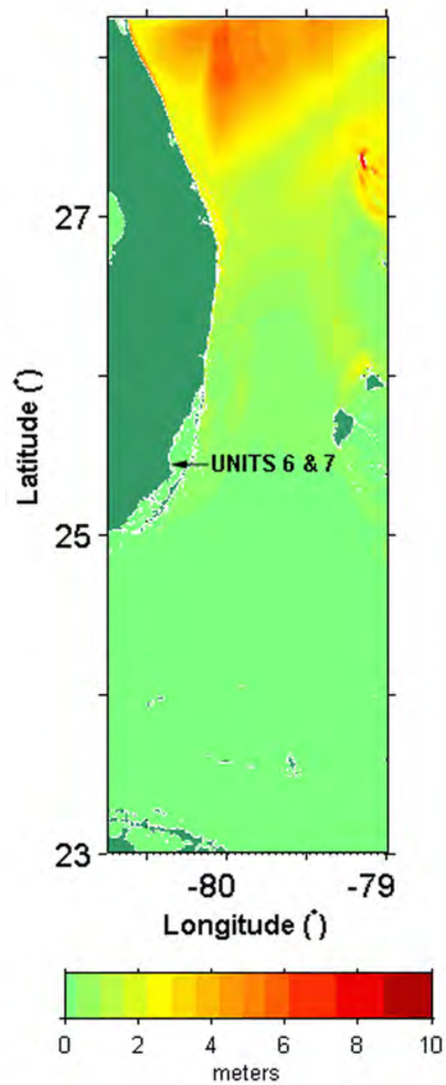
Note: Colors in elevation legend represent water surface elevations relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Figure 2.4.6-257 Simulated Propagation of the Cape Fear Tsunami (Static Source) in Grid B at 100, 120, 140, 160, and 180 Minutes after the Submarine Failure



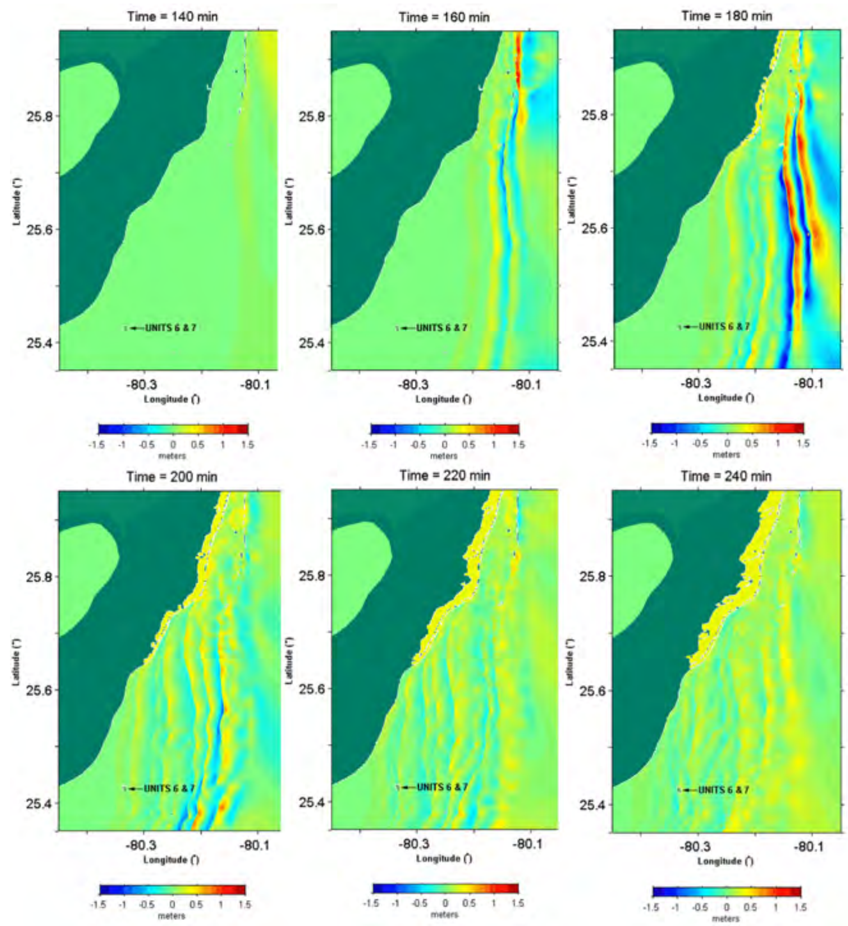
Note: Colors in elevation legend represent water surface elevations relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Figure 2.4.6-258 Simulated Maximum Water Surface Elevation during the Propagation of the Cape Fear Tsunami (Static Source) in Grid B



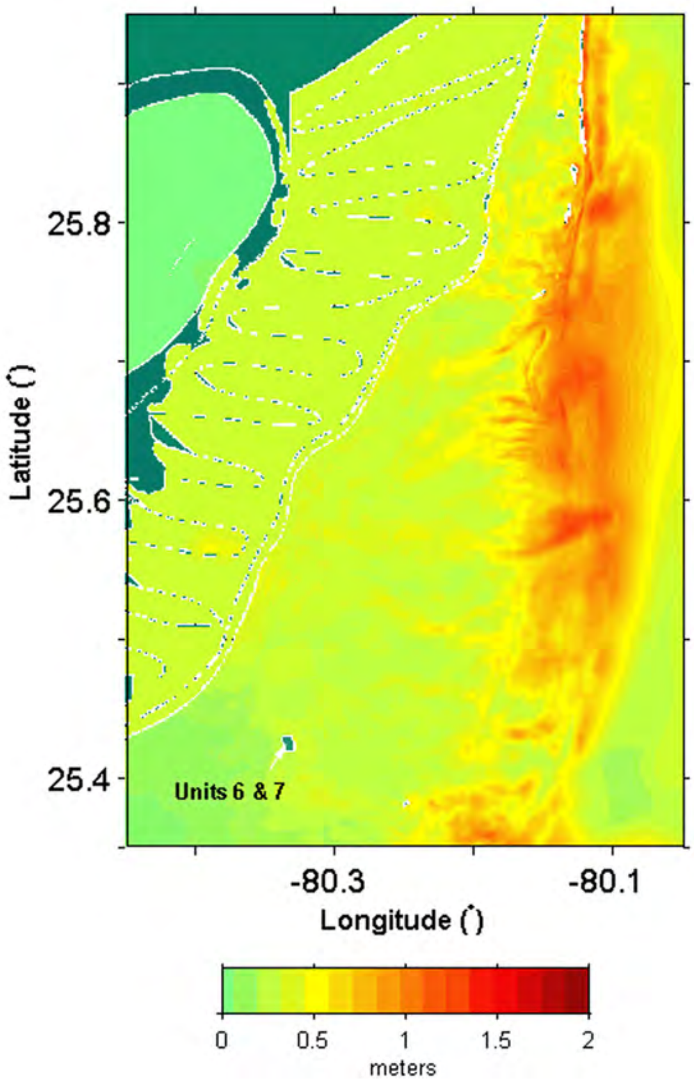
Note: Colors in elevation legend represent water surface elevations relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Figure 2.4.6-259 Simulated Propagation of the Cape Fear Tsunami (Static Source) in Grid C at 140, 160, 180, 200, 220, and 240 Minutes after the Submarine Failure



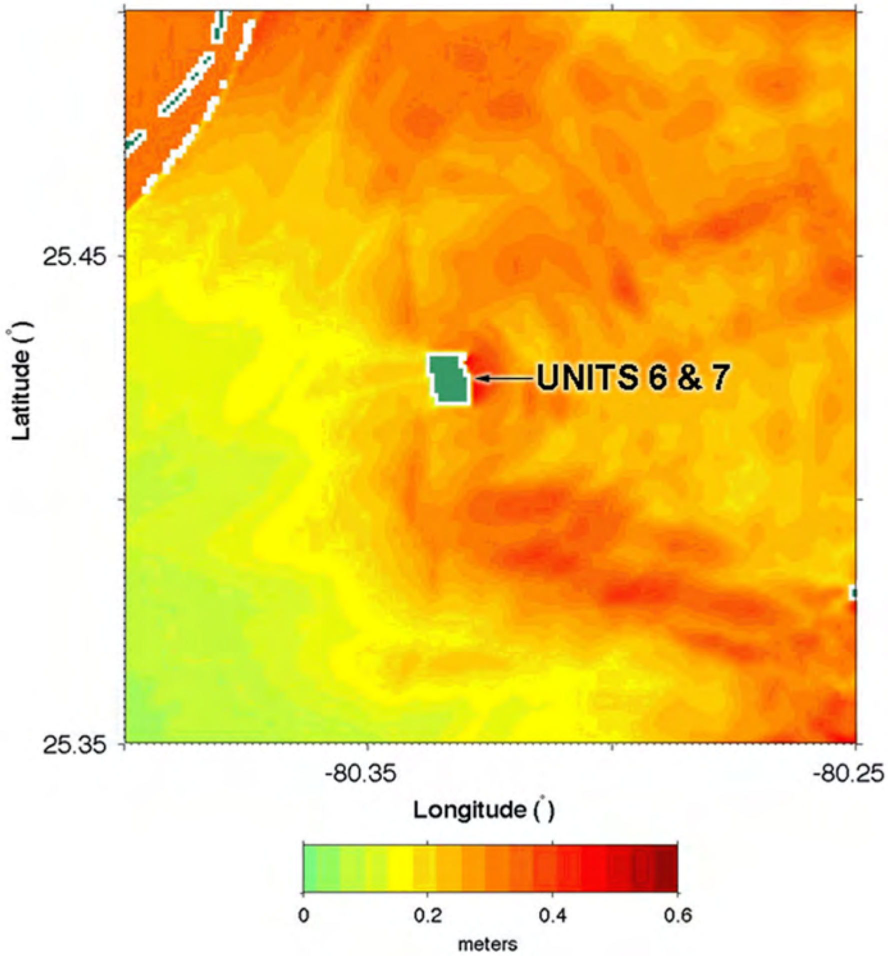
Note: Colors in elevation legend represent water surface elevations relative to MLW.

Figure 2.4.6-260 Simulated Maximum Water Surface Elevation during the Propagation of the Cape Fear Tsunami (Static Source) in Grid C



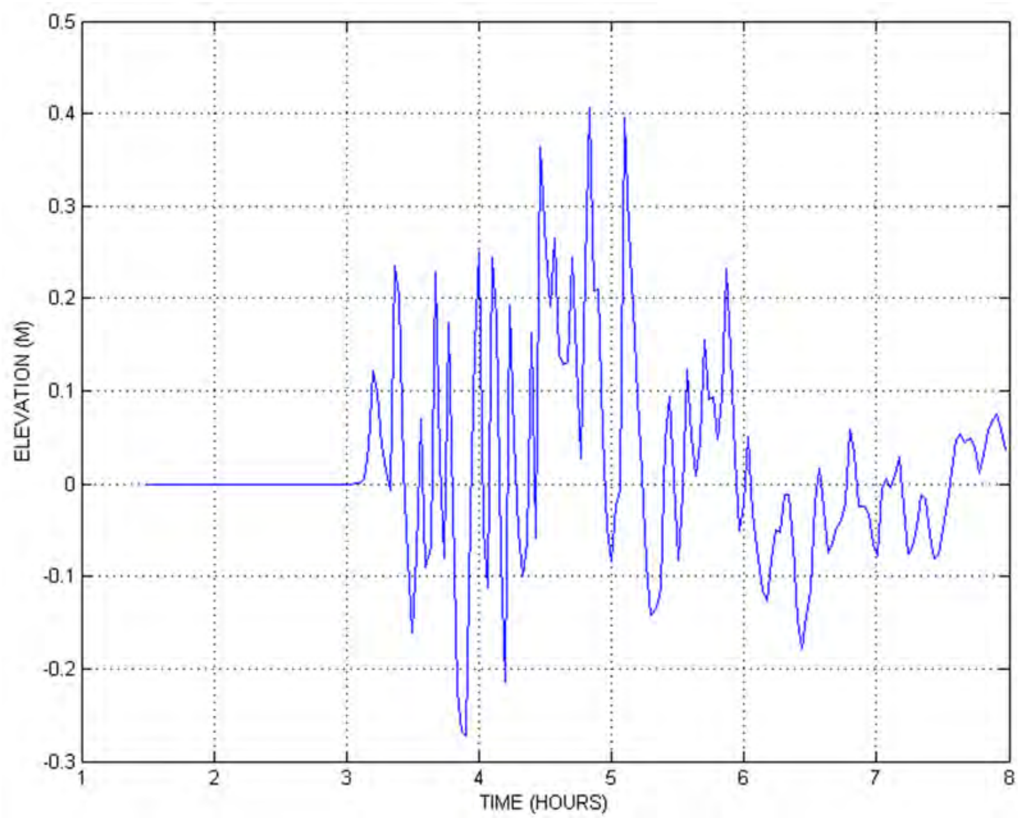
Note: Colors in elevation legend represent water surface elevations relative to MLW.

Figure 2.4.6-261 Simulated Maximum Water Surface Rise, Relative to the Initial Sea Water Level, during the Propagation of the Cape Fear Tsunami (Static Source) in the Vicinity Of Units 6 & 7



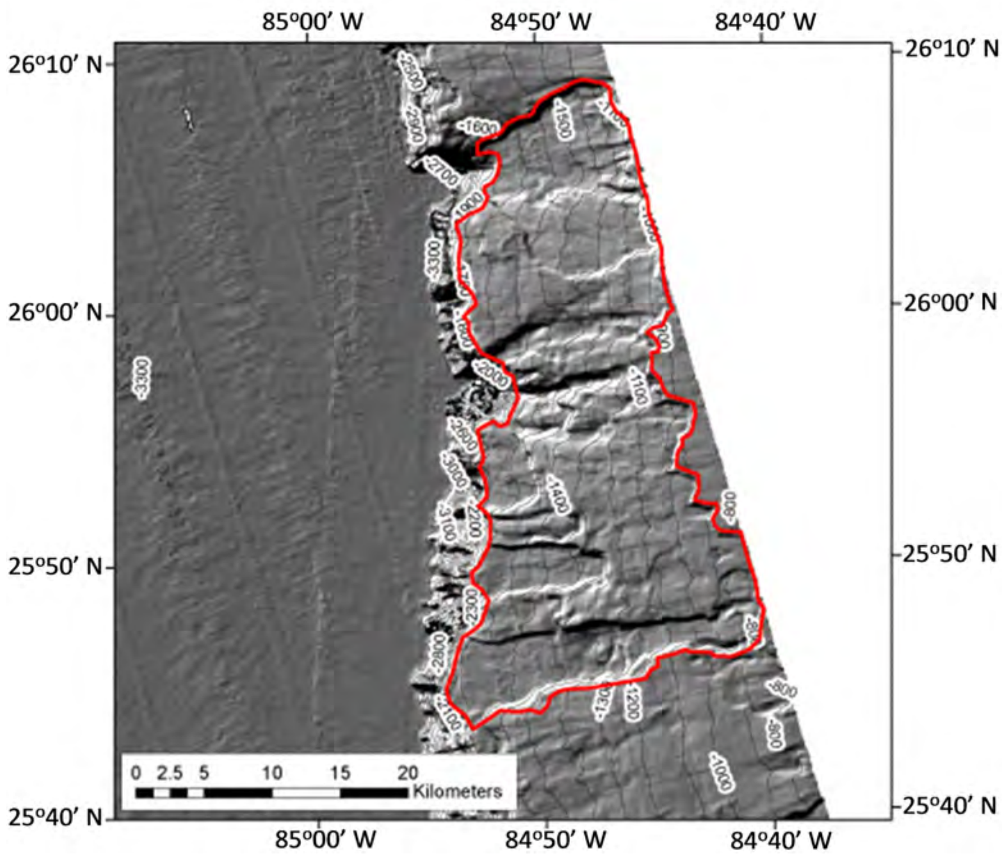
Note: Colors in elevation legend represent water surface elevations relative to MLW.

Figure 2.4.6-262 Water Surface Elevation near Units 6 & 7 as a Function of Time Following the Cape Fear Tsunami (Static Source)



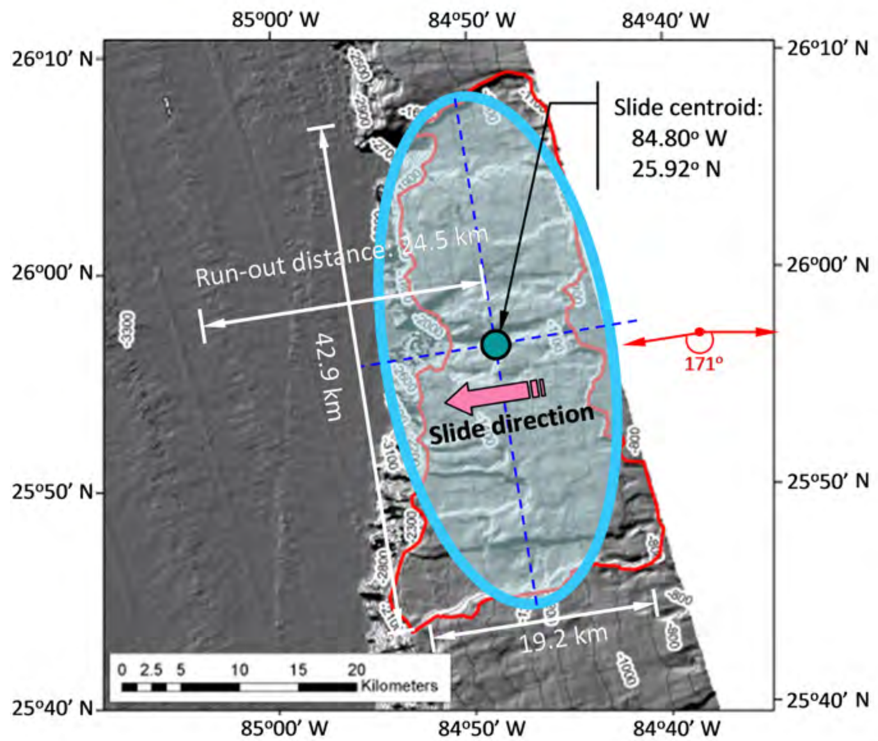
Note: Water surface elevations are relative to the initial water level.

Figure 2.4.6-263 Outline of Maximum Credible Submarine Slide above the Florida Escarpment, Developed from Multibeam Bathymetric Data



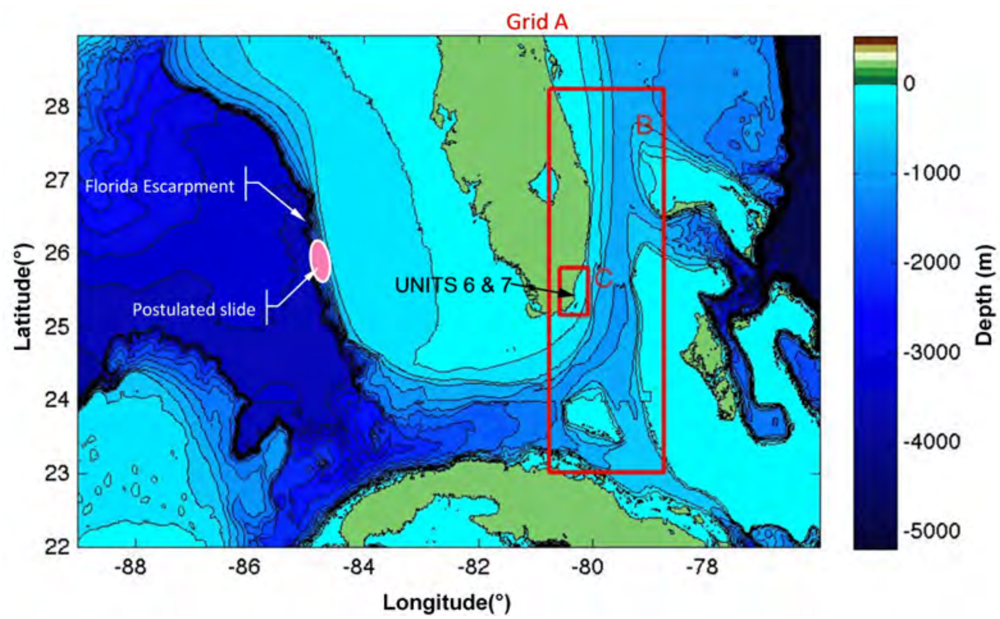
Source: Reference 239

Figure 2.4.6-264 Approximation of the Maximum Credible Submarine Slide above the Florida Escarpment with an Ellipse



Source: Reference 239

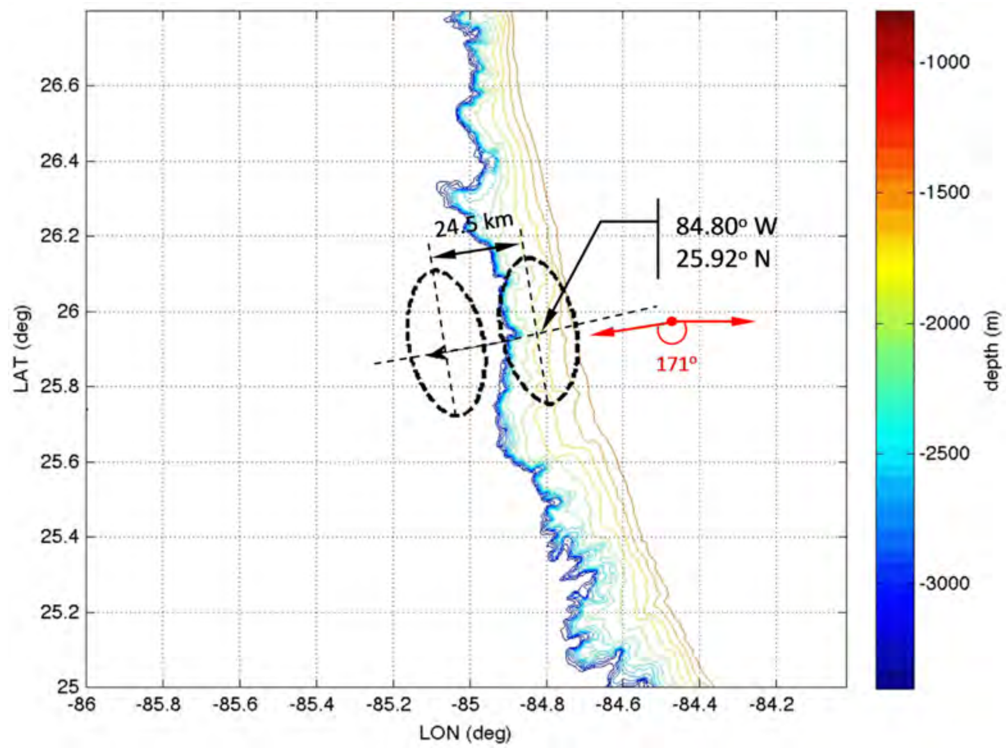
Figure 2.4.6-265 Model Domain and Bathymetry in the Three Nested Grids Used in the FUNWAVE Simulations



Note: Colors in elevation legend represent water depths relative to MSL for ETOP01 data and MLW for Coastal Relief Model data.

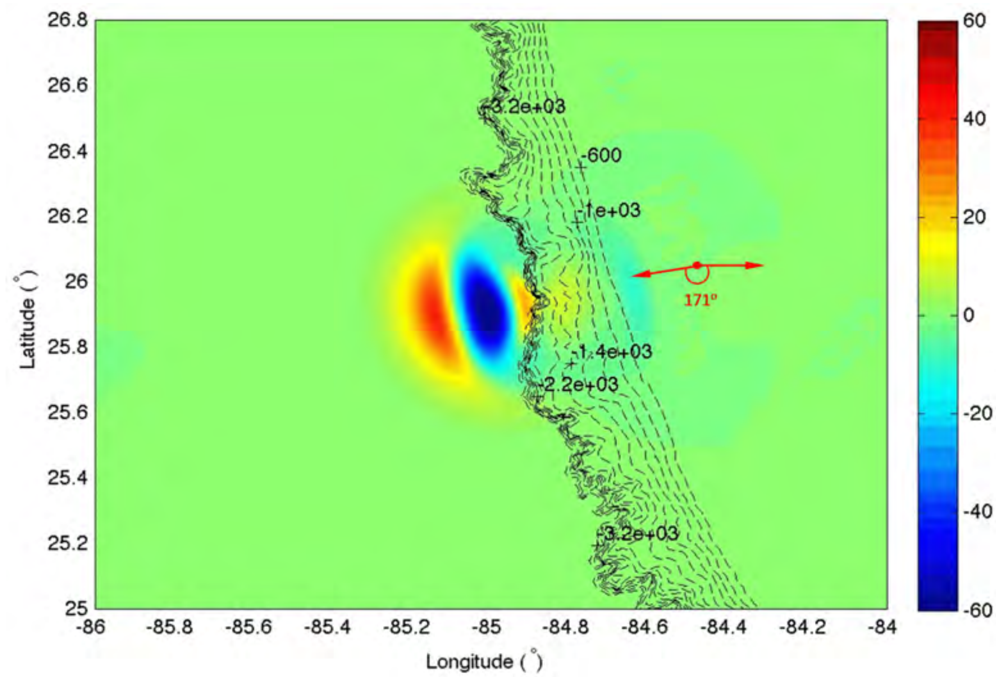
Source: References 244 and 246

Figure 2.4.6-266 Location and Lateral Extent of the Postulated Submarine Mass Failure for the Florida Escarpment Slide Simulations and Local Bathymetry



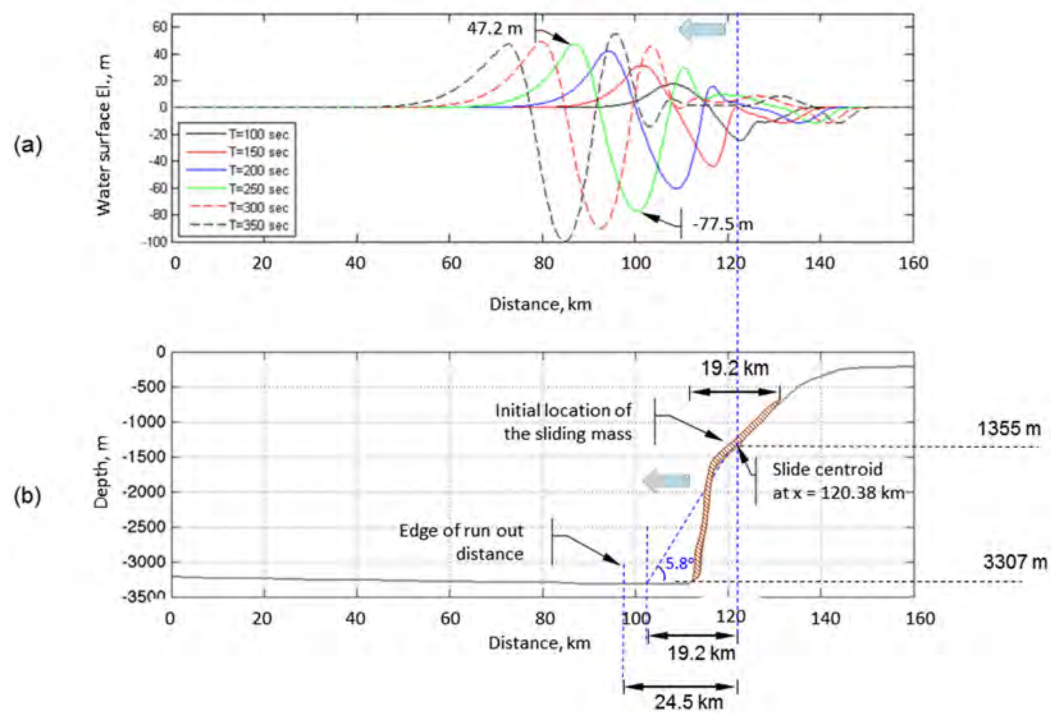
Note: Colors in elevation legend represent water depths relative to MLW.
Source: Reference 246

Figure 2.4.6-267 Initial Wave Generated by NHWAVE (Dynamic Source) for the Florida Escarpment Submarine Failure



Note: Colors in elevation legend indicate water surface elevation (MLW). Bathymetry contours indicate water depths (MLW) in meters.

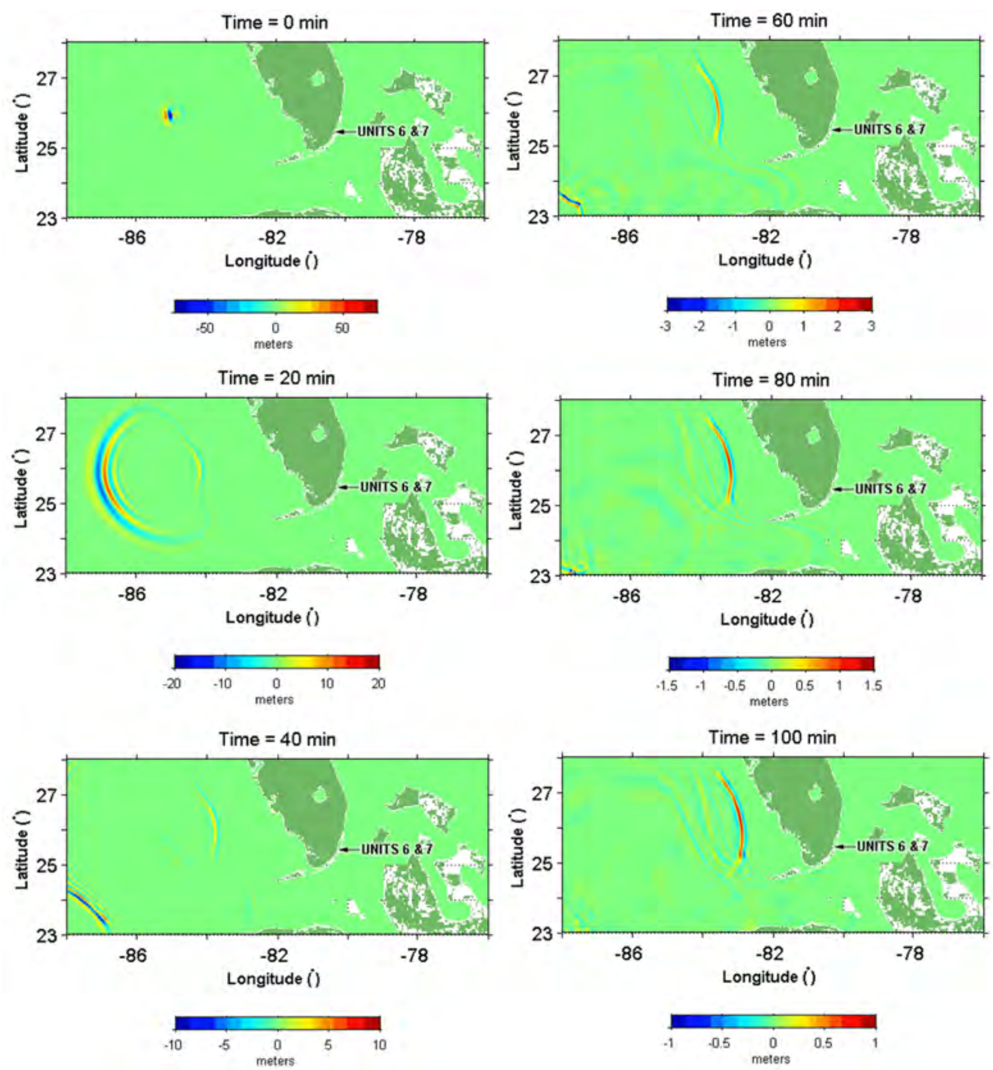
Figure 2.4.6-268 (a) Water Surface Profiles in the Direction of the Slide Motion at Different Times after the Initiation of the Slide Obtained from NHWAVE and (b) Ocean Floor Profile (Lower Panel)



Note 1: The water surface profiles and cross section shown in this figure are along the minor axis of the ellipse shown in Figure 2.4.6-264.

Note 2: Water surface elevations in the upper panel and depths in the lower panel are relative to MLW, respectively.

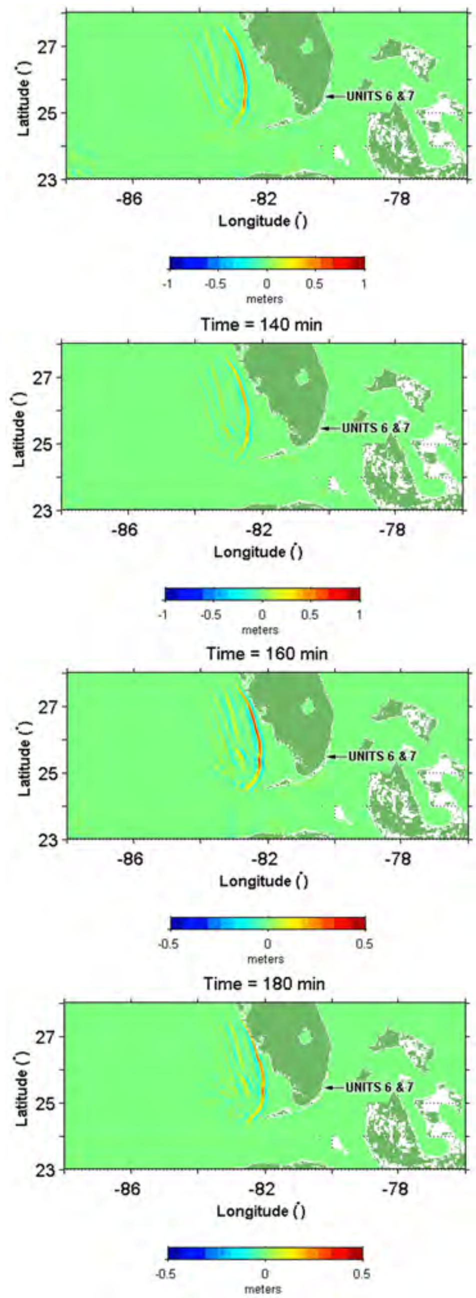
Figure 2.4.6-269 Simulated Propagation of the Florida Escarpment Tsunami (Dynamic Source) in Grid A at 0, 20, 40, 60, 80, and 100 Minutes after the Submarine Mass Failure



Note: Colors in elevation legend represent water surface elevations in meters relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Source: References 244 and 246

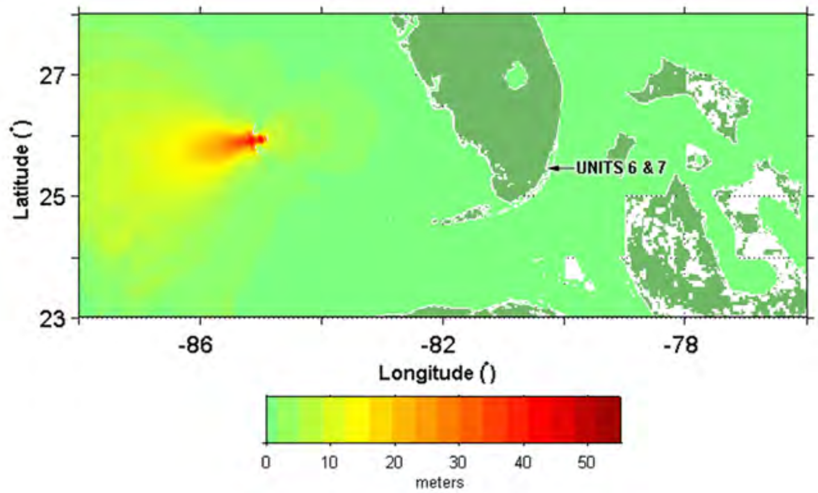
Figure 2.4.6-270 Simulated Propagation of the Florida Escarpment Tsunami (Dynamic Source) in Grid A at 120, 140, 160, and 180 Minutes after the Submarine Mass Failure



Note: Colors in elevation legend represent water surface elevations in meters relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Source: References 244 and 246

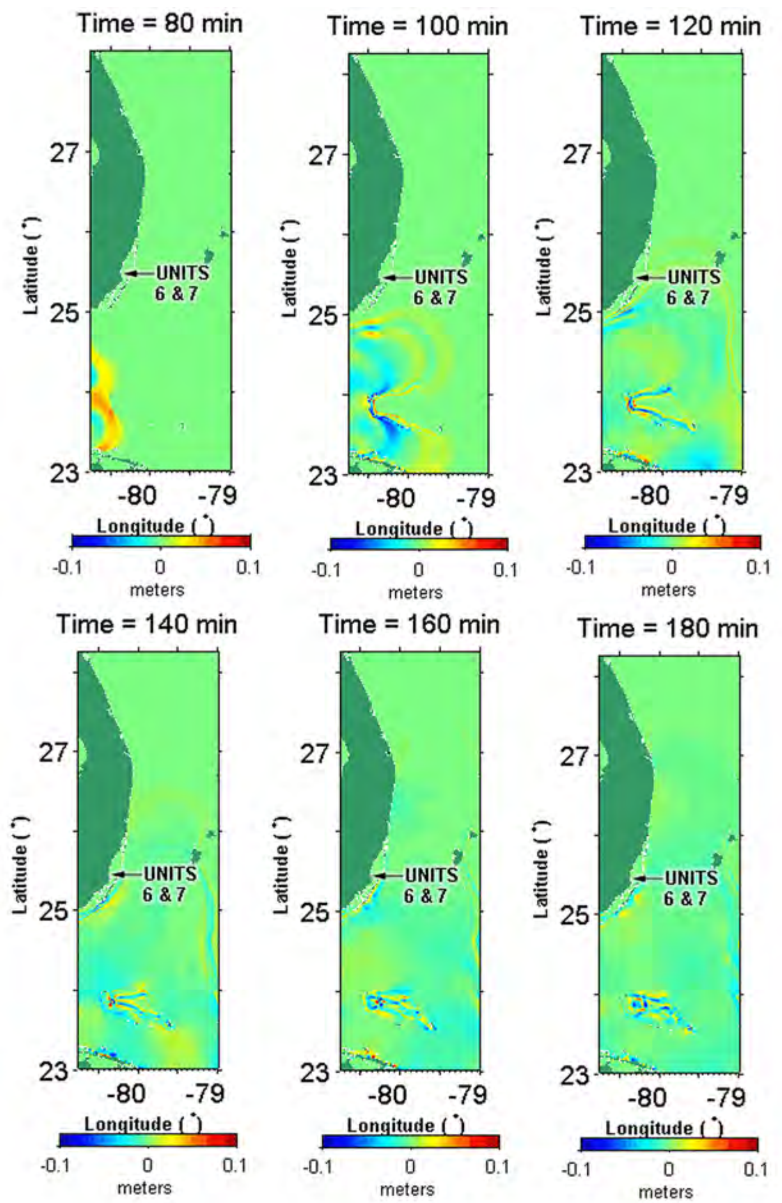
Figure 2.4.6-271 Simulated Maximum Wave Height during the Propagation of the Florida Escarpment Tsunami (Dynamic Source) in Grid A



Note: Colors in elevation legend represent water surface elevations relative in meters to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Source: References 244 and 246

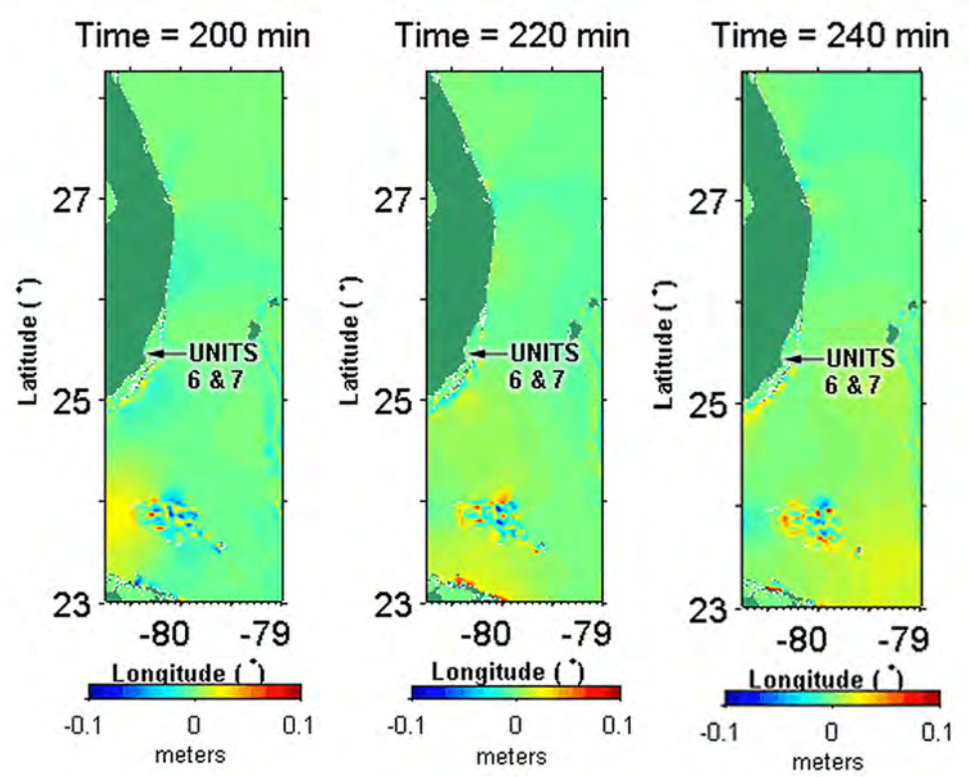
Figure 2.4.6-272 Simulated Propagation of the Florida Escarpment Tsunami (Dynamic Source) in Grid B at 80, 100, 120, 140, and 160 Minutes after the Submarine Mass Failure



Note: Colors in elevation legend represent water surface elevations in meters relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Source: References 244 and 246

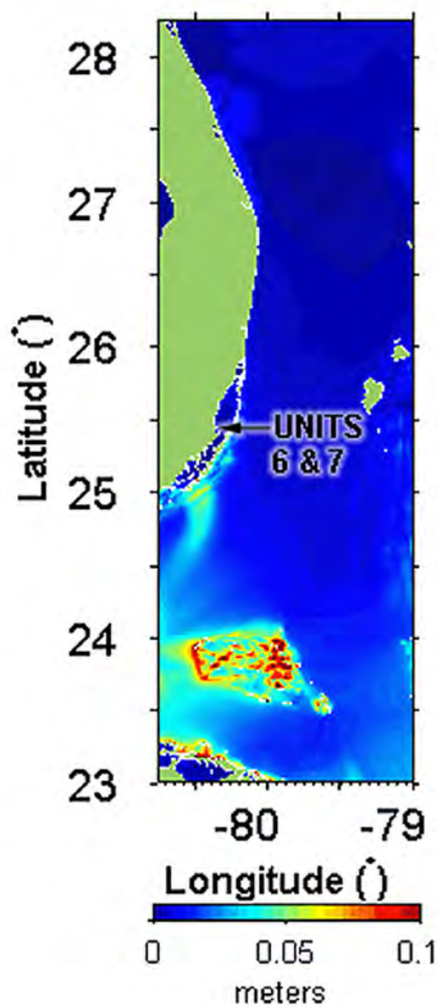
Figure 2.4.6-273 Simulated Propagation of the Florida Escarpment Tsunami (Dynamic Source) in Grid B at 200, 220, and 240 Minutes after the Submarine Mass Failure



Note: Colors in elevation legend represent water surface elevations in meters relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

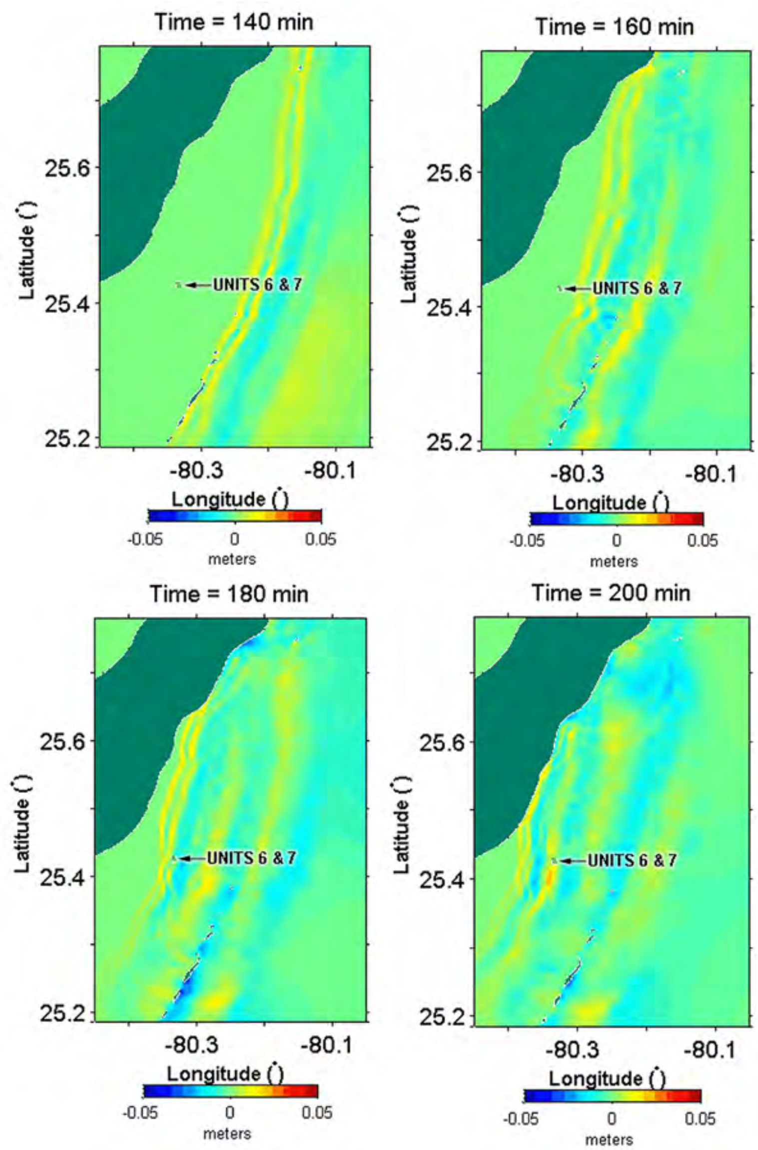
Source: References 244 and 246

Figure 2.4.6-274 Simulated Maximum Wave Height during the Propagation of the Florida Escarpment Tsunami (Dynamic Source) In Grid B



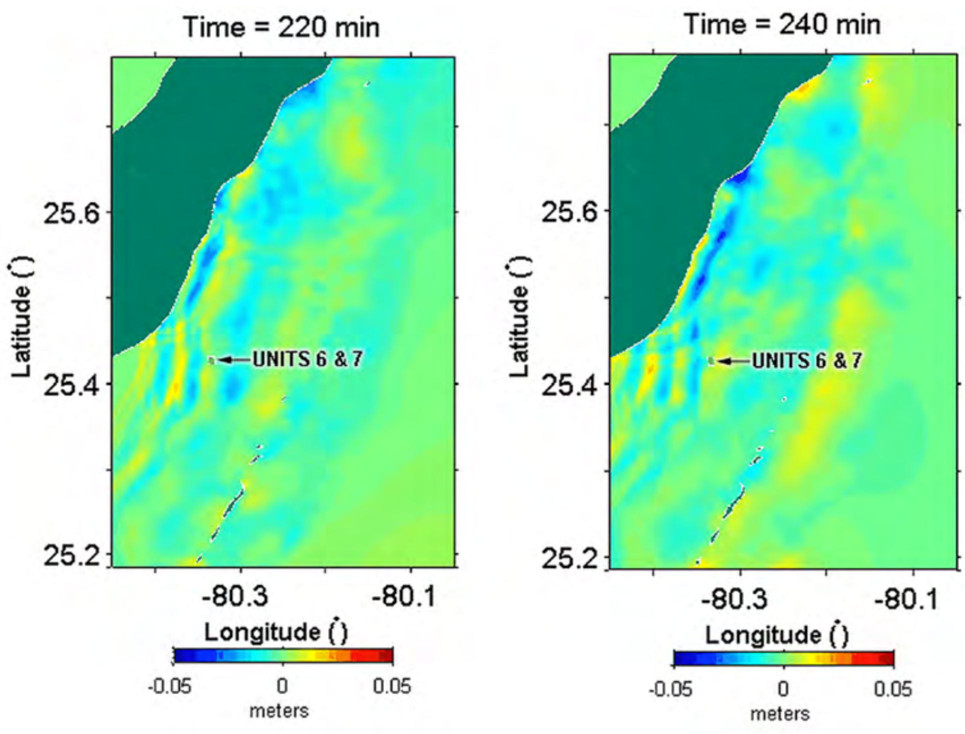
Note: Colors in elevation legend represent water surface elevations in meters relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.
Source: References 244 and 246

Figure 2.4.6-275 Simulated Propagation of the Florida Escarpment Tsunami (Dynamic Source) in Grid C at 140, 160, 180, and 200 Minutes after the Submarine Failure



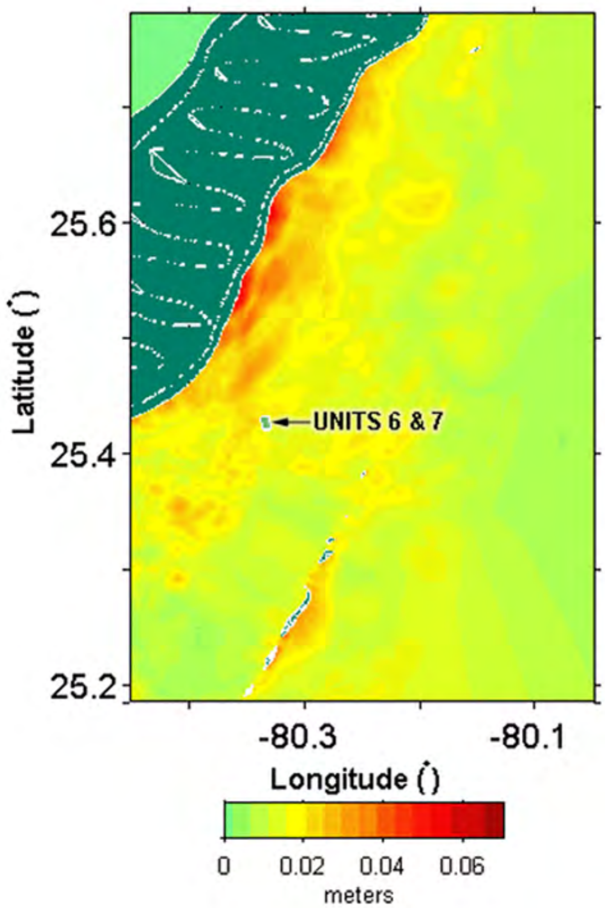
Note: Colors in elevation legend represent water surface elevations in meters relative to MLW.

Figure 2.4.6-276 Simulated Propagation of the Florida Escarpment Tsunami (Dynamic Source) in Grid C at 140, 160, 180, 200, 220, and 240 Minutes after the Submarine Failure



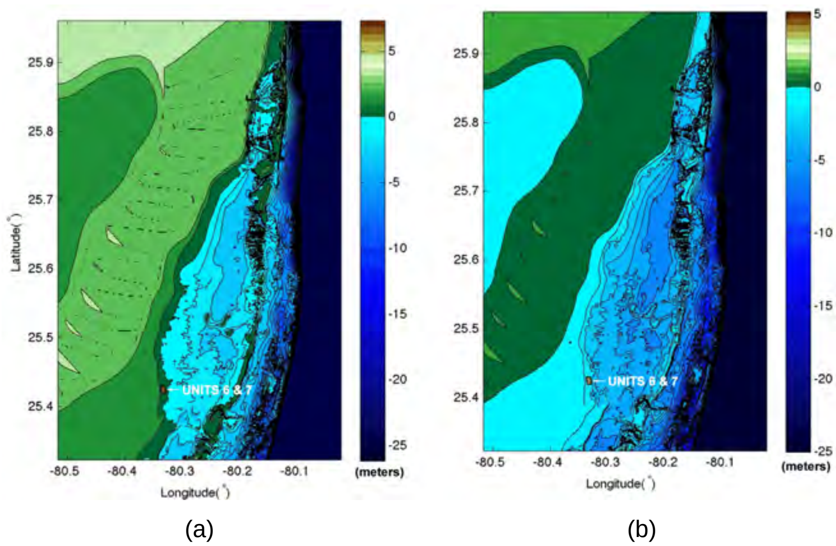
Note: Colors in elevation legend represent water surface elevations in meters relative to MLW.

Figure 2.4.6-277 Simulated Maximum Water Surface Elevation during the Propagation of the Florida Escarpment Tsunami (Dynamic Source) in Grid C



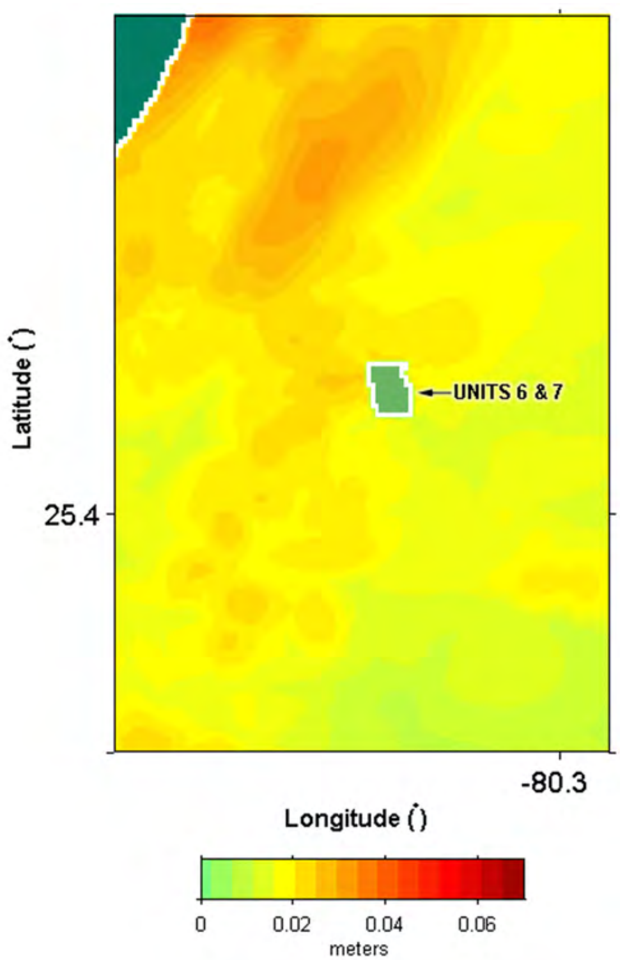
Note: Colors in elevation legend represent water surface elevations in meters relative to MLW.

Figure 2.4.6-278 (a) Water Depth Relative to MLW over the Area of Grid C without the Water Level Rise that is Used to Define the Initial Condition for the Tsunami Propagation Simulations; and (b) Water Depth Relative to the Assumed Initial Water Surface in the Florida Escarpment Tsunami Simulations



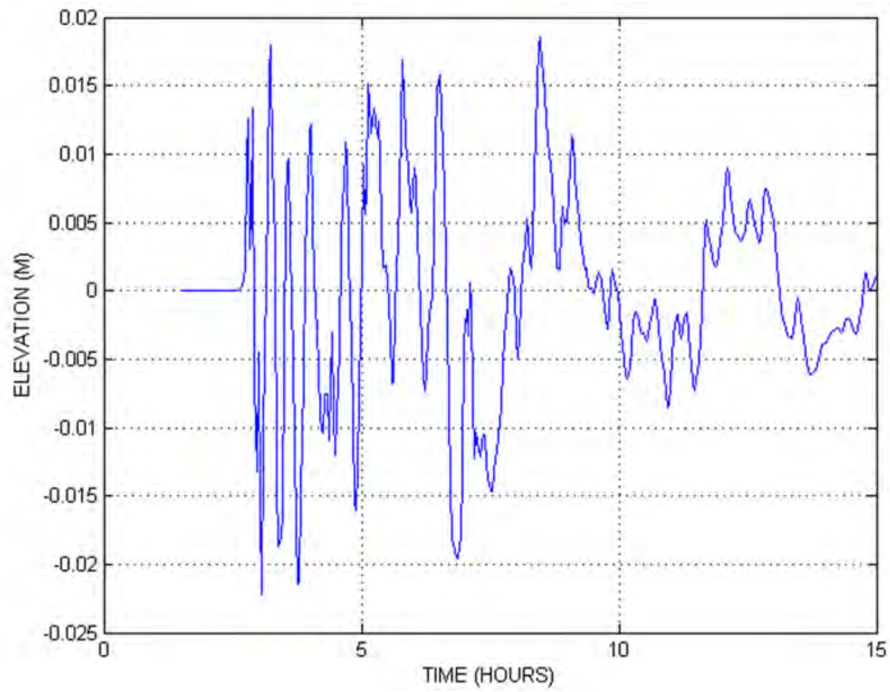
Note: Colors in elevation legend represent water depths relative to MLW.

Figure 2.4.6-279 Simulated Maximum Water Surface Rise, Relative to the Initial Sea Water Level, during the Propagation of the Florida Escarpment Tsunami (Dynamic Source) in the Vicinity of Units 6 & 7



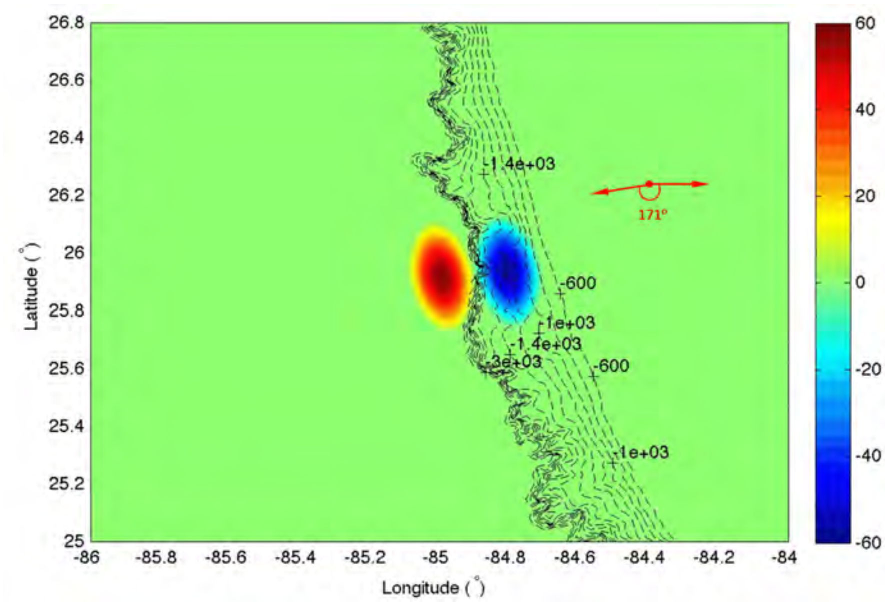
Note: Colors in elevation legend represent water surface elevations in meters relative to MLW.

Figure 2.4.6-280 Water Surface Elevation near Units 6 & 7 as a Function of Time Following the Florida Escarpment Tsunami (Dynamic Source)



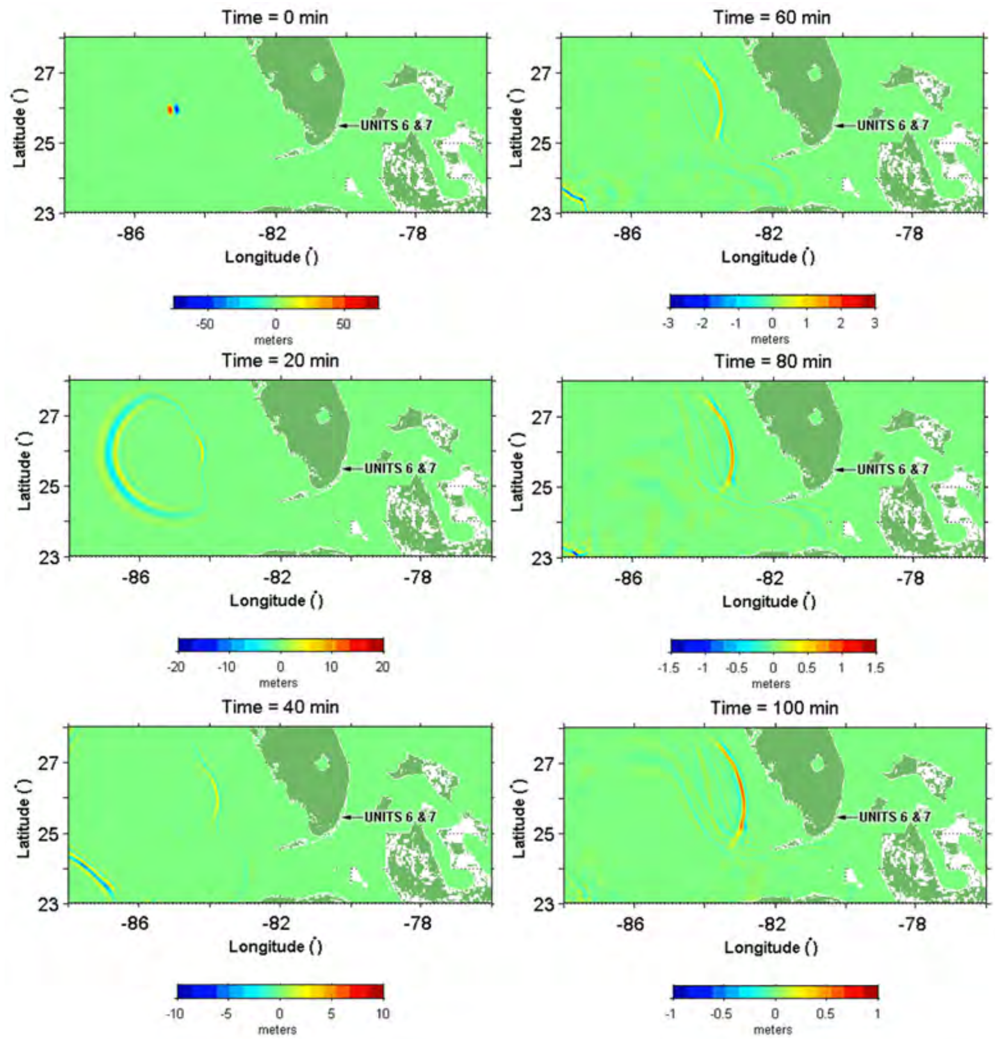
Note: Water surface elevations are relative to MLW and the initial water level.

Figure 2.4.6-281 Initial Wave for a Static Source Representation of the Florida Escarpment Submarine Failure Shown in Figure 2.4.6-254



Note: Colors in elevation legend indicate water surface elevation (MLW). Bathymetry contours indicate water depths (MLW) in meters.

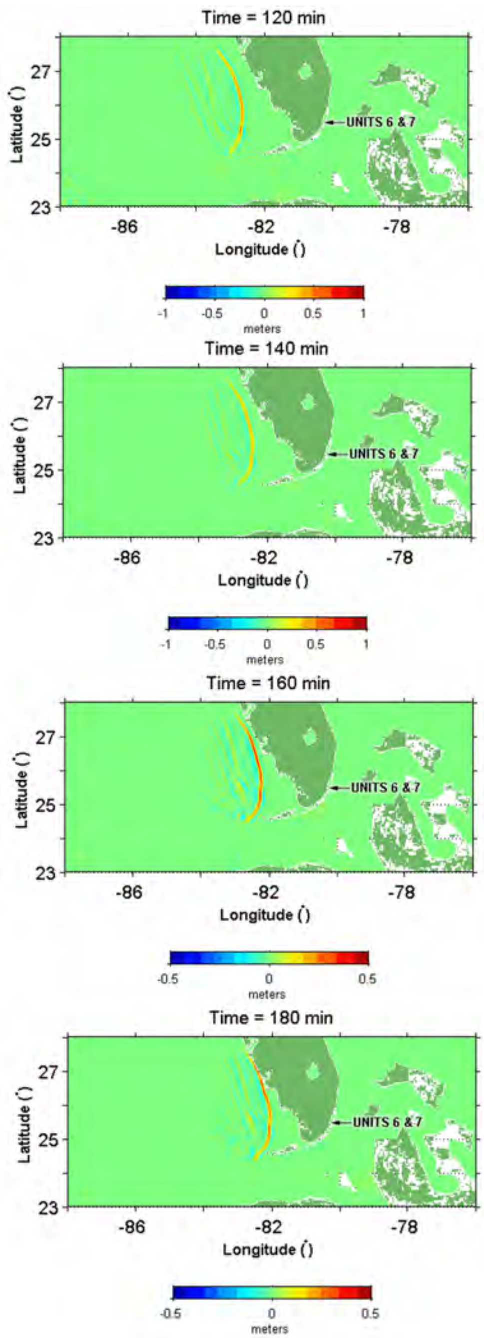
Figure 2.4.6-282 Simulated Propagation of the Florida Escarpment Tsunami (Static Source) in Grid A at 0, 20, 40, 60, 80, and 100 Minutes after the Submarine Failure



Note: Colors in elevation legend represent water surface elevations in meters relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Source: References 244 and 246

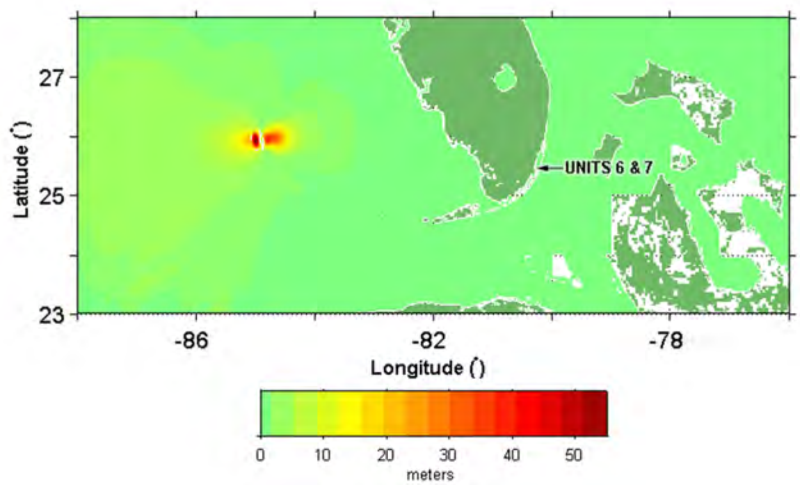
Figure 2.4.6-283 Simulated Propagation of the Florida Escarpment Tsunami (Static Source) in Grid A at 120, 140, and 160 Minutes after the Submarine Failure



Note: Colors in elevation legend represent water surface elevations in meters relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Source: References 244 and 246

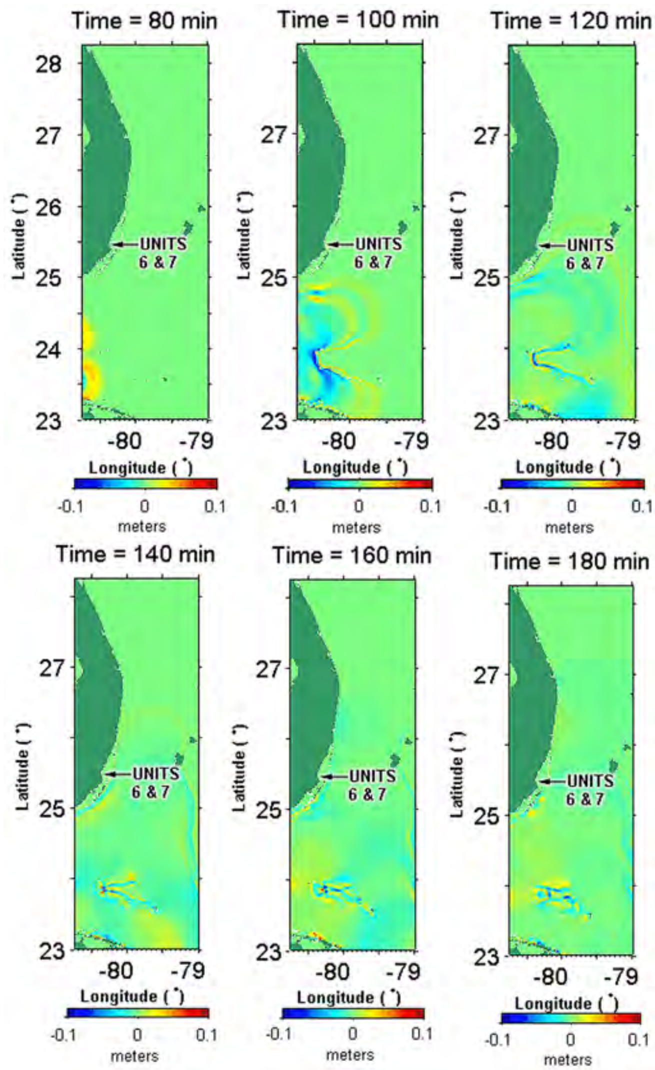
Figure 2.4.6-284 Simulated Maximum Water Surface Elevation during the Propagation of the Florida Escarpment Tsunami (Static Source) in Grid A



Note: Colors in elevation legend represent water surface elevations relative in meters to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Source: References 244 and 246

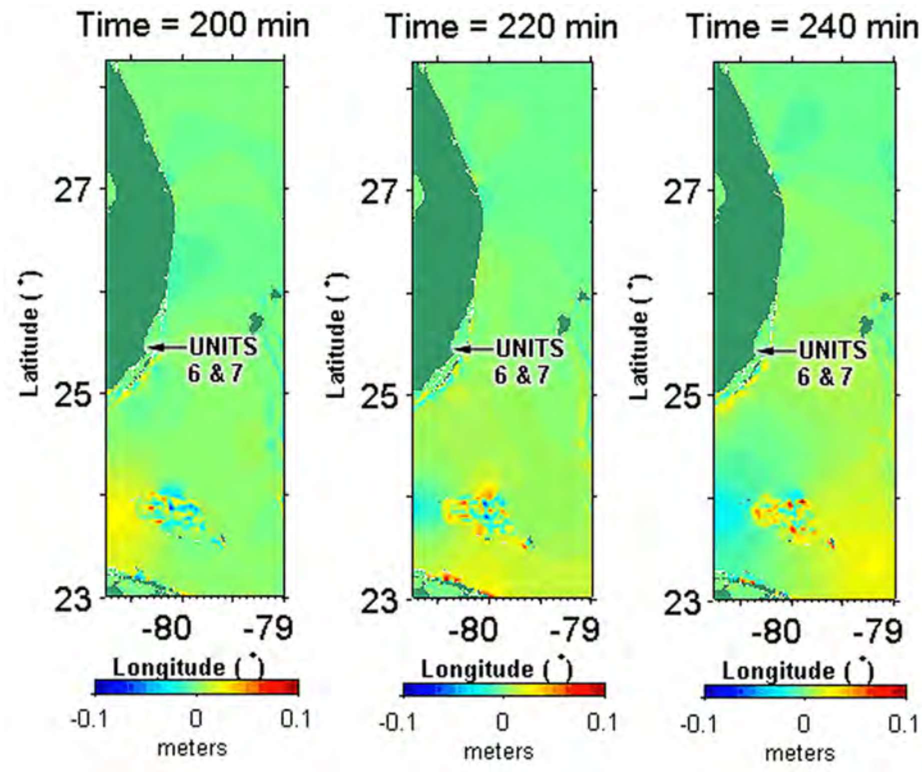
Figure 2.4.6-285 Simulated Propagation of the Florida Escarpment Tsunami (Static Source) in Grid B at 80, 100, 120, 140, 160, and 180 Minutes after the Submarine Failure



Note: Colors in elevation legend represent water surface elevations in meters relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Source: References 244 and 246

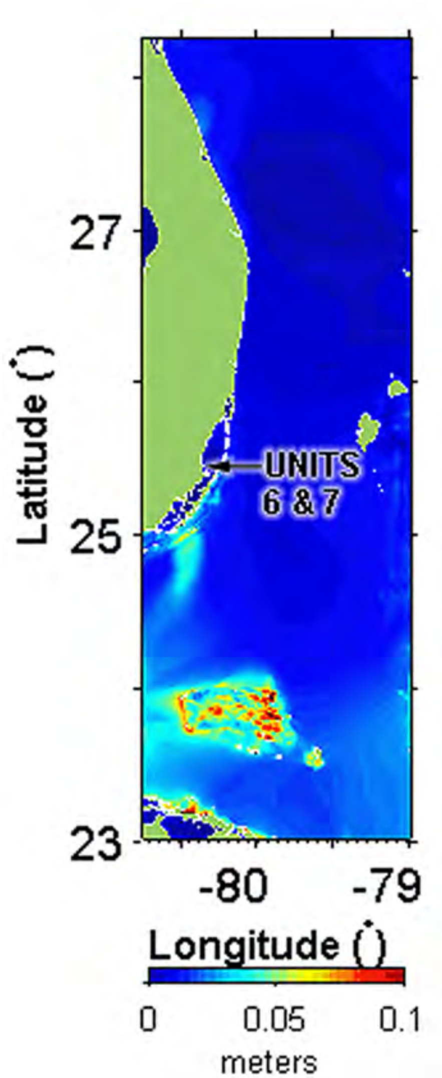
Figure 2.4.6-286 Simulated Propagation of the Florida Escarpment Tsunami (Static Source) in Grid B at 200, 220, and 240 Minutes after the Submarine Failure



Note: Colors in elevation legend represent water surface elevations in meters relative to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

Source: References 244 and 246

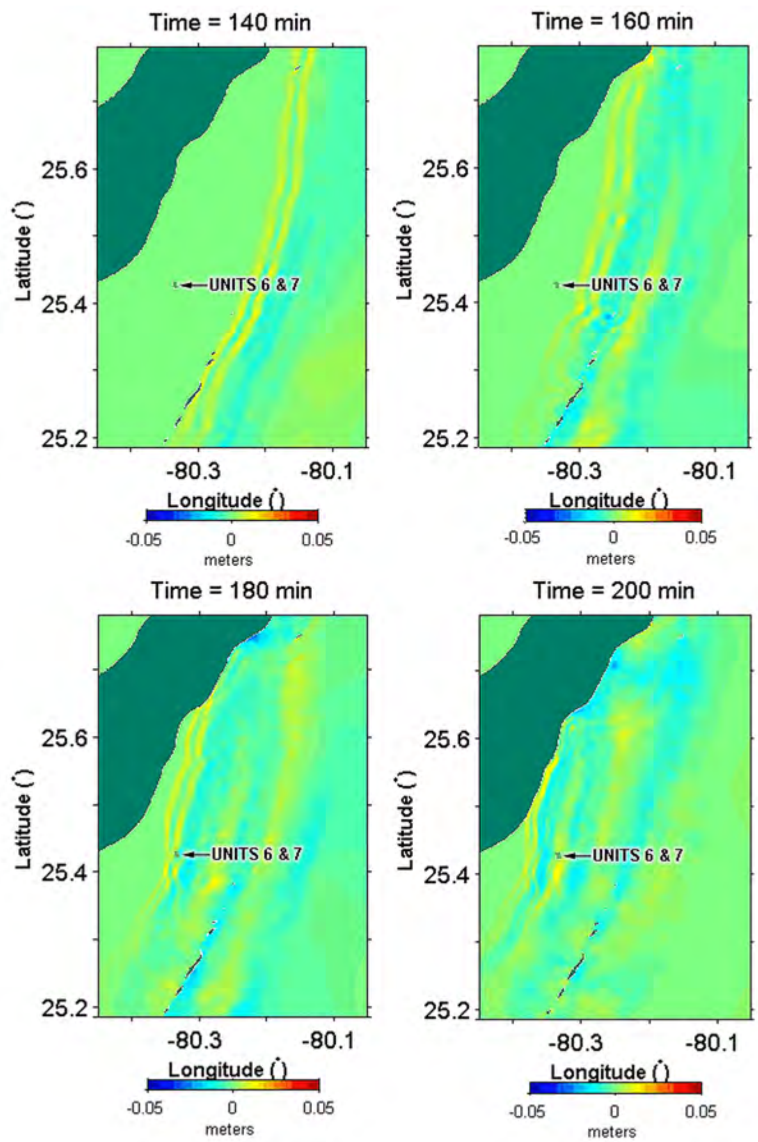
Figure 2.4.6-287 Simulated Maximum Water Surface Elevation during the Propagation of the Florida Escarpment Tsunami (Static Source) in Grid B



Note: Colors in elevation legend represent water surface elevations relative in meters to MSL for ETOPO1 data and MLW for Coastal Relief Model data.

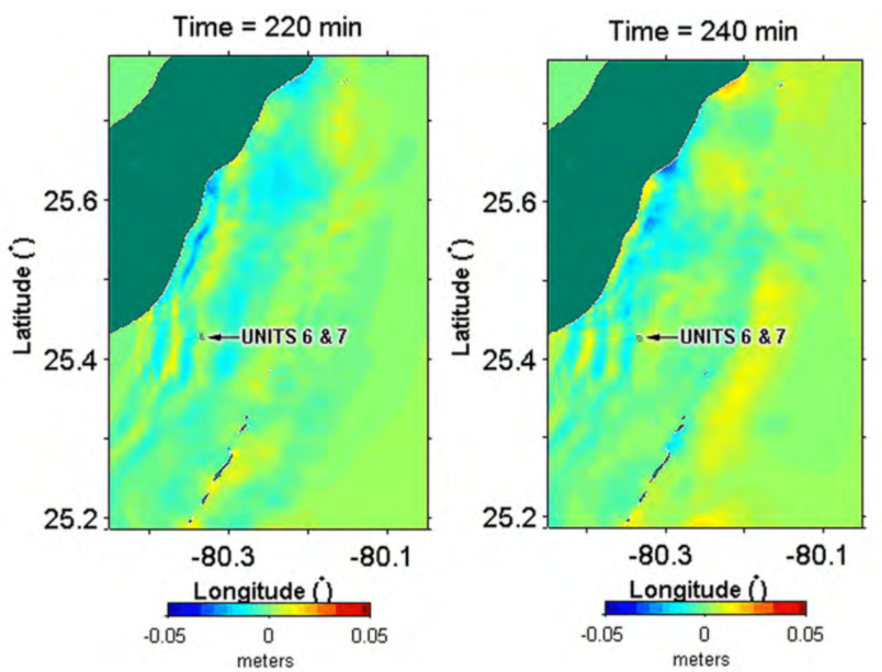
Source: References 244 and 246

Figure 2.4.6-288 Simulated Propagation of the Florida Escarpment Tsunami (Static Source) in Grid C at 140, 160, 180, and 200 Minutes after the Submarine Failure



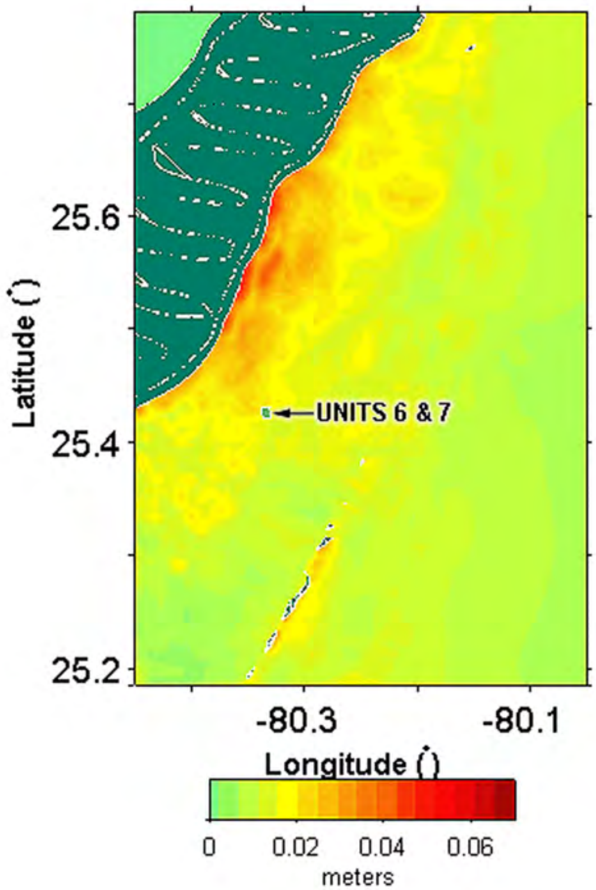
Note: Colors in elevation legend represent water surface elevations in meters relative to MLW.

Figure 2.4.6-289 Simulated Propagation of the Florida Escarpment Tsunami (Static Source) in Grid C at 220 and 240 Minutes after the Submarine Failure



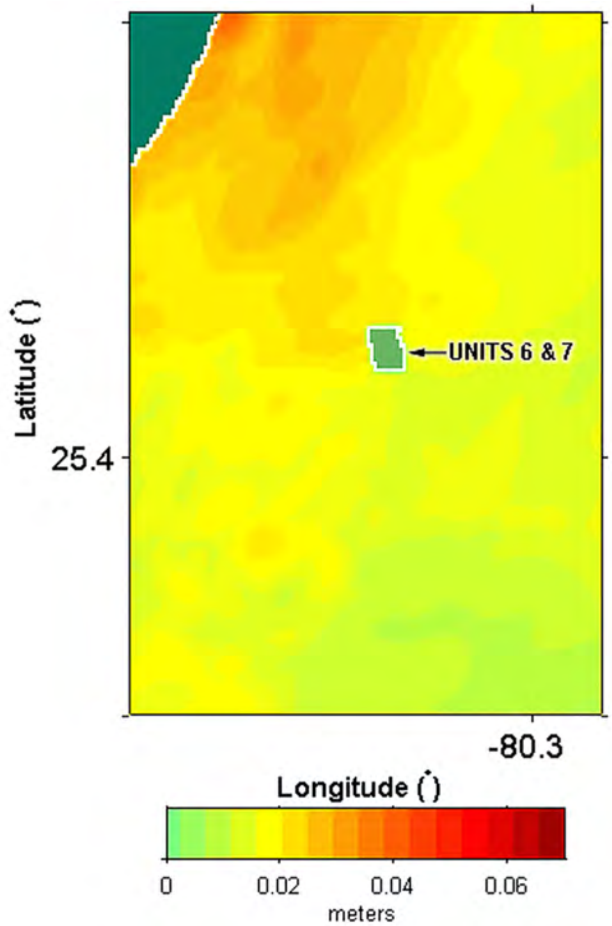
Note: Colors in elevation legend represent water surface elevations in meters relative to MLW.

Figure 2.4.6-290 Simulated Maximum Water Surface Elevation during the Propagation of the Florida Escarpment Tsunami (Static Source) in Grid C



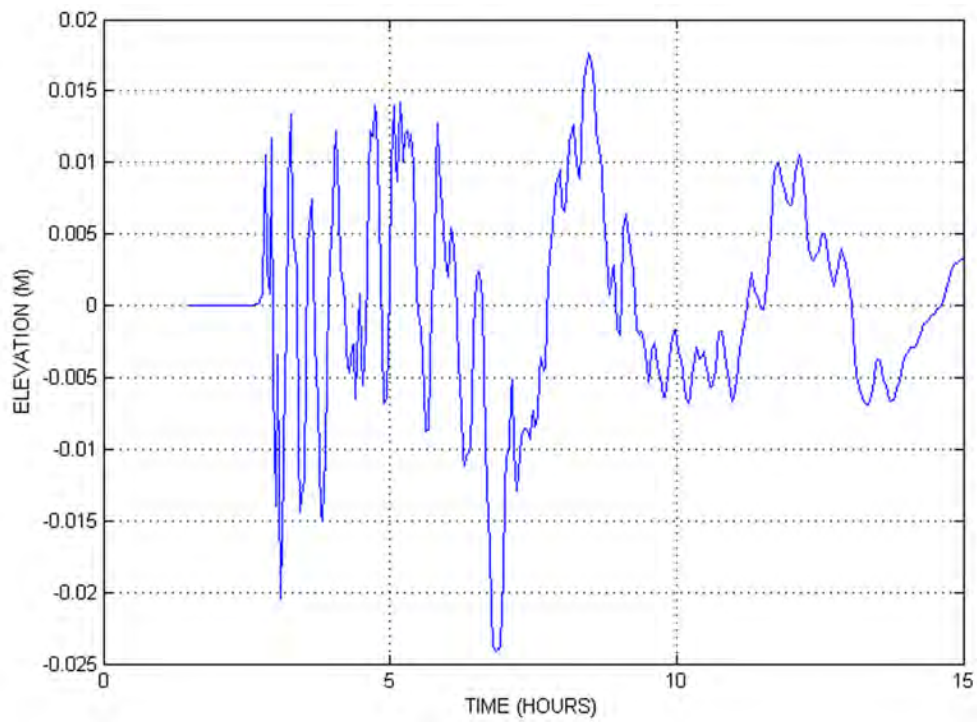
Note: Colors in elevation legend represent water surface elevations in meters relative to MLW.

Figure 2.4.6-291 Simulated Maximum Water Surface Rise, Relative to the Initial Sea Water Level, during the Propagation of the Florida Escarpment Tsunami (Static Source) in the Vicinity of Units 6 & 7



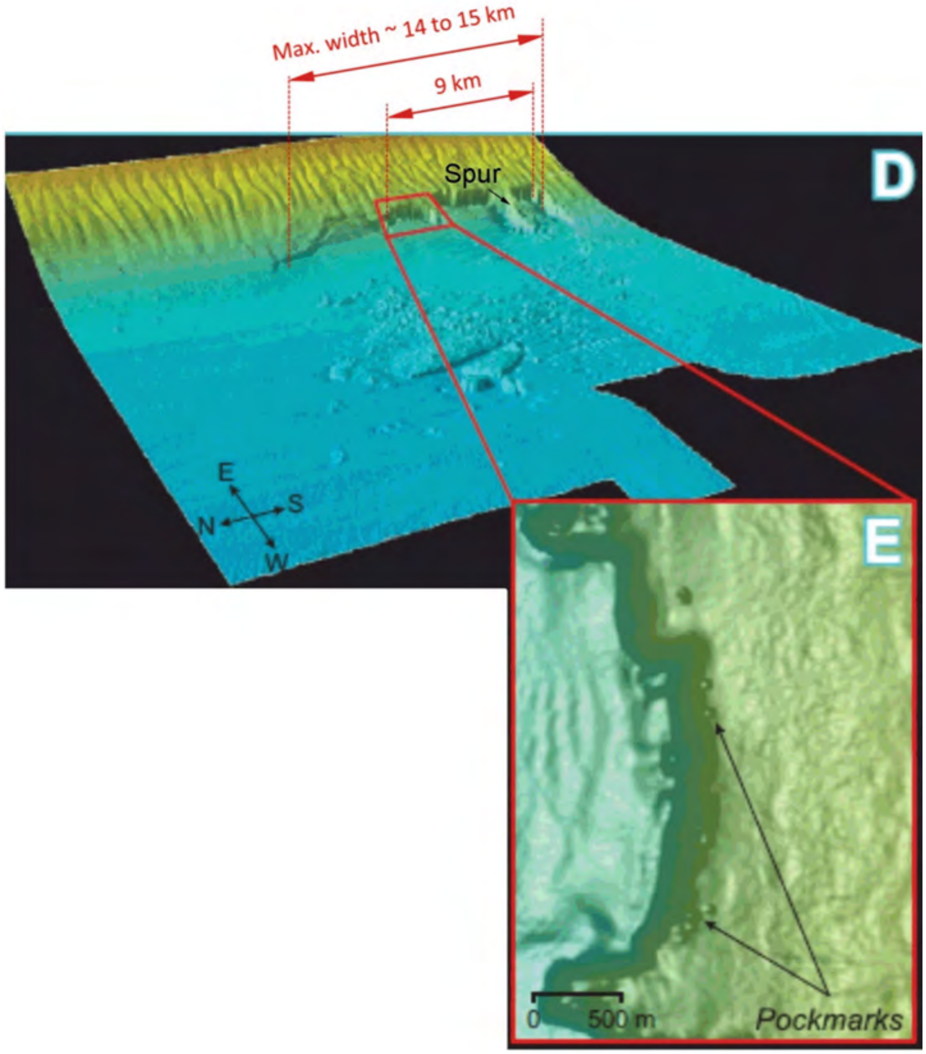
Note: Colors in elevation legend represent water surface elevations in meters relative to MLW.

Figure 2.4.6-292 Water Surface Elevation near the Units 6 & 7 as a Function of Time Following the Florida Escarpment Tsunami (Static Source)



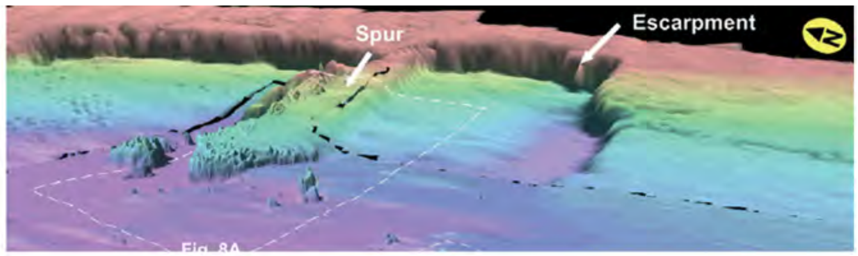
Note: Water surface elevations in meters are relative to the initial water level.

Figure 2.4.6-293 Three-Dimensional View of Mass Transport Complex at the Great Bahama Bank

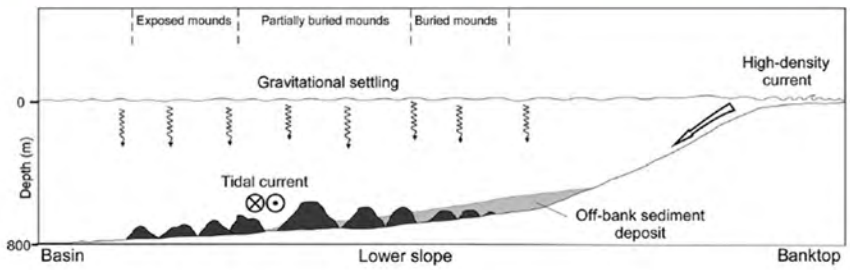


Source: Modified from Figure 1D of Reference 260.

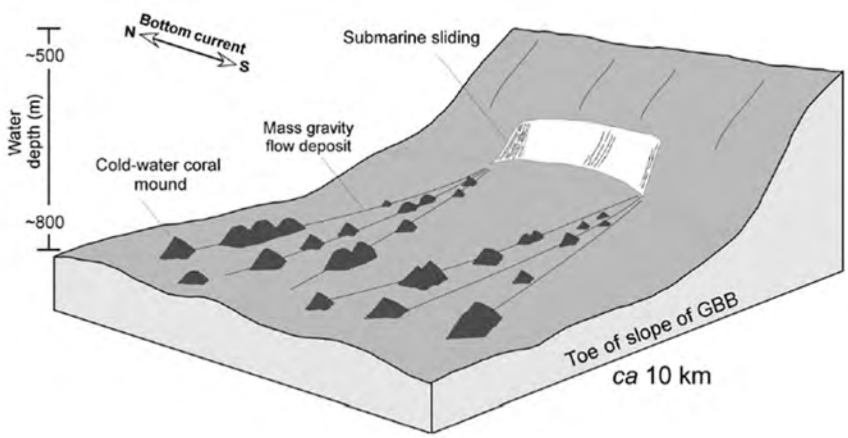
Figure 2.4.6-294 (a) Three-Dimensional View of the Two Southern Scars (b) Generalized Profile Showing the Variability of Mound Size with Respect to the Off-Bank Sediment Deposits Across the GBB Slope, and (c) Schematic Three-Dimensional Representation of the Slide



(a)



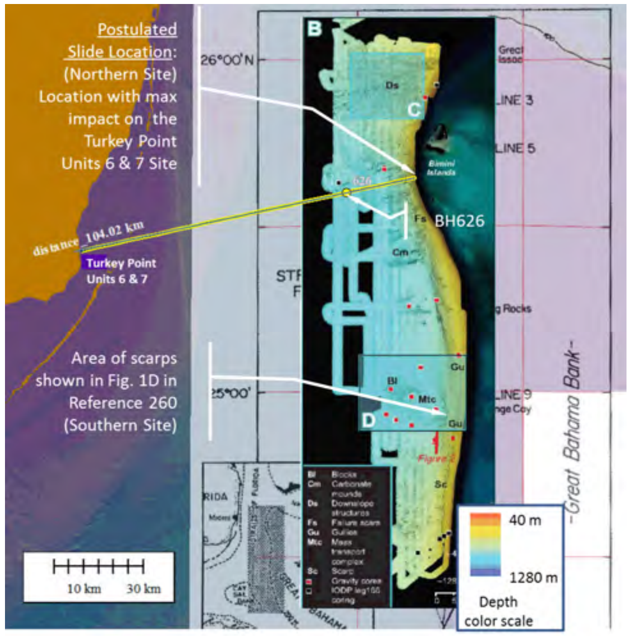
(b)



(c)

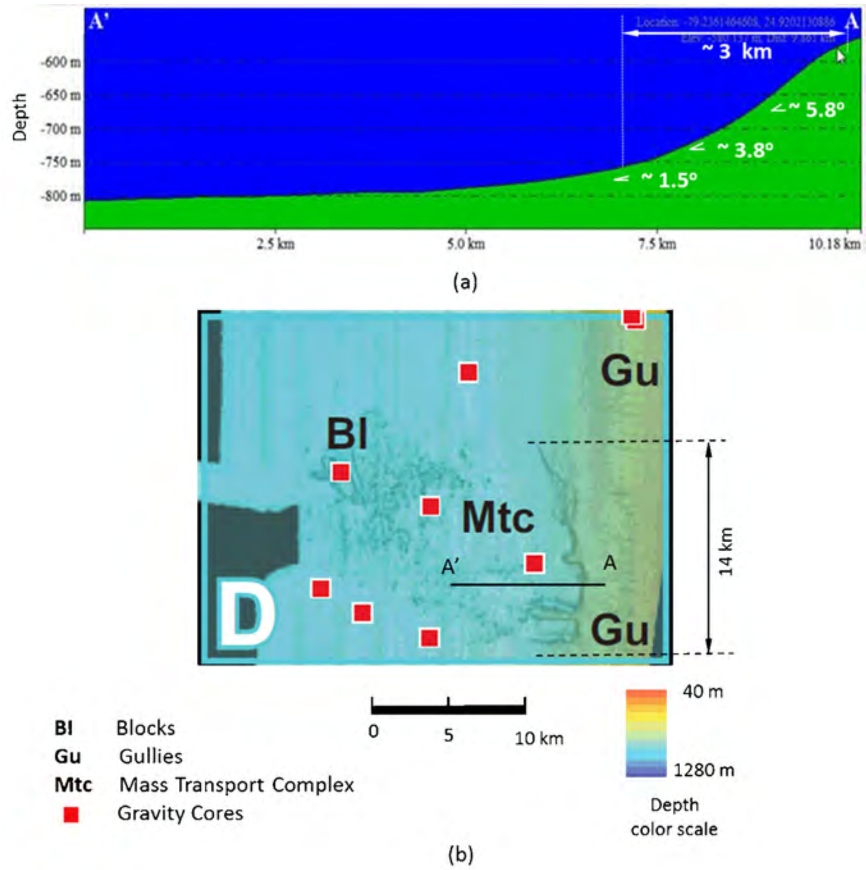
Source: Modified from Reference 262.

Figure 2.4.6-295 Location of Potential Submarine Slide Locations Along the Great Bahama Bank



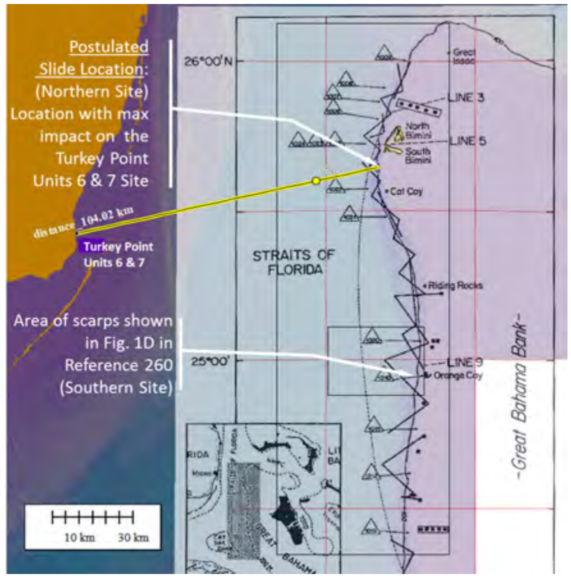
Source: Modified from Reference 260.

Figure 2.4.6-296 (a) Ocean Bottom Profile Along Line A-A', (b) Map Showing the Location of Line A-A'



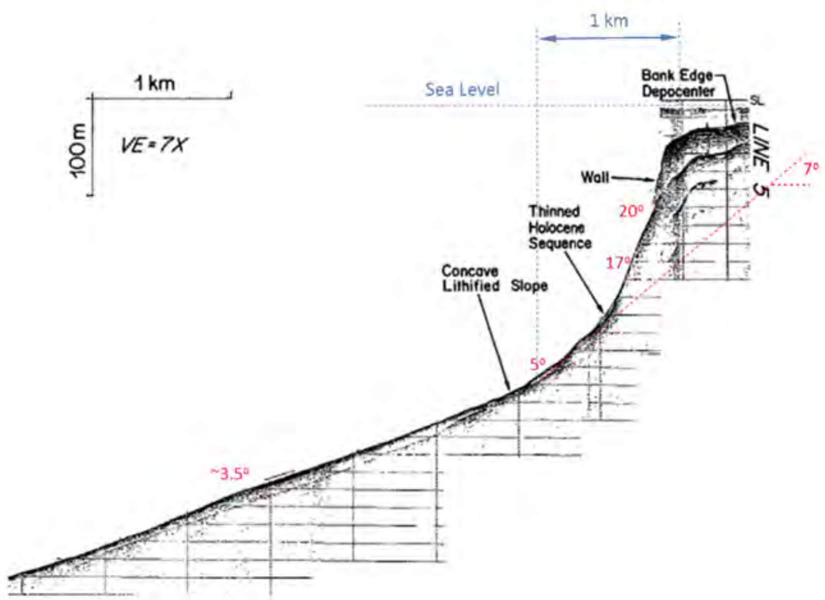
Note: The location of rectangle D is shown in Figure 2.4.6-295.
Source: Modified from Reference 260.

Figure 2.4.6-297 Location of Postulated Slide Location Along the Great Bahama Bank and Location of Seismic Profiles



Source: Modified from Reference 263.

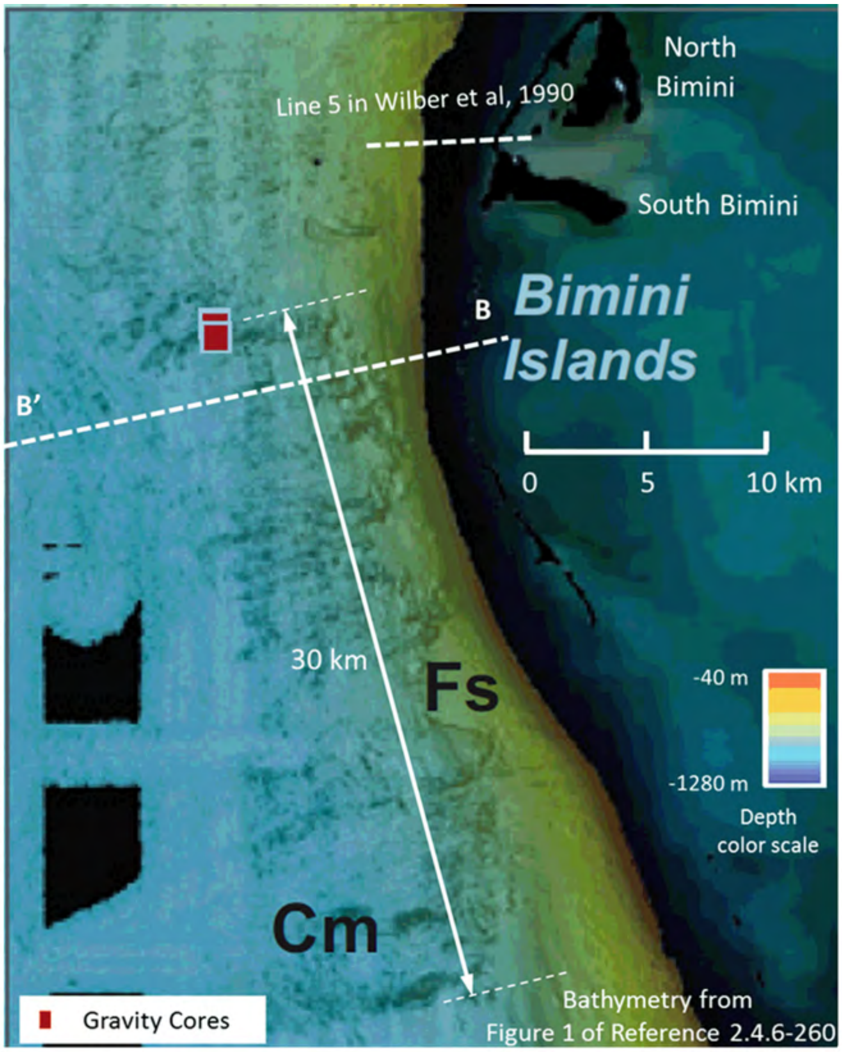
Figure 2.4.6-298 Seismic Profile Line 5



Note:
1. The location of this profile is shown in Figure 2.4.6-297.
2. VE represents Vertical Exaggeration.

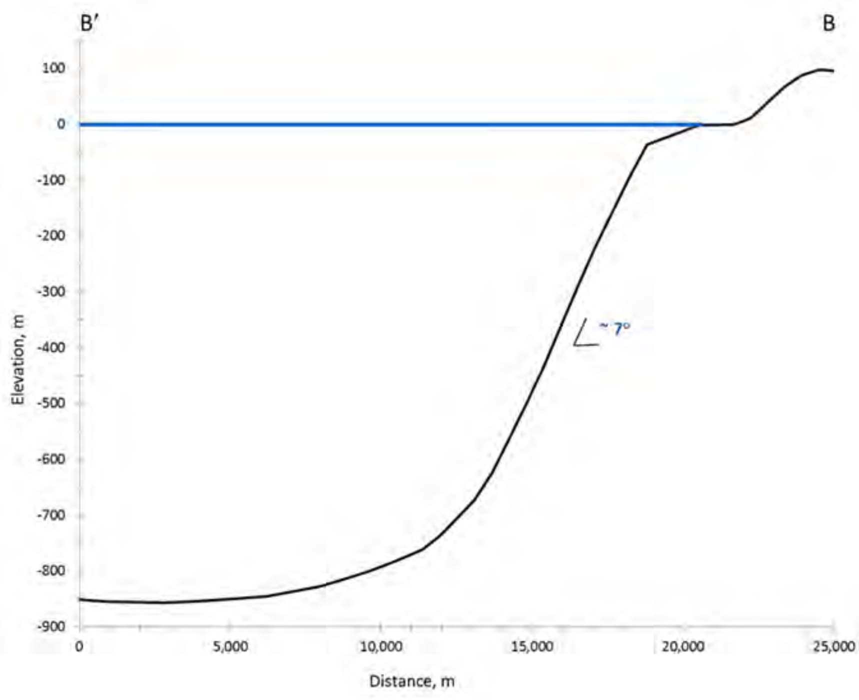
Source: Modified from Reference 263.

Figure 2.4.6-299 Bathymetry in the Vicinity of the Postulated Slide Location



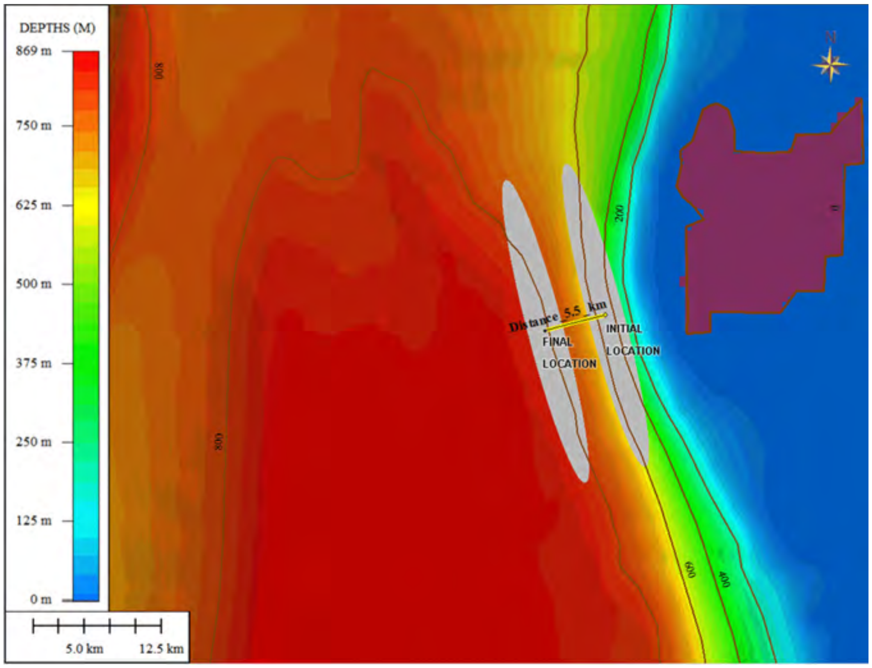
Source: Modified from Reference 260.

Figure 2.4.6-300 Ocean Bottom Profile Along the Line B-B'



Note: The location of this profile is shown in Figure 2.4.6-299.

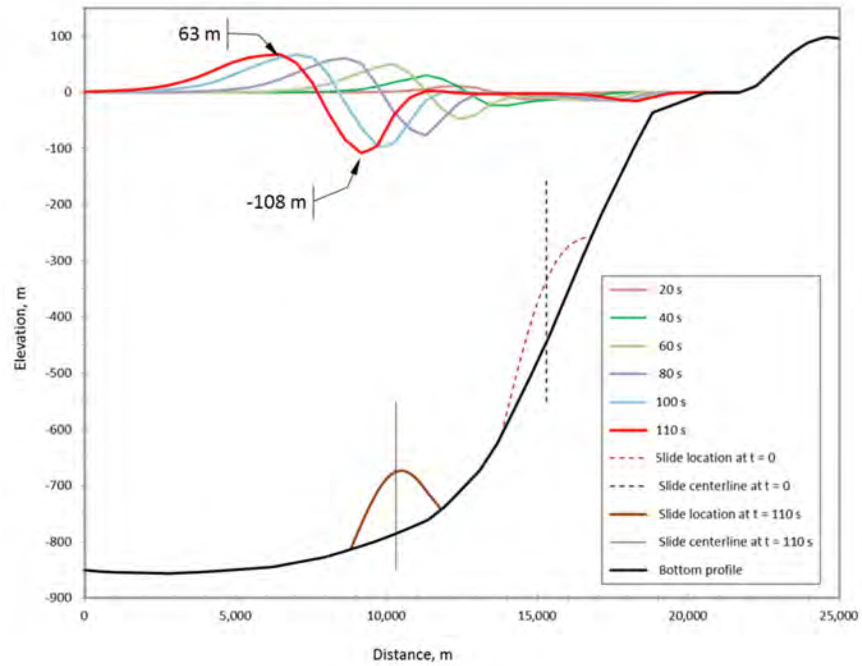
Figure 2.4.6-301 Location and Lateral Extent of the Postulated Slope Failure Along the GBB for Case 1



Notes:
1. Bathymetry contour elevations relative to MLW.
2. Also shown is the final position of the slide at the end of the run-out distance.

Figure 2.4.6-302 Initial Wave Generated by NHWAVE for Case 1 (Dynamic Source, 7-Degree Slope), at 110 Seconds after Initialization of the Slide

Figure 2.4.6-303 Case 1 (Dynamic Source, 7-Degree Slope): Water Surface Profiles in the Direction of the Slide Motion at Different Times After the Initiation of the Slide Obtained from NHWAVE



Note: The water surface profiles and cross section shown in this figure are along the minor axis of the ellipse shown in Figure 2.4.6-302.

Figure 2.4.6-304 Case 2 (Dynamic Source, 20-Degree Slope): Initial Wave Generated by NHWAVE at 140 Seconds After Initialization of the Slide

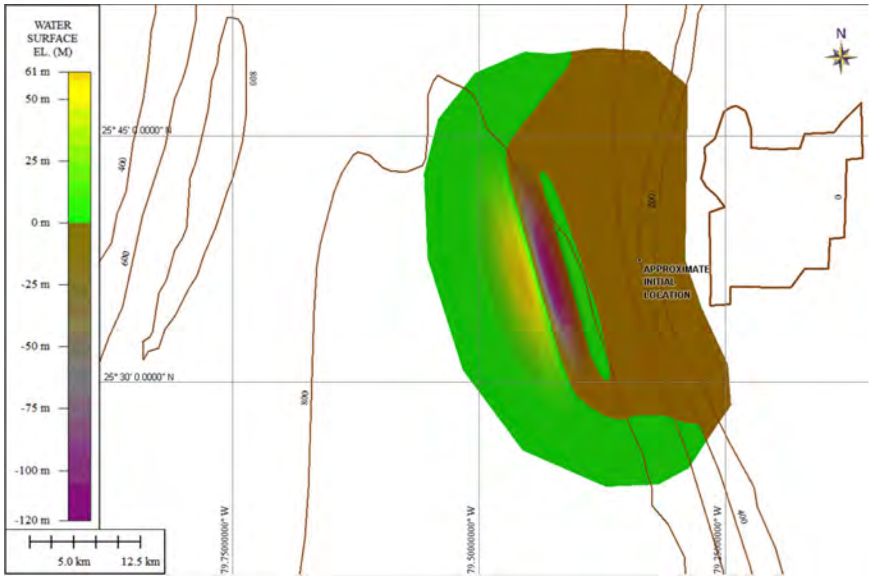


Figure 2.4.6-305 Case 2 (Dynamic Source, 20-Degree Slope): Water Surface Profile in the Direction of the Slide Motion at Different Times After the Initiation of the Slide

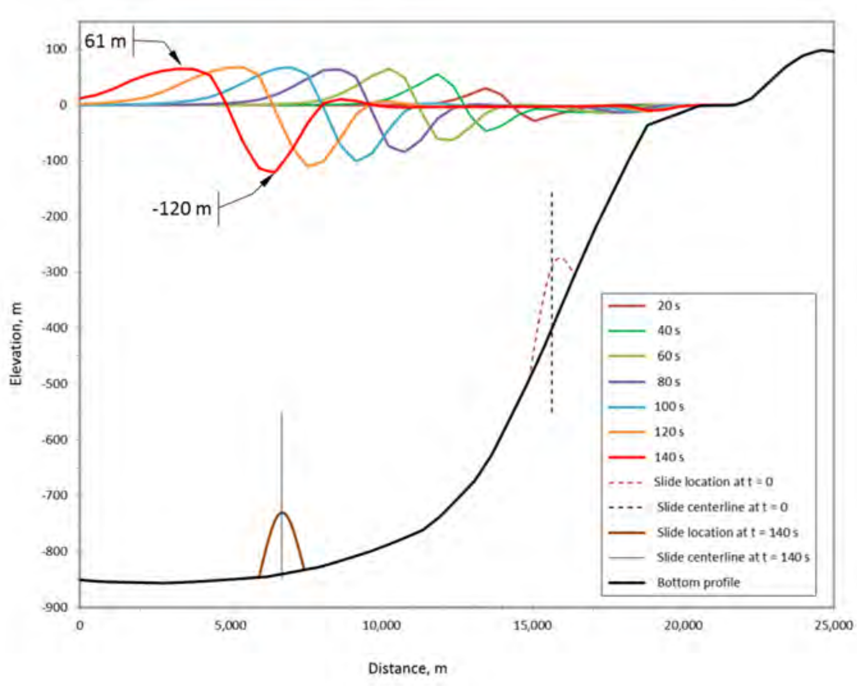
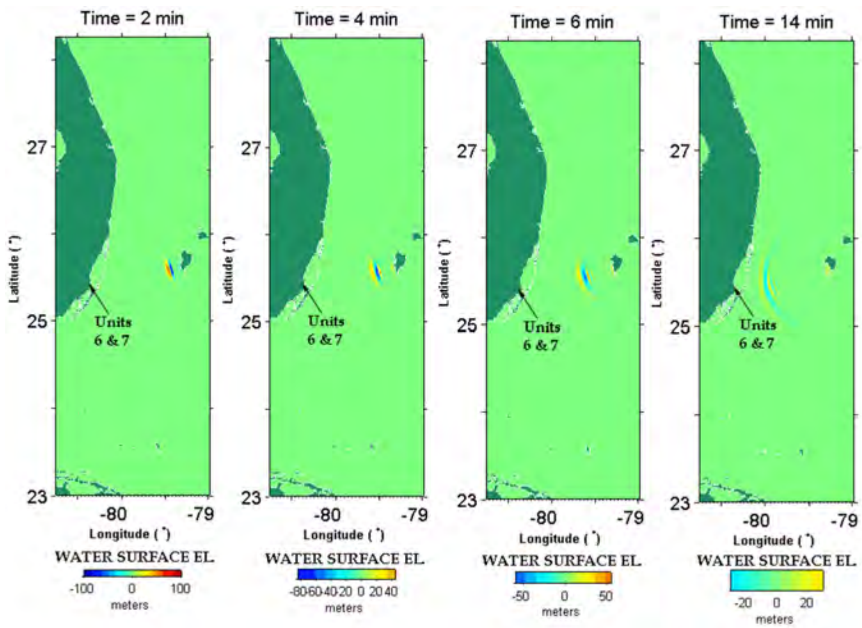


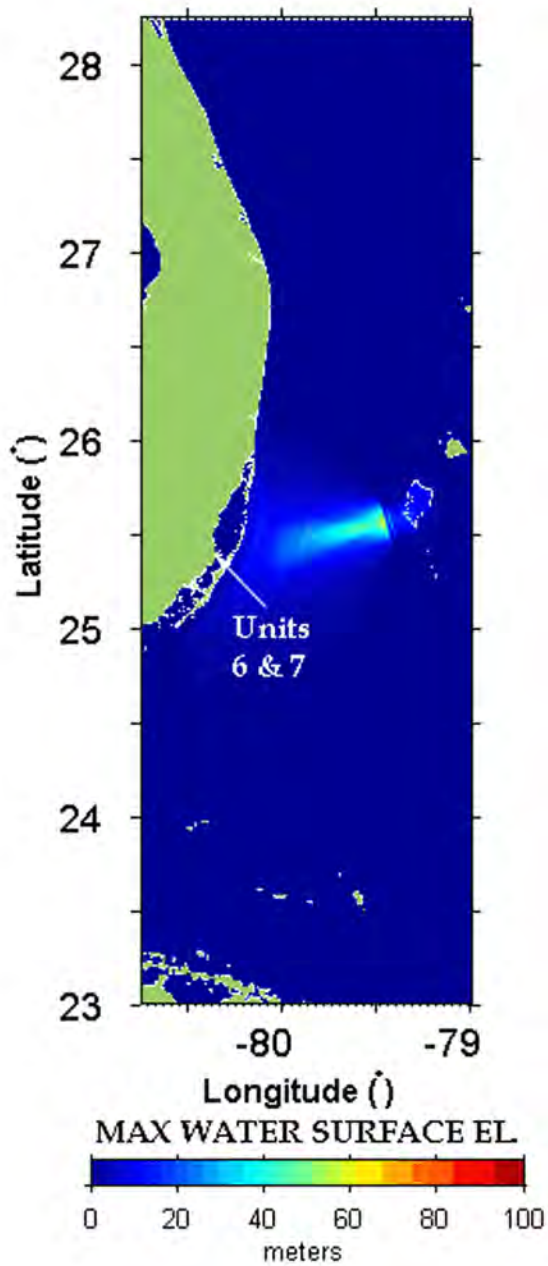
Figure 2.4.6-306 Case 1 (Dynamic Source, 7-Degree Slope): Simulated Propagation of the Tsunami Wave in Grid B at 2, 4, 6, and 14 Minutes After the Slope Failure



Notes:

1. The above time steps assume a hot-start initial condition.
2. The total time since initiation of the slide includes an additional 110 seconds (1.8 minutes).
3. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
4. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

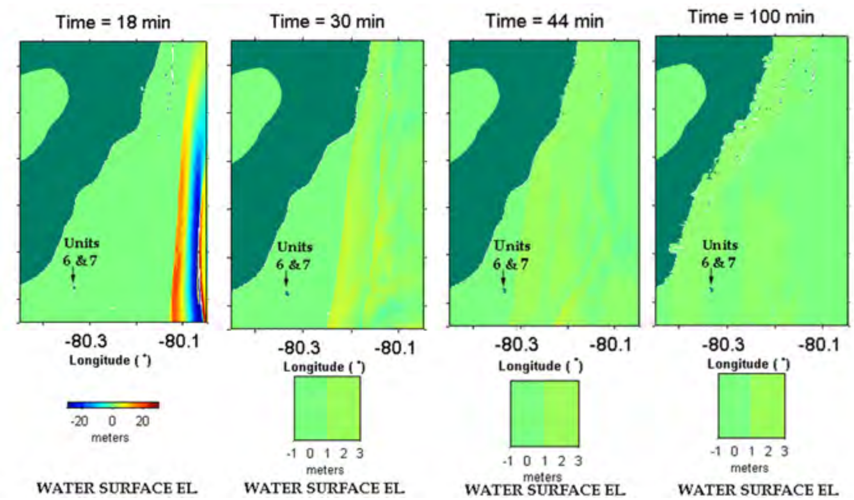
Figure 2.4.6-307 Case 1 (Dynamic Source, 7-Degree Slope): Simulated Maximum Wave Height in Grid B During the Propagation of the Tsunami Generated by the Slope Failure



Notes:

1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

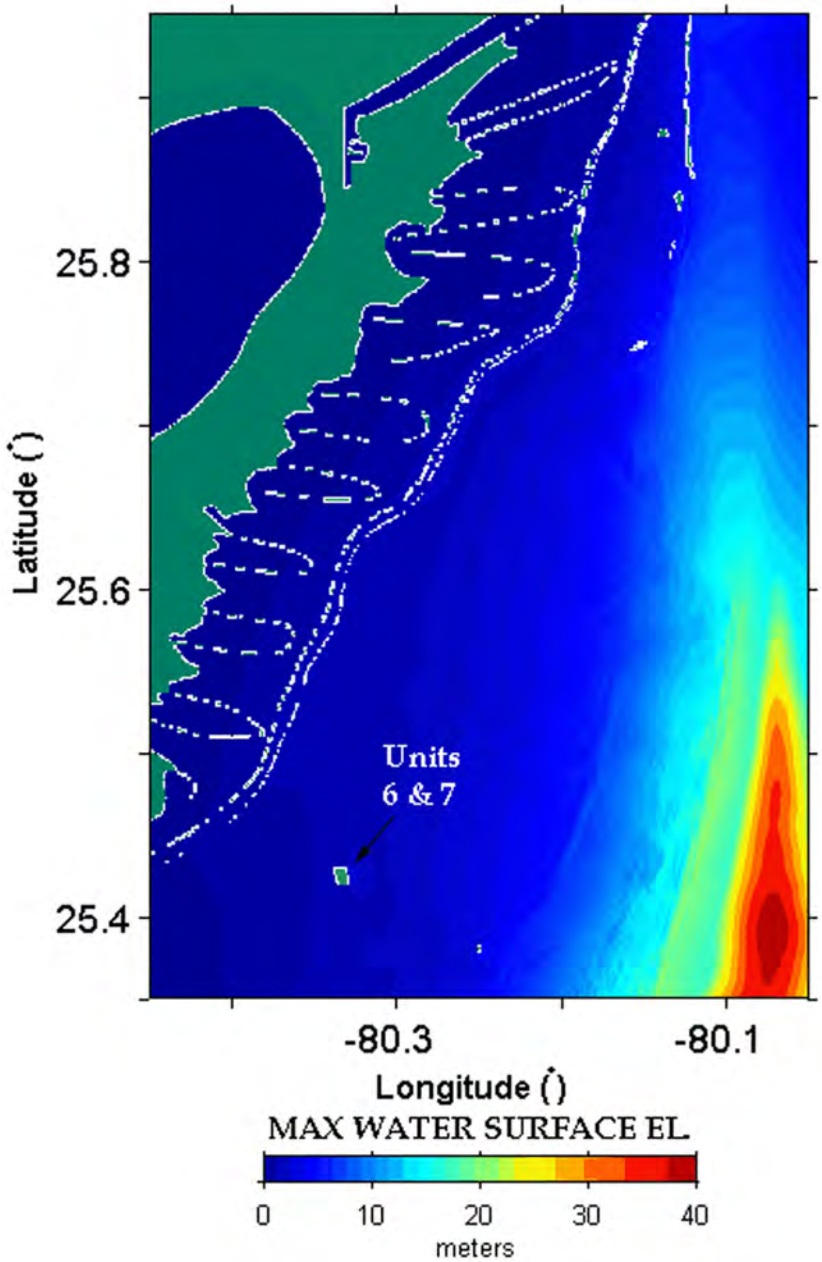
Figure 2.4.6-308 Case 1 (Dynamic Source, 7-Degree Slope): Simulated Propagation of the Tsunami Wave in Grid C at 18, 30, 44, and 100 Minutes After the Slope Failure



Notes:

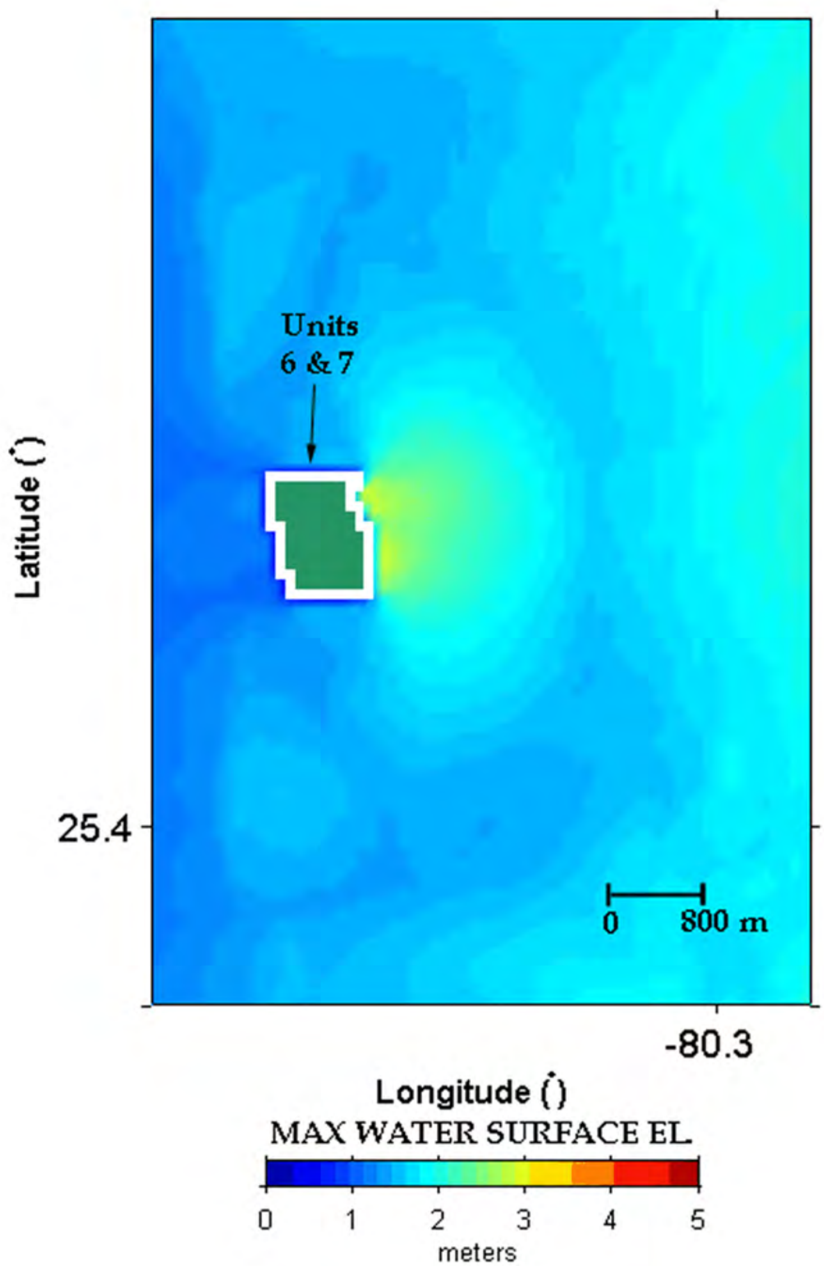
1. The above time steps assume a hot-start initial condition.
2. The total time since initiation of the slide includes an additional 110 seconds (1.8 minutes).
3. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
4. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

Figure 2.4.6-309 Case 1 (Dynamic Source, 7-Degree Slope): Simulated Maximum Wave Height in Grid C During the Propagation of the Tsunami Wave Generated by the Slope Failure



Notes:
1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

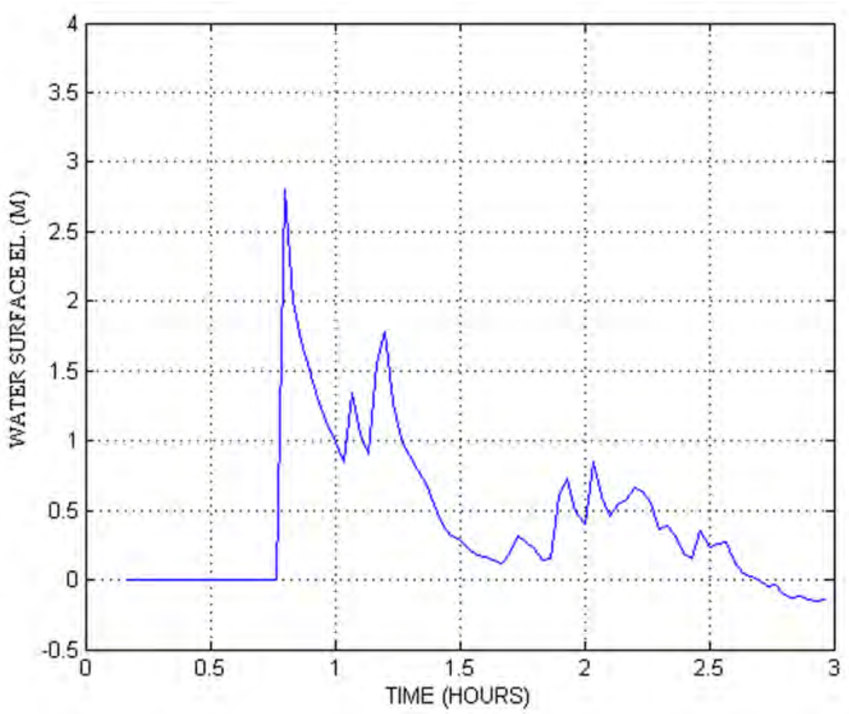
Figure 2.4.6-310 Case 1 (Dynamic Source, 7-Degree Slope): Simulated Maximum Water Surface Rise, Relative to the Initial Seawater Level, in the Vicinity of the Turkey Point Units 6 & 7 Site During the Propagation of the Tsunami Wave Generated by the Slope Failure



Notes:

1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

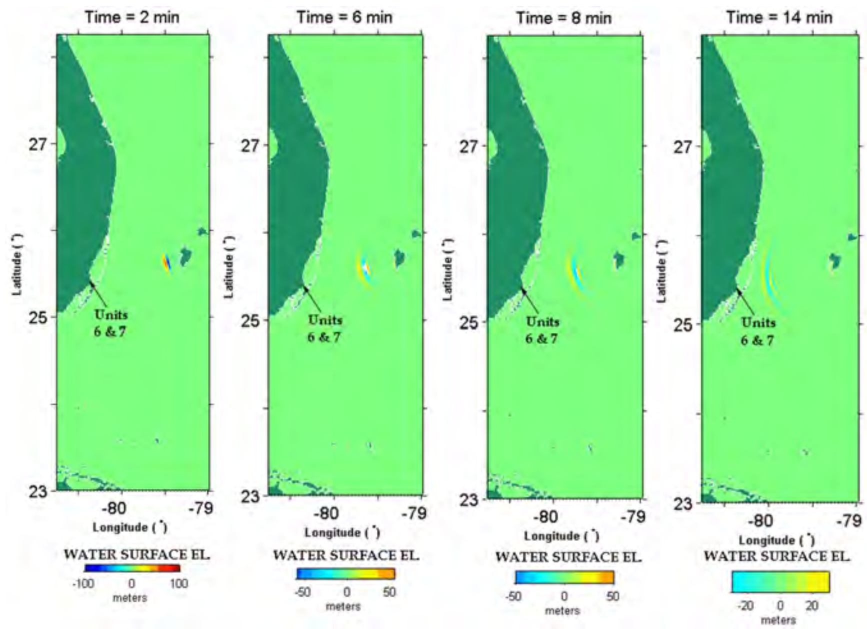
Figure 2.4.6-311 Case 1 (Dynamic Source, 7-Degree Slope): Water Surface Elevation at the Turkey Point Units 6 & 7 Site as a Function of Time Following the Tsunami Wave Generated by the Slope Failure



Notes:

1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.
3. Time zero is at the start of FUNWAVE-TVD simulation. The total time since initiation of the slide includes an additional 110 seconds (1.8 minutes).

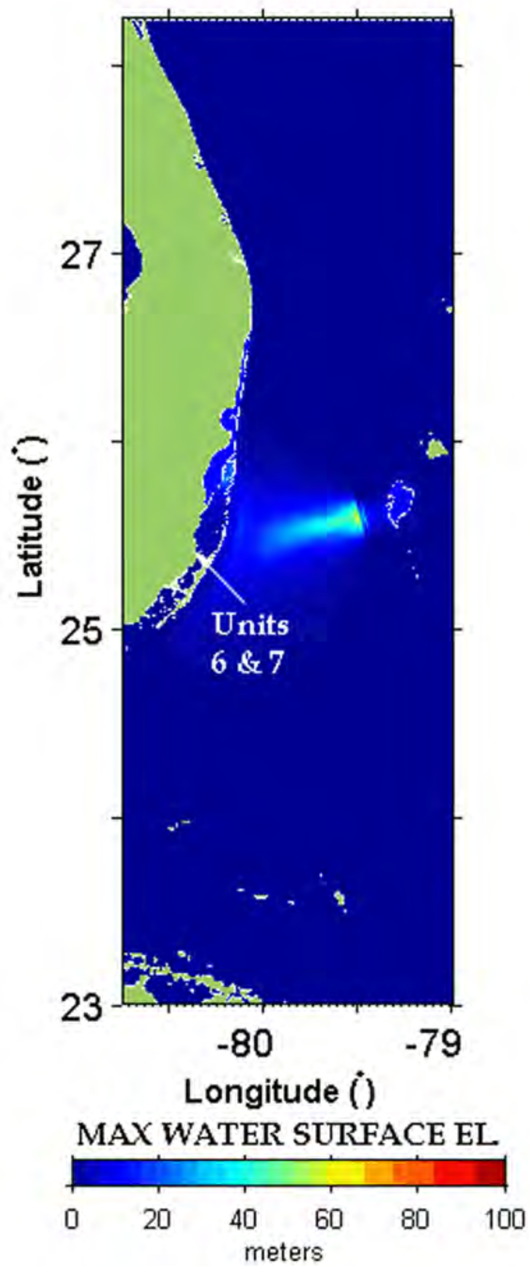
Figure 2.4.6-312 Case 2 (Dynamic Source, 20-Degree Slope): Simulated Propagation of the Tsunami Wave in Grid B at 2, 6, 8, and 14 Minutes After the Slope Failure



Notes:

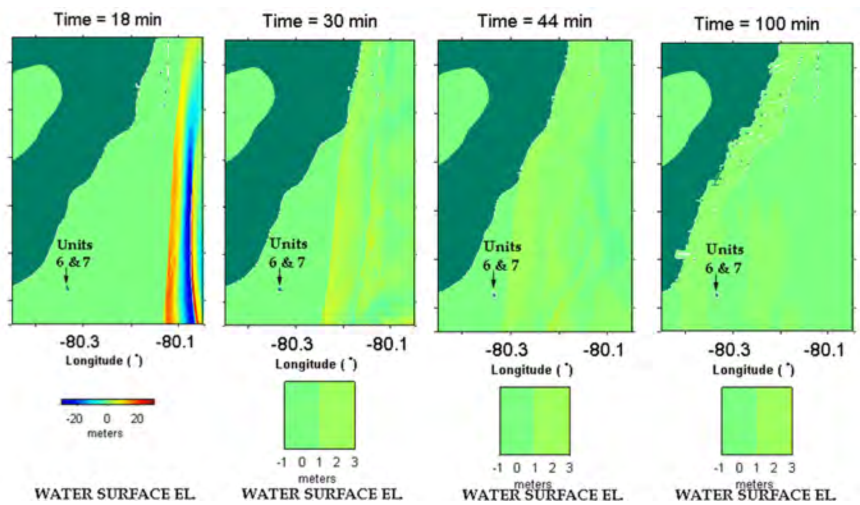
1. The above time steps assume a hot-start initial condition.
2. The total time since initiation of the slide includes an additional 140 seconds (2.3 minutes).
3. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
4. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

Figure 2.4.6-313 Case 2 (Dynamic Source, 20-Degree Slope): Simulated Maximum Wave Height in Grid B During the Propagation of the Tsunami Generated by the Slope Failure



Notes:
1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

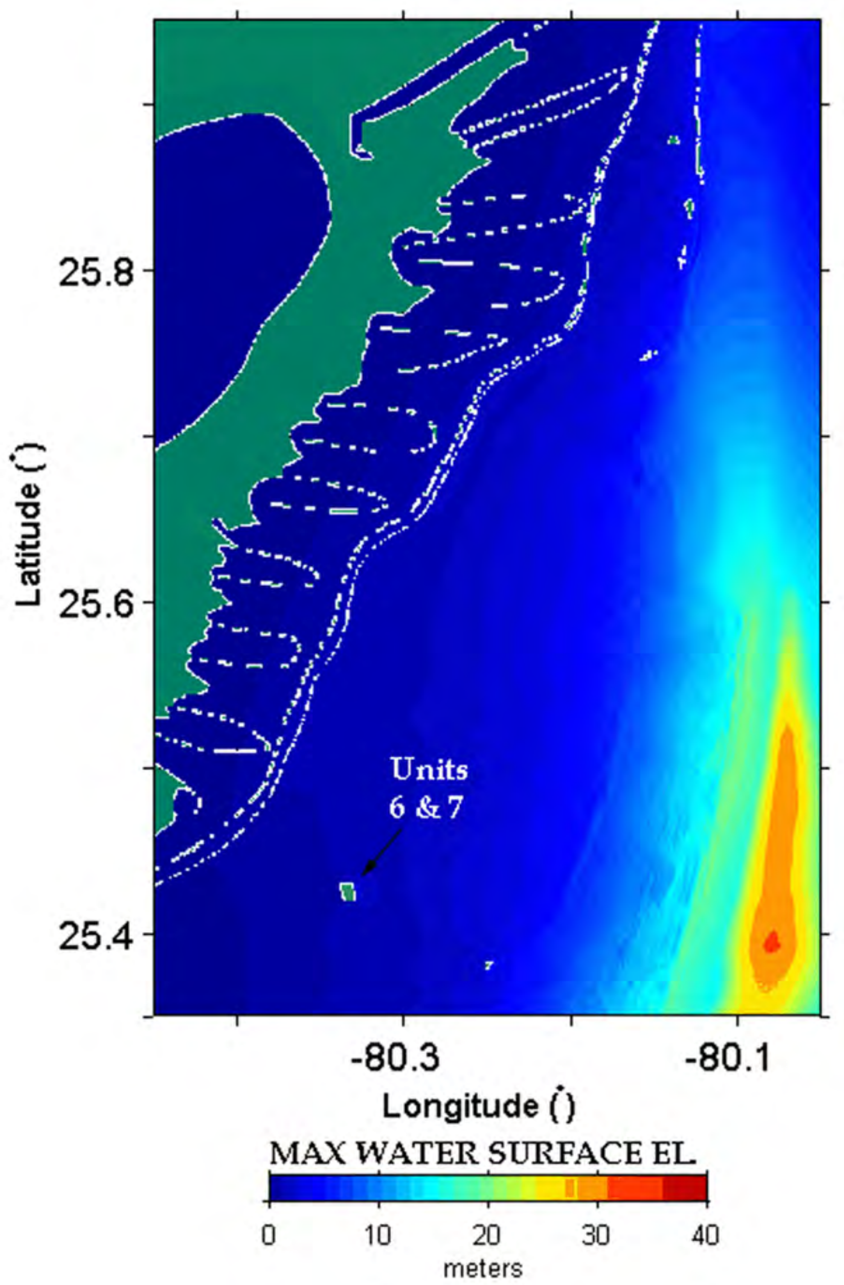
Figure 2.4.6-314 Case 2 (Dynamic Source, 20-Degree Slope): Simulated Propagation of the Tsunami Wave in Grid C at 18, 30, 44, and 100 Minutes after the Slope Failure



Notes:

1. The above time steps assume a hot-start initial condition.
2. The total time since initiation of the slide includes an additional 140 seconds (2.3 minutes).
3. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
4. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

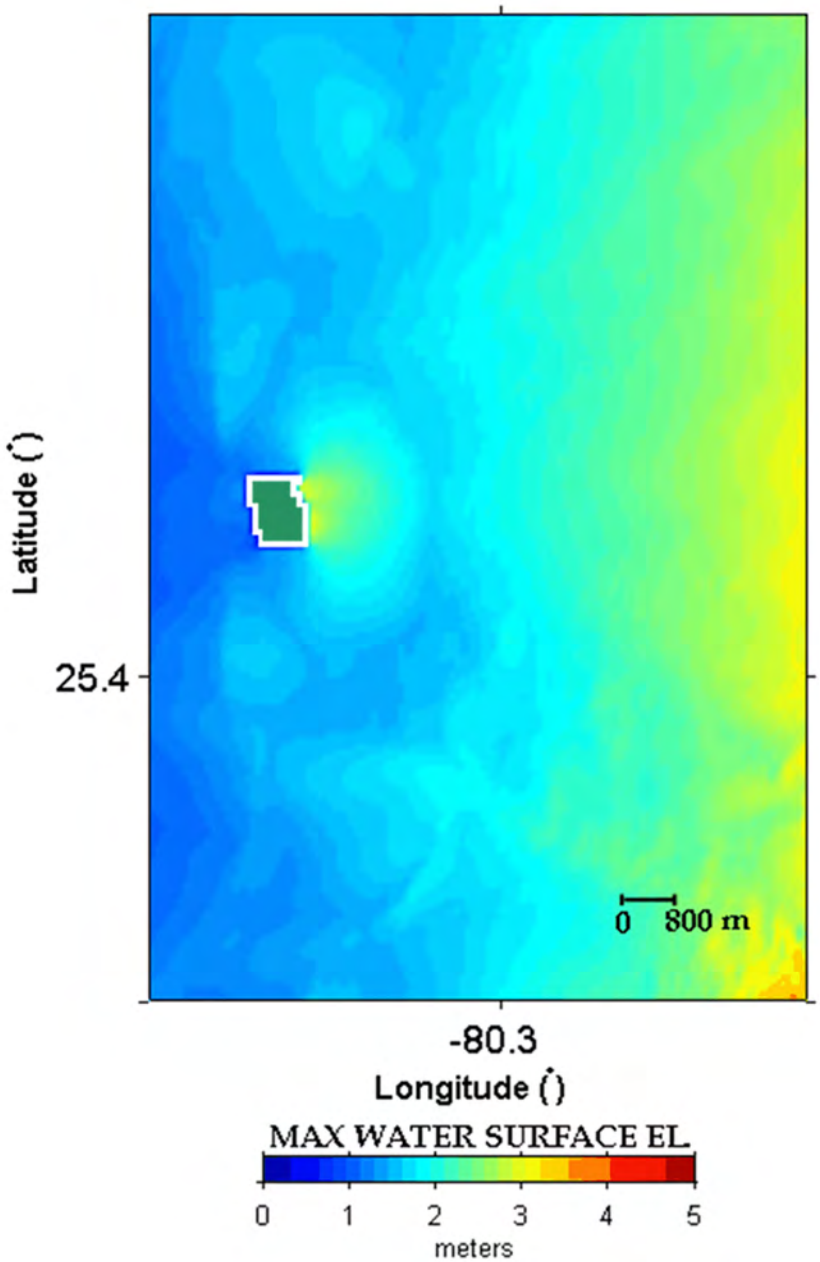
Figure 2.4.6-315 Case 2 (Dynamic Source, 20-Degree Slope): Simulated Maximum Wave Height in Grid C During the Propagation of the Tsunami Wave Generated by the Slope Failure



Notes:

1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

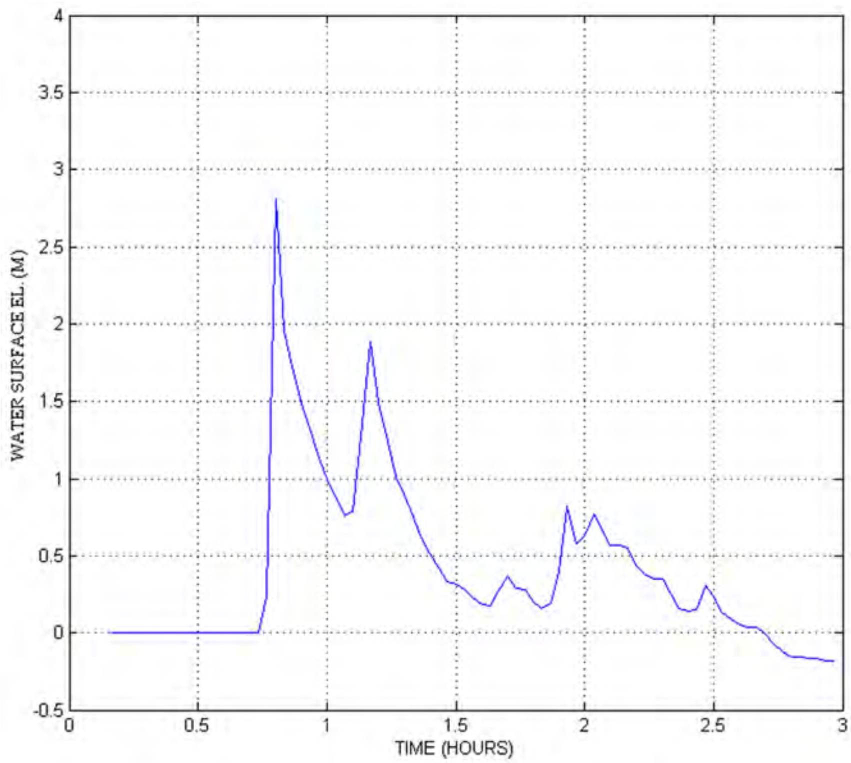
Figure 2.4.6-316 Case 2 (Dynamic Source, 20-Degree Slope): Simulated Maximum Water Surface Rise, Relative to the Initial Seawater Level, in the Vicinity of the Turkey Point Units 6 & 7 Site During the Propagation of the Tsunami Wave Generated by the Slope Failure



Notes:

1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

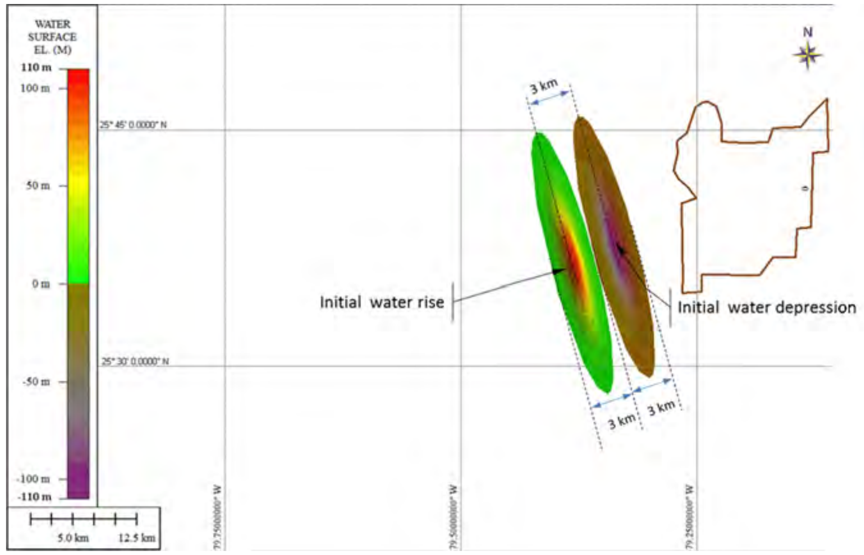
Figure 2.4.6-317 Case 2 (Dynamic Source, 20-Degree Slope): Water Surface Elevation at the Turkey Point Units 6 & 7 Site as a Function of Time Following the Tsunami Wave Generated by the Slope Failure



Notes:

1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.
3. Time zero is at the start of FUNWAVE-TVD simulation. The total time since initiation of the slope includes an additional 140 seconds (2.3 minutes).

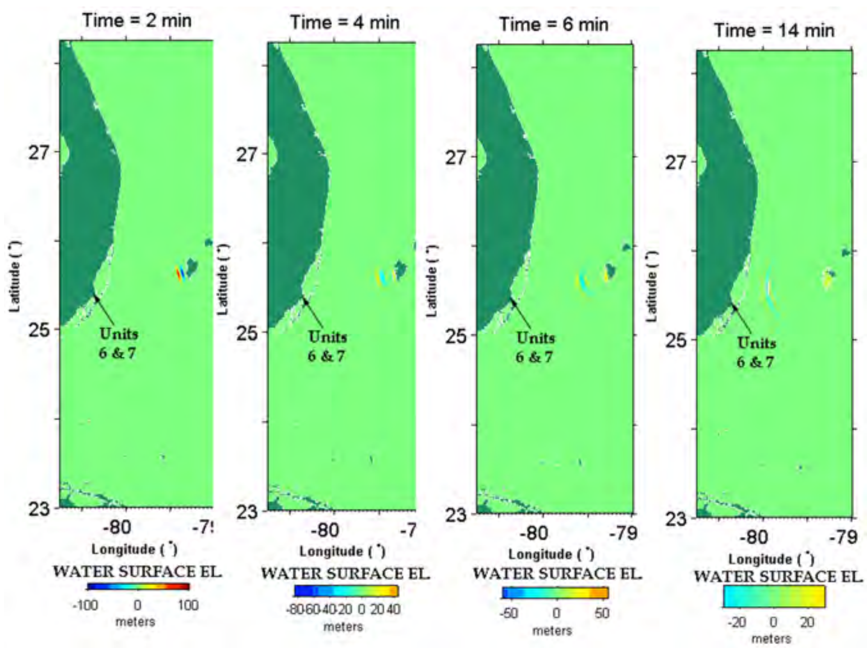
Figure 2.4.6-318 Case 3 (Static Source): Initial Wave for a Static Source Equal to the Postulated Slide at the Great Bahama Bank



Notes:

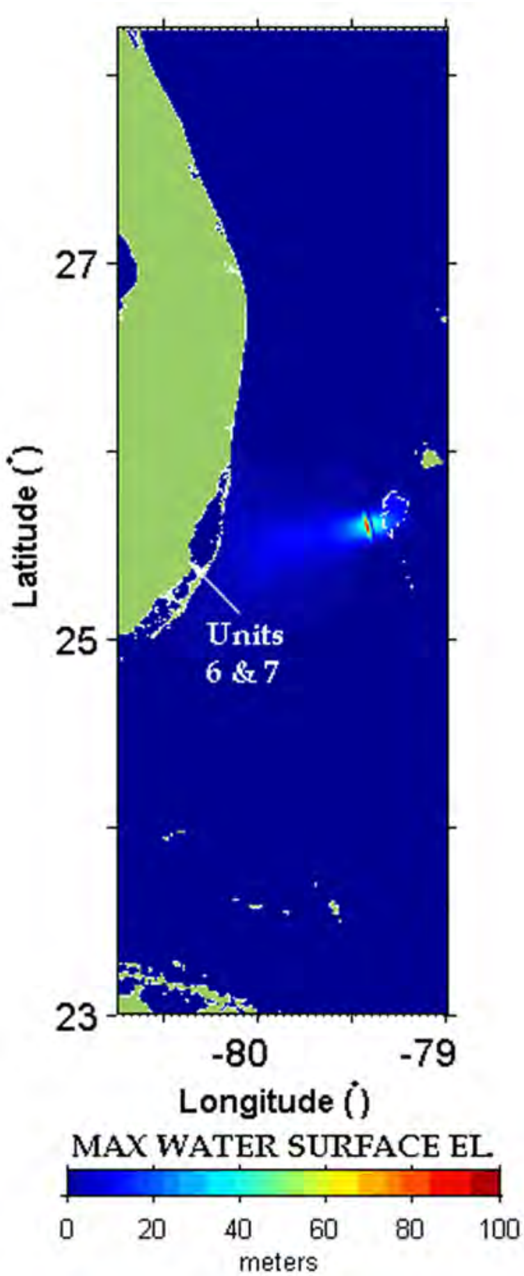
1. In the definition of the static source, the initial water depression shown above is directly above the initial position of the slide, i.e., before the initiation of movement.
2. The final position of the slide does not enter in the definition of the static source.

Figure 2.4.6-319 Case 3 (Static Source): Simulated Propagation of the Tsunami Wave in Grid B at 2, 4, 6, and 14 Minutes After the Slope Failure



Notes:
1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

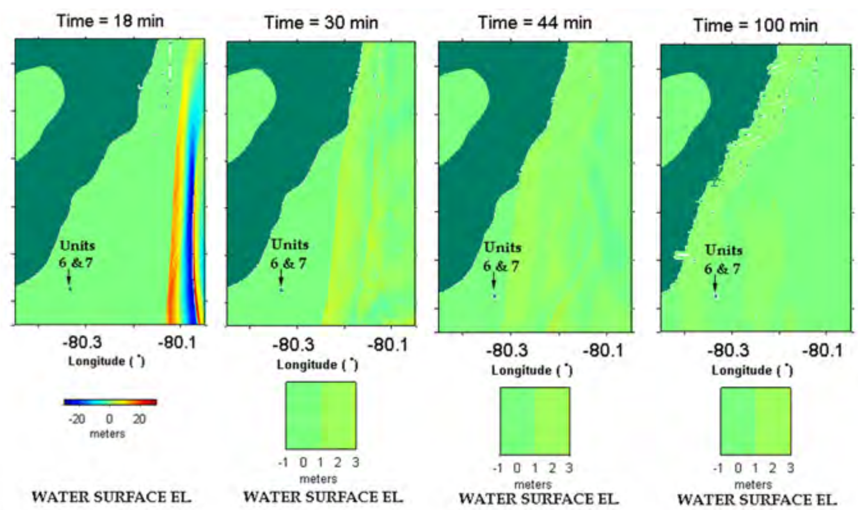
Figure 2.4.6-320 Case 3 (Static Source): Simulated Maximum Wave Height in Grid B During the Propagation of the Tsunami Generated by the Slope Failure



Notes:

1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

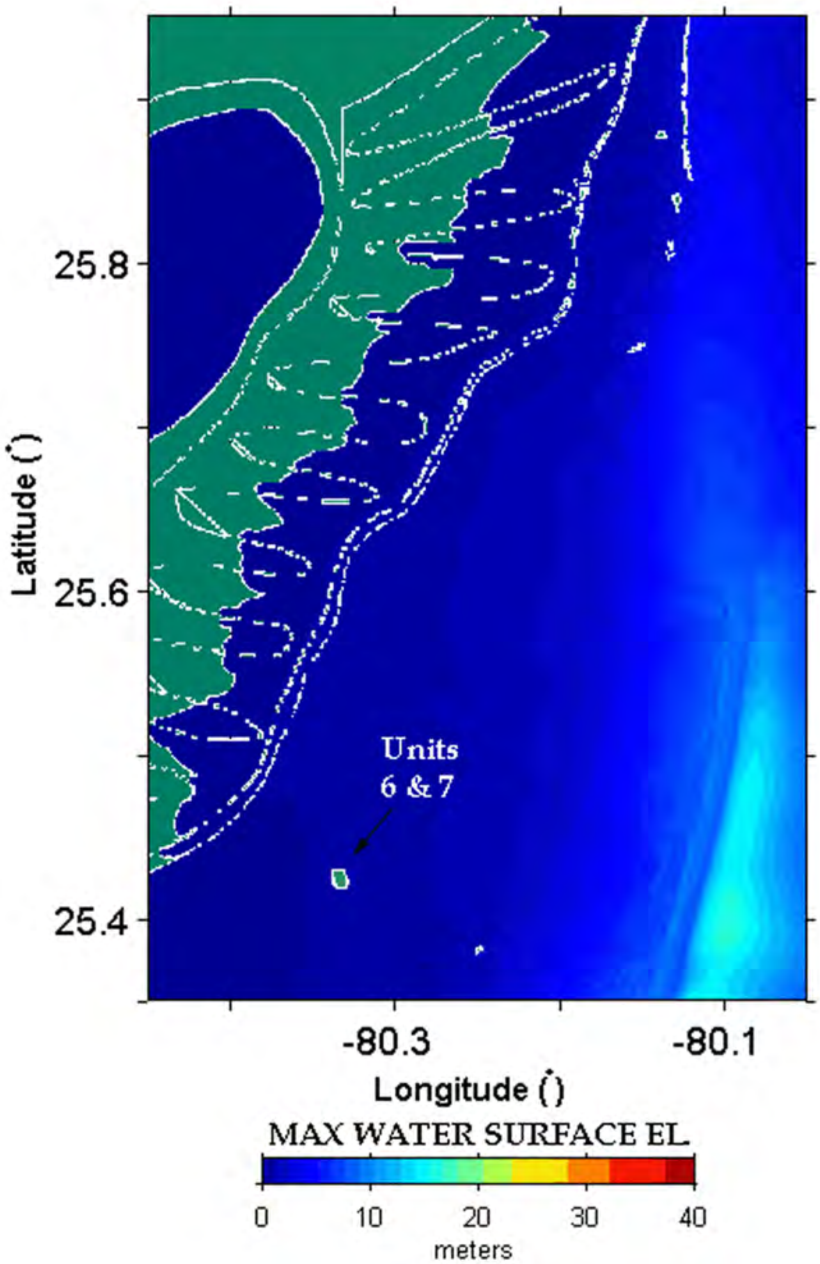
Figure 2.4.6-321 Case 3 (Static Source): Simulated Propagation of the Tsunami Wave in Grid C at 18, 30, 44, and 100 Minutes after the Slope Failure



Notes:

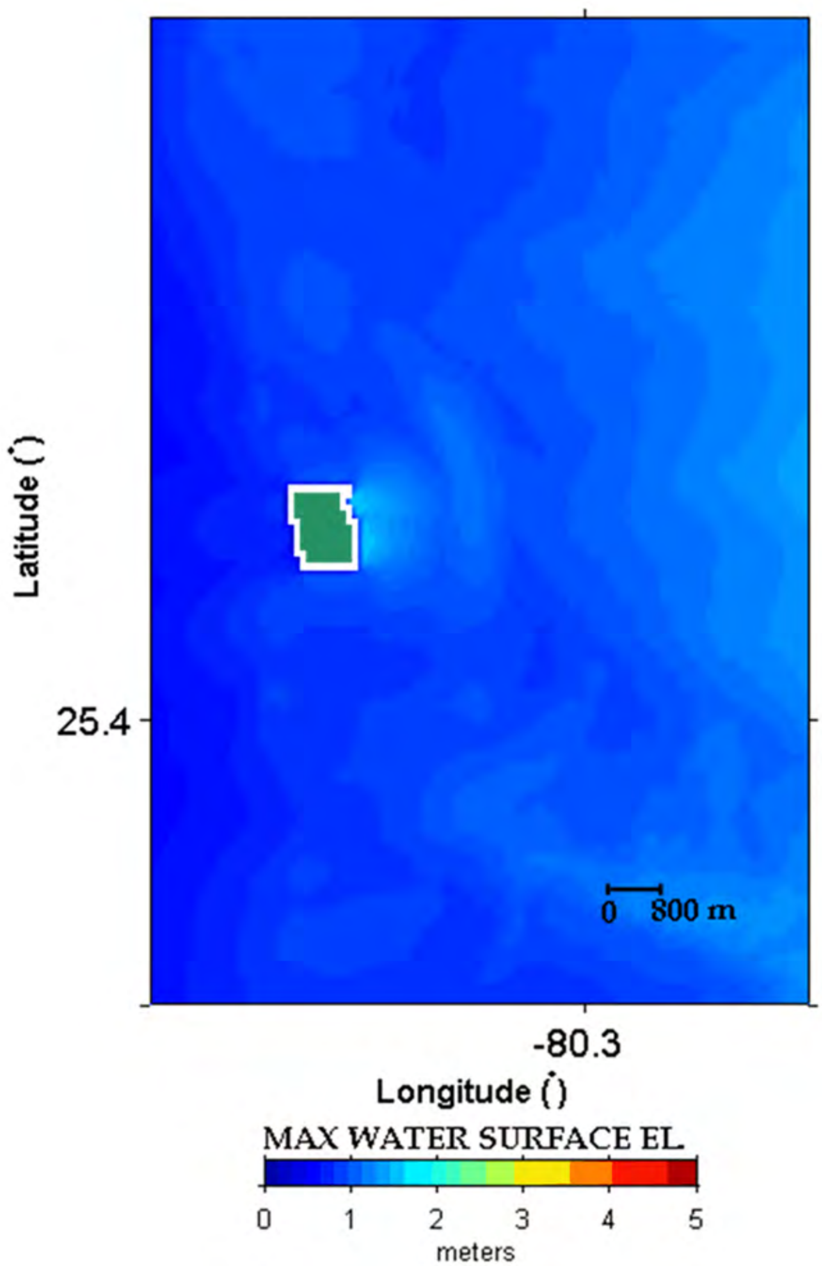
1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

Figure 2.4.6-322 Case 3 (Static Source): Simulated Maximum Wave Height in Grid C During the Propagation of the Tsunami Wave Generated by the Slope Failure



Notes:
1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

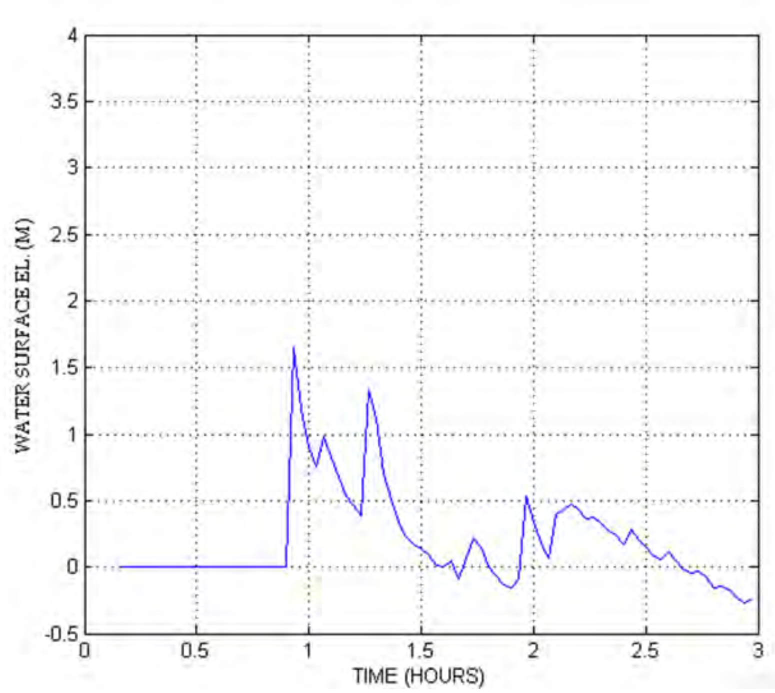
Figure 2.4.6-323 Case 3 (Static Source): Simulated Maximum Water Surface Rise, Relative to the Initial Seawater Level, in the Vicinity of the Turkey Point Units 6 & 7 Site During the Propagation of the Tsunami Wave Generated by the Slope Failure



Notes:

1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

Figure 2.4.6-324 Case 3 (Static Source): Water Surface Elevation at the Turkey Point Units 6 & 7 Site as a Function of Time Following the Tsunami Wave Generated by the Slope Failure



Notes:

1. Water surface elevations presented in the above figure are relative to the initial water surface level in FUNWAVE-TVD.
2. The initial water surface level in FUNWAVE-TVD is 1.68 meters MLW.

SUBSECTION 2.4.7: ICE EFFECTS
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2.4.7 ICE EFFECTS

PTN COL 2.4-2 The potential impact of ice effects on Units 6 & 7 is analyzed by evaluating historical hydrometeorological data from the USGS and NOAA and by examining the historical occurrences of ice events including a detailed search of the *Ice Jam Database* of the USACE. Results of this evaluation are summarized below.

The climate near Units 6 & 7 is subtropical marine with occasional freezing air temperatures (Reference 201). Freezing events were reported for the years 1977 and 1989 (Reference 202). These freezing events are captured in the historical air temperature data obtained from the National Climate Data Center (NCDC) of NOAA (Reference 201). However, as described below, the corresponding daily average temperatures always stayed above freezing.

Water temperature data are obtained from USGS stations (Reference 203). Due to data quality, data from 13 stations of the available 449 stations within 30 miles (48 kilometers) of the plant area are used. These 13 stations are listed in Table 2.4.7-201 and are shown in Figure 2.4.7-201. Figure 2.4.7-202 plots the water temperature at these stations for 1953–2007. The results indicate that water temperatures remain well above the freezing point with the minimum water temperature of 54.0°F (12.2°C) recorded on April 3, 1959, in the Snapper Creek Canal at Miller Drive near S. Miami Station (USGS No. 02290610) (Reference 203). The station is 20 miles (32 kilometers) northwest of the plant area.

Air temperature data of two meteorological stations are obtained from NCDC of NOAA (Reference 201). These stations are the Homestead Experimental Station (12 miles [19 kilometers] west of the plant area, Cooperative ID 084091, period of record from 1910 to 1988 with a continuous record starting in 1931) and the Miami International Airport Station (24 miles [38 kilometers] north of the plant area, Cooperative ID 085663, period of record from 1948 to 2008). Figure 2.4.7-201 shows the location of the two meteorological stations. Table 2.4.7-202 summarizes subfreezing and corresponding daily average temperatures on record. Although the data at the two stations show below-freezing air temperatures with a minimum of 26°F (–3.3°C), measured on December 13, 1934, March 2, 1941, and February 16, 1943, at the Homestead Experimental Station, the daily average temperatures remained above freezing. The minimum daily average temperature of 38°F (3.3°C) occurred on December 24, 1989, at Miami International Airport Station (Reference 201).

There are no records of ice jams in Florida in the *Ice Jam Database* of USACE (Reference 204). Ice sheet formation, wind-driven ice ridges, and frazil or anchor ice formation are also precluded because subfreezing water and daily average air temperatures have not occurred based on the available historical data.

The design of the AP1000 reactor employs a passive containment cooling system that functions as the safety-related ultimate heat sink. This system is described in DCD Subsection 6.2.2. The passive containment cooling system does not require an open surface water source to perform its safety-related function and, therefore, is not affected by surface water ice conditions.

2.4.7.1 References

201. U.S. Department of Commerce, NOAA, NCDC Homestead Experimental Station (Cooperative Id 084091) and Miami International Airport (Cooperative Id 085663) Station Data. Available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?WWDI~StnSrch~StnID~10100175 and at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?WWDI~StnSrch~StnID~20004250, accessed August 6, 2008.

202. U.S. Department of Commerce, NOAA, *Florida's Top 10 Weather Events of the 20th Century.* Available at http://www.srh.noaa.gov/tlh/topevents/, accessed September 25, 2008.

203. U.S. Geological Survey, *Water-Quality Samples for the Nation*, Water Temperatures for Biscayne Canal at S-28 Near Miami, Florida (Station #02286340), Little River Canal at S-27 at Miami, Florida (Station #02286380), Miami Canal at NW36 ST, Florida (Station #02288600), Miami Canal at Water Plant at Hialeah, Florida (Station #02288500), Miami Canal East of Levee 30 Near Miami, Florida (Station #02287395), Mowry Canal Near Homestead, Florida (Station #02290725), Snake Creek Ca at S-29 at North Miami Beach, Florida (Station #02286300), Snake Creek Canal at NW67 Ave Nr Hialeah, Florida (Station #02286200), Snake Creek Canal Below S-30 Nr Hialeah, Florida (Station #02286181), Tamiami Canal near Coral Gables, Florida (Station #02289500), Tamiami Canal Outlets L-30 to L-67A Nr Miami, Florida (Station #02289060), West Highway Creek near Homestead, Florida (Station #251433080265000), Snapper Creek C at Miller Drive Nr Smiami, Florida (Station #02290610). Available at http://nwis.waterdata.usgs.gov/usa/nwis/qwdata, accessed September 25, 2008.

204. U.S. Army Corps of Engineers, *Ice Jam Database*, Cold Region Research and Engineering Laboratory. Available at http://www.crrel.usace.army.mil/ierd/icejam/icejam.htm, accessed August 13, 2008.

PTN COL 2.4-2

Table 2.4.7-201
USGS Stations Used to Characterize the Typical Water Temperatures Near Units 6 & 7

USGS Station[(a)]	Station No.	Period of Record
BISCAYNE CANAL AT S-28 NEAR MIAMI	2286340	1968–1996
LITTLE RIVER CANAL AT S-27 AT MIAMI	2286380	1958–1996
MIAMI CANAL AT NW36 ST	2288600	1967–1996
MIAMI CANAL AT WATER PLANT AT HIALEAH	2288500	1953–1979
MIAMI CANAL EAST OF LEVEE 30 NEAR MIAMI	2287395	1961–1980
MOWRY CANAL NEAR HOMESTEAD	2290725	1969–1980
SNAKE CREEK CA AT S-29 AT NORTH MIAMI BEACH	2286300	1967–1980
SNAKE CREEK CANAL AT NW67 AVE NR HIALEAH	2286200	1960–1980
SNAKE CREEK CANAL BELOW S-30 NR HIALEAH	2286181	1961–1975
TAMIAMI CANAL NEAR CORAL GABLES	2289500	1963–1980
TAMIAMI CANAL OUTLETS L-30 TO L-67A NR MIAMI	2289060	1953–1982
WEST HIGHWAY CREEK NEAR HOMESTEAD	251433080265000	2003–2007
SNAPPER CREEK C AT MILLER DRIVE NR SMIAMI	2290610	1958–1976

(a) Water temperature data from 449 stations were examined. Only 13 stations listed in the table above have periodic measurements useful for analysis. In addition, although the period of records for the stations is from 1939 to 2007, data prior to 1953 are sporadic and were not considered in this evaluation.

Source: Reference 203

PTN COL 2.4-2

Table 2.4.7-202 (Sheet 1 of 2)
Subfreezing and Corresponding Daily Average Temperatures at NCDC Stations Near Units 6 & 7

Homestead Experimental Station (Period of Record 1910 to 1988)					
Date	Temperature °F		Date	Temperature °F	
	Minimum	Average		Minimum	Average
12/03/1910	31.0	46.5	01/26/1951	30.0	48.0
02/03/1917	30.0	40.0	01/05/1953	32.0	53.5
02/06/1917	32.0	49.5	12/17/1953	32.0	49.0
01/02/1918	30.0	51.0	12/22/1954	30.0	49.0
01/04/1918	27.0	43.5	12/23/1954	32.0	53.5
03/02/1920	31.0	51.5	01/06/1956	31.0	51.5
12/17/1920	32.0	51.0	01/09/1956	29.0	46.5
02/28/1922	29.0	(a)	01/10/1956	31.0	50.5
12/28/1923	27.0	56.5	01/15/1956	27.0	49.0
01/02/1927	30.0	47.5	01/10/1958	31.0	44.5
01/12/1927	30.0	49.0	02/05/1958	27.0	48.5
03/04/1927	32.0	51.0	02/14/1958	32.0	49.0
01/29/1928	30.0	48.5	01/22/1960	29.0	44.0
12/29/1928	32.0	52.0	01/23/1960	30.0	44.5
03/05/1930	32.0	51.0	01/24/1960	28.0	45.5
12/12/1934	31.0	44.5	01/21/1961	32.0	49.5
12/13/1934	26.0	40.0	12/29/1961	32.0	47.0
12/12/1937	32.0	47.5	12/30/1961	32.0	47.5
01/28/1938	32.0	48.5	12/10/1962	30.0	44.0
01/20/1939	32.0	46.5	12/11/1962	29.0	48.0
01/28/1940	28.0	39.5	12/14/1962	30.0	44.5
01/29/1940	30.0	44.0	12/15/1962	31.0	48.5
01/30/1940	30.0	46.0	01/14/1964	32.0	41.5
01/11/1941	31.0	49.0	01/15/1964	30.0	46.5
03/02/1941	26.0	46.0	01/18/1965	30.0	45.0
02/03/1942	30.0	49.0	01/31/1966	31.0	48.0
03/04/1942	32.0	50.5	01/20/1971	30.0	41.5
02/16/1943	26.0	47.0	01/19/1977	31.0	39.5
12/20/1943	30.0	49.0	01/20/1977	27.0	44.0
02/09/1945	32.0	55.0	01/13/1981	31.0	46.0
02/06/1947	29.0	48.5	01/19/1981	32.0	50.0
01/02/1949	30.0	51.5	12/26/1983	31.0	39.5
11/27/1949	31.0	53.0	01/22/1985	30.0	41.0
11/29/1950	30.0	49.0	01/23/1985	32.0	43.0
12/19/1950	30.0	47.0	03/02/1986	32.0	48.0

PTN COL 2.4-2

Table 2.4.7-202 (Sheet 2 of 2) Subfreezing and Corresponding Daily Average Temperatures at NCDC Stations Near Units 6 & 7

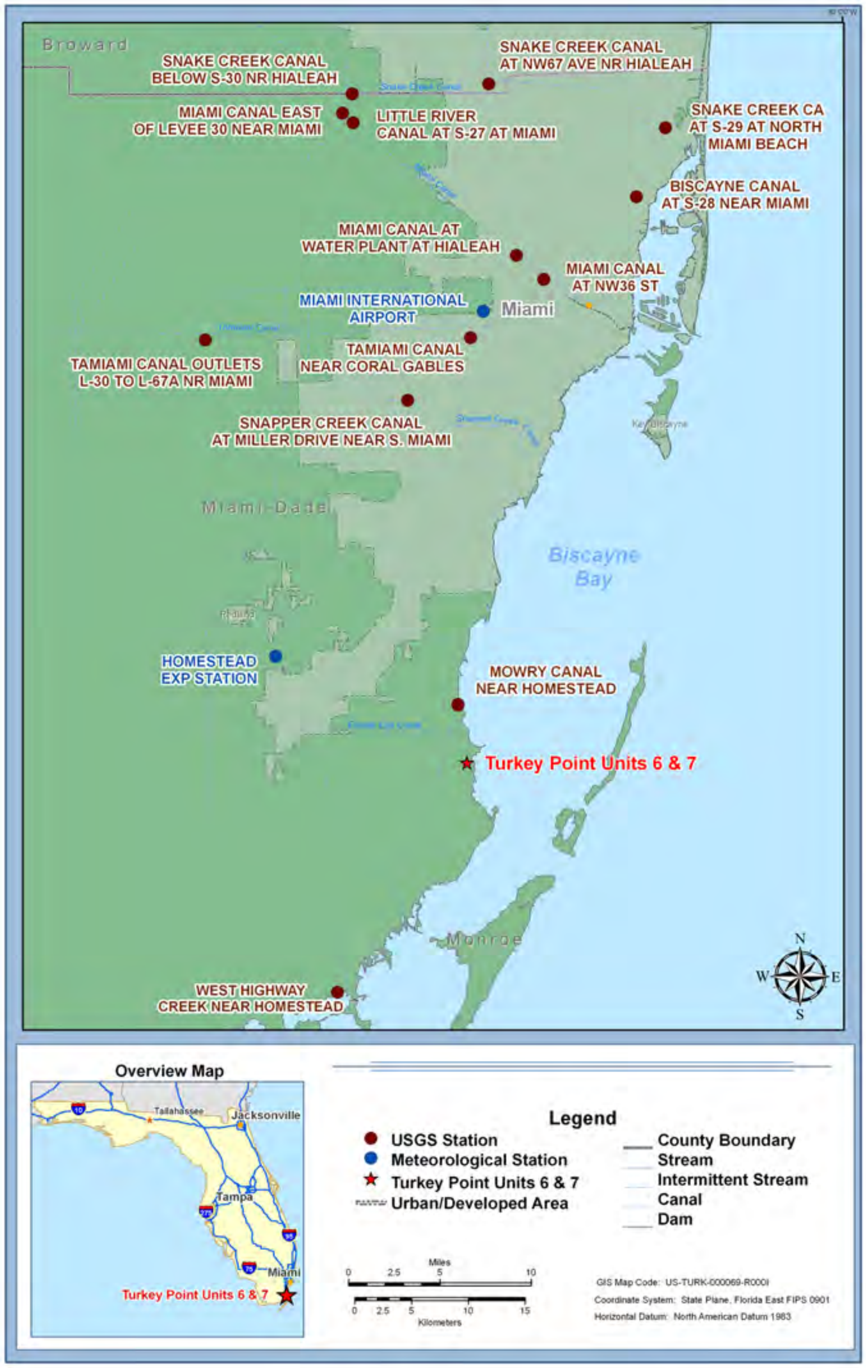
Homestead Experimental Station (Period of Record 1910 to 1988)					
Date	Temperature °F		Date	Temperature °F	
	Minimum	Average		Minimum	Average
12/20/1950	32.0	49.5	—	—	—
Miami International Airport (Period of Record 1948 to 2008)					
Date	Temperature °F		Date	Temperature °F	
	Minimum	Average		Minimum	Average
01/20/1977	31.0	45.0	01/22/1985	30.0	41.5
03/03/1980	32.0	42.5	12/24/1989	31.0	38.0
01/13/1981	32.0	46.5	12/25/1989	30.0	42.5

(a) This data point is not available. However, based on all the data available, the daily average temperature is not expected to fall below freezing.

Source: Reference 201

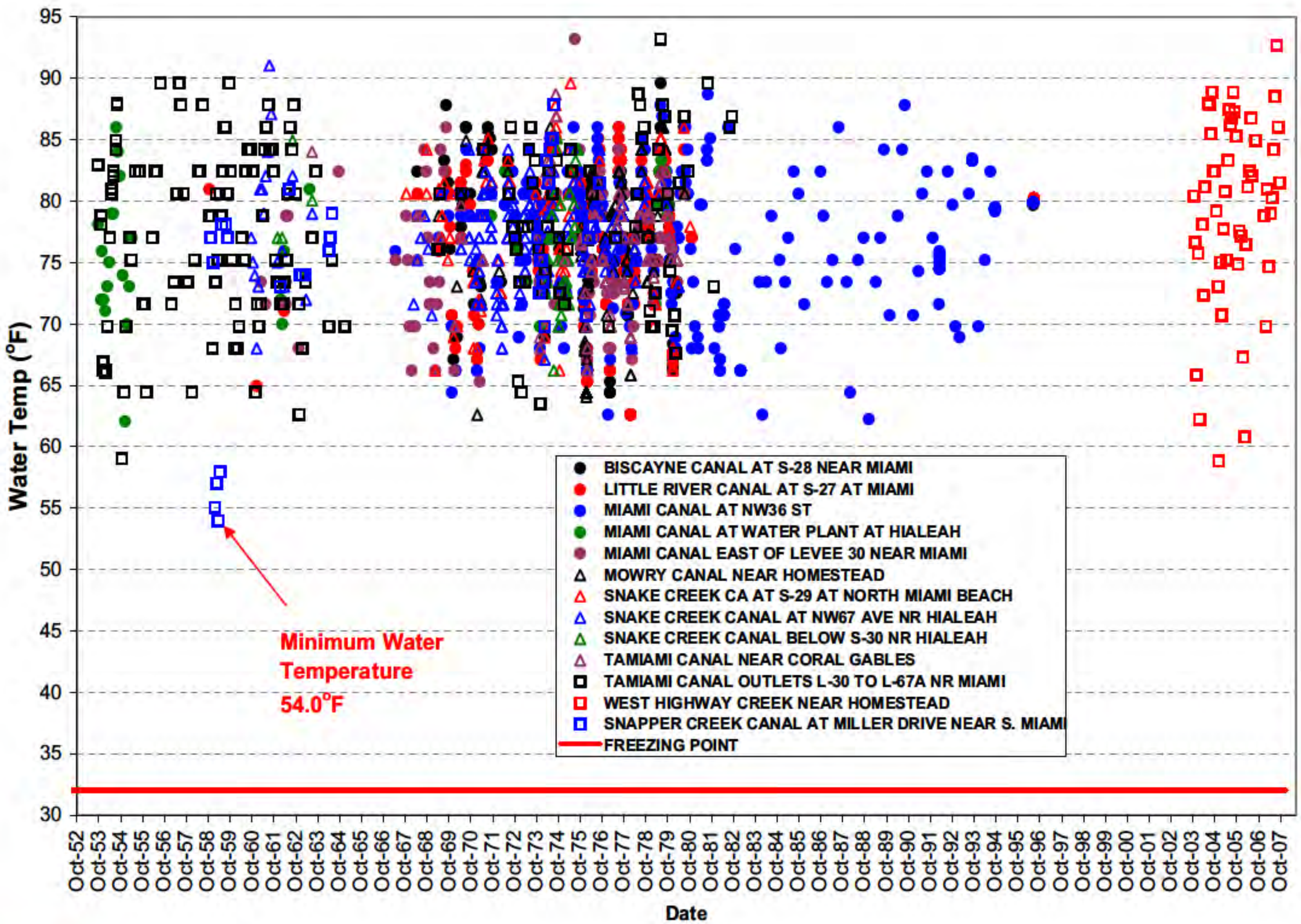
PTN COL 2.4-2

Figure 2.4.7-201 Meteorological and USGS Stations Near Units 6 & 7 Where Historical Air Temperature and Water Temperature Data Were Collected



PTN COL 2.4-2

Figure 2.4.7-202 Water Temperatures at the USGS Stations Near Units 6 & 7



Reference 203

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PTN COL 2.4-1 2.4.8 COOLING WATER CANALS AND RESERVOIRS

The design of the AP1000 reactor employs a passive containment cooling system that functions as the safety-related ultimate heat sink. This system is described in DCD Subsection 6.2.2. The passive containment cooling system does not require an open surface water source to perform its safety-related function. There are no safety-related cooling water canals or reservoirs related to the operation of Units 6 & 7.

2.4.8.1 Cooling Water Canals

Units 6 & 7 do not use cooling water canals for normal plant cooling or for emergency cooling. The plant area of Units 6 & 7 is surrounded by an existing industrial wastewater facility/cooling canals, as shown in Figure 2.4.1-203, which performs the cooling function for Units 1 to 4. The cooling canals consist of 168 miles of recirculating canals that occupy an area approximately 5900 acres. The canals are 200 feet wide and are generally shallow with 1 to 3 feet of water depth. The berms on the canals are approximately 90 feet wide. The canals undergo routine maintenance and the removal of aquatic vegetation from the bottom of the canals to minimize flow restriction. The cooling canals receive plant effluents from Units 1 to 4, as well as blowdown flow from the mechanical draft cooling towers of Unit 5, but there is no surface water discharge from the canals to other water bodies. Because the cooling canals are much lower in elevation than 26.0 feet NAVD 88, the design plant grade of Units 6 & 7, it does not cause any flooding concern to the safety-related structures, systems, and components of Units 6 & 7. In addition, there is no reliance of Units 6 & 7 on these existing canals for any plant water use.

2.4.8.2 Makeup Water Reservoirs

The mechanical draft cooling towers, that function as the normal heat sinks for the circulating water system of the main condensers of Units 6 & 7, are designed to operate on two makeup water sources: reclaimed water and saltwater through radial collector wells. Each of the two makeup water sources can independently support full load operation of the station. Reclaimed water is supplied by the Miami-Dade Water and Sewer Department to the FPL reclaimed water facility and is delivered to an onsite makeup water reservoir (MWR) after treatment. Reclaimed water from the reservoir is then transferred to the cooling tower basins via a set of cooling tower makeup pumps when the system is running on

reclaimed water. The MWR has no safety-related function. It provides makeup water inventory to support the continuous operation of the cooling towers for both units. When the cooling towers require makeup water from the radial collector wells, saltwater is transferred directly to the cooling tower basins, bypassing the MWR.

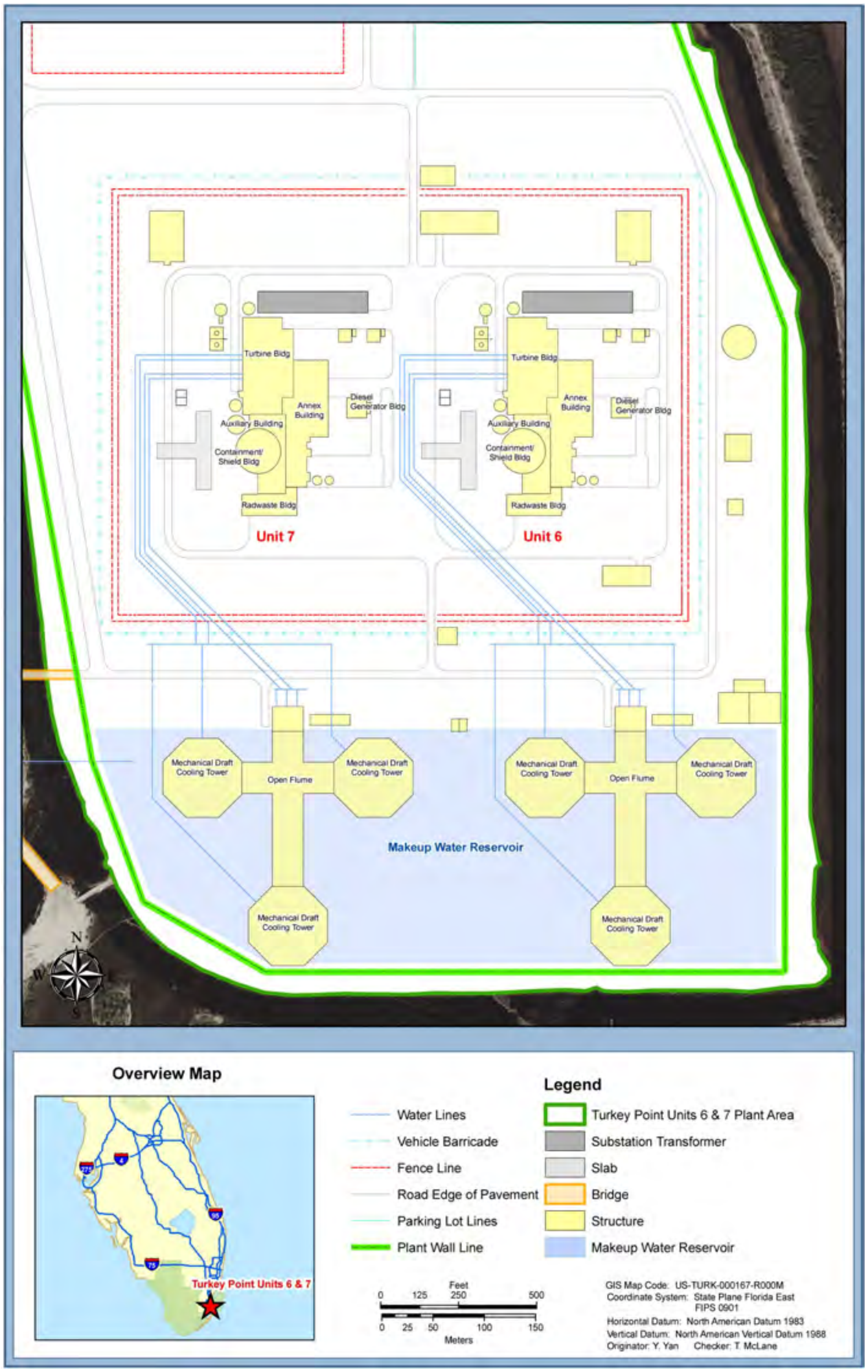
The MWR is made of concrete and is located on the south side of the plant area, as shown in Figure 2.4.8-201. The north side of the reservoir is approximately 2200 feet long, and the south side is approximately 1800 feet long. The bottom elevation of the reservoir is at –2.0 feet NAVD 88, and the top of the concrete walls is at elevation 24.0 feet NAVD 88 with the maximum storage level at elevation 22.5 feet NAVD 88. The six cooling towers, three for each unit and their common open channel flumes, occupy part of the footprint of the MWR as shown in Figure 2.4.8-201.

The MWR is a self-contained reservoir and has no other contributing drainage area and the only other inflow is direct rainfall. Return effluents from the FPL water treatment facility, sanitary waste treatment facility, blowdown from the cooling towers, and miscellaneous clean water drains are directed to the blowdown sump before being discharged into the underground injection wells.

Low flow conditions are presented in Subsection 2.4.11. In conclusion, there is no impact to the safety-related structures, systems, and components as a result of a low water condition in the MWR. Subsection 2.4.4 addresses the effect of potential breaching of the MWR and concludes that safety-related structures are not impacted.

PTN COL 2.4-1

Figure 2.4.8-201 Layout of Major Plant Facilities



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2.4.9 CHANNEL DIVERSIONS

PTN COL 2.4-3 Units 6 & 7 are located on the western shore of Biscayne Bay. Based on the seismic, geological, topographical, thermal, and hydrological evidences of the region, there is no plausible risk that the safety-related facilities and functions of the plant will be adversely affected by channel diversions or shoreline migrations as described below.

The site's geologic setting, including the seismic and stratigraphic properties, is described in Subsection 2.5.1. Units 6 & 7 are located within the Southern Slope subprovince of the Southern Zone physiographic subregion of the Florida Platform (a partly submerged peninsula of the continental shelf) within the Atlantic Coastal Plain physiographic province. The geology was influenced by sea level fluctuations, processes of carbonate and clastic deposition, and erosion. The Paleogene (early Cenozoic) is dominated by the deposits of carbonate rocks, while the Neogene (late Cenozoic) is more influenced by the deposits of quartzitic sands, silts, and clays. The geology is dominated by flat, planar bedding in late Pleistocene and older units. The original site was within 3 feet of sea level and was uniformly flat throughout with the exception of a few isolated vegetated depressions. The local terrain was covered with a thin (less than 6 feet) veneer of organic muck that overlaid the Pleistocene Miami Limestone. There is no geological or topographic evidence that indicates historical channel diversions in the general area.

According to the hydrological description in Subsection 2.4.1, there are no major natural rivers or channels located near Units 6 & 7, and the preconstruction elevation within the plant area where the safety-related facilities are located varies from approximately –2.4 feet to 0.8 feet NAVD 88. An extensive system of canals, as shown on Figures 2.4.1-208 and 2.4.1-209, was built between Lake Okeechobee and the Atlantic Ocean, Biscayne Bay and Gulf of Mexico during the last century for the purposes of drainage, flood protection, and water supply.

Consisting of multiple waterways with locks and gates for controlling flow and water levels, the canal system has elevated levees along the left and right banks to contain flood flow during storm events and is not susceptible to channel migration or cutoff. There is no evidence of channel diversions in the area as a result of natural flooding events since the canal system was built.

As described in Subsection 2.4.1, the Biscayne Bay is bounded by mainland Florida to the west; by barrier islands and a wide, shallow opening of coral shoal near the middle of the bay; and by several channels and cuts to the east. The barrier islands are located between the bay and the Atlantic Ocean. The Biscayne Bay is a shallow subtropical lagoon with a natural depth ranging from 3 to 9 feet. However, much of the bay has been dredged and the current depth ranges from 6 to 10 feet (Reference 201). There is historical evidence of shoreline changes along the Florida coasts, including the western shore of Biscayne Bay where Units 6 & 7 are located.

Shoreline changes along east Florida are due to hurricanes, tropical storms, northeasters, and tidal and wave actions (References 202, 203, and 204). These forces effect erosion of sandy beaches and barrier islands, especially around inlets (Reference 202). In addition, coastal protection structures amplify shoreline fluctuations by changing the natural long shore sediment transport pattern. Although the lagoons along east Florida (such as Biscayne Bay) are protected by barrier islands, wakes generated by boats in the lagoons can contribute to local shore erosion in some areas (Reference 202). Any migration of the shoreline due to coastal protection structures, dredging, and other human activities near and around the plant site should be gradual and will be addressed before the safety-related facilities are adversely impacted.

Reference 202 provides a summary of long- and short-term shoreline change for the southeast Atlantic coast. Long-term rates of shoreline change were estimated based on surveys of shoreline positions from the 1800s to 1999, and short-term rates of shoreline change were estimated based on 1970s and 1999 shoreline positions. The average long- and short-term shoreline-change rates for east Florida are 0.2 ±0.6 meter/year (0.66 ±2.0 feet/year) and 0.7 meter/year (2.3 feet/year), respectively (plus sign indicates accretion and minus sign indicates erosion). This long-term shoreline rate of change is relatively small compared to shoreline changes for the other parts of the southeast Atlantic coast because tidal and wave energy levels are low and beach nourishments are common where shore erosion persists. Nevertheless, at least 39 percent of the east Florida shoreline experiences a long-term average erosion rate of 0.5 meter/year (1.6 feet/year). The study did not estimate the long- and short-term shoreline change rates specifically for Biscayne Bay. However, shoreline changes in the Biscayne Bay, especially along the western shore, are expected to be smaller because of the protection provided by the barrier islands. Any erosion or inundation of the barrier islands due to long-term wave action would be gradual

with sufficient warning and will be addressed before the safety-related facilities are adversely impacted.

Figure 2.4.9-201 shows the shorelines near Units 6 & 7 for the years 1928, 1946, and 1971/1972 (Reference 205). As the figure indicates, there has been some shoreline erosion between 1928 and 1971/1972 (approximately a 43-year lapse), although some areas also experienced accretion. Nevertheless, between the years 1946 and 1971/1972 (approximately a 25-year lapse), only minor shoreline changes were observed. Any shoreline changes that would occur near Units 6 & 7 as a result of long-term tidal and wave actions would be relatively gradual with sufficient warning for mitigating actions to be implemented before the safety facilities will be adversely impacted.

Shoreline changes as a result of hurricanes or tropical storms occur on a shorter time scale. As addressed in Subsection 2.4.5, during the landfall of Hurricane Andrew in 1992, the combined storm surge and astronomical tide in the northern Biscayne Bay ranged from 4 to 6 feet NGVD 29, which is approximately 2.4 to 4.4 feet NAVD 88 based on the datum relationship given in Subsection 2.4.1. The maximum surge height of 16.9 feet NGVD 29 (15.3 feet NAVD 88) from Hurricane Andrew was observed on the western shoreline near the center of the Biscayne Bay. In the southern part of the Biscayne Bay, the surge elevation ranged from 4 to 5 feet NGVD 29 (2.4 to 3.4 feet NAVD 88). During the landfall of the hurricane, the mainland coast of Biscayne Bay, from Rickenbacker Causeway to Turkey Point, experienced a strong onshore surge (Reference 206). The lower beach slope erosion from the hurricane seldom exceeded 0.3 to 1 meter (1 to 3.3 feet) and the lateral erosion of the shoreline was less than 10 meters (33 feet) (Reference 206). As described in Subsection 2.4.10, the Units 6 & 7 plant area is built up to higher elevations from the adjacent grade and is protected by a retaining wall structure with the top of wall elevation varying from 20 feet to 21.5 feet NAVD 88. In addition, the retaining wall, though not a safety-related structure, is designed to withstand the hydrostatic and hydrodynamic forces from hurricane surge up to the probable maximum storm surge and coincidental wave run-up actions. Therefore, no adverse impact on the structures, systems, or components is expected as a result of shoreline erosion caused by hurricane or tropical storm surges.

Long-term sea level rise will cause a landward shift of the shoreline position, inundating low-lying areas along the coast. As described in Subsection 2.4.5, the long-term average sea level rise at the plant property is expected to be approximately 0.78 foot per century (0.094 inch/year), similar to the sea level rise rate at Miami Beach, Florida. The rate of the sea level rise is too slow to cause

any significant short-term shoreline change. On a long-term perspective, the determination of the design basis flood level, established as a result of the probable maximum hurricane storm surge, has included the effect of sea level rise as described in Subsection 2.4.5. Descriptions of safety-related flood protection measures for Units 6 & 7 are detailed in Subsection 2.4.10.

Because the plant property is flat and no major rivers are located nearby, there is no potential for subaerial landslide-generated flooding. In addition, as addressed in Subsection 2.4.6, the largest submarine landslide zones near Units 6 & 7 are identified along the salt domes of the Carolina Trough where tectonic activities of the salt domes have been suggested as one of the triggering mechanisms for these slides. Units 6 & 7 are located approximately 400 miles southwest of Blake Spur, with a wide and shallow continental shelf in between, and, therefore, the impact of any submarine landslide-generated tsunami in the continental shelf north of Blake Spur would be considerably reduced before reaching Units 6 & 7. Subsection 2.4.6 concludes that the safety function of the plant will not be affected by tsunami induced flooding or low water conditions.

As presented in Subsection 2.4.7, there are no records of ice jams in the region of South Florida where Units 6 & 7 are located. Therefore, there is no potential for flooding or low water concerns as a result of channel diversions both upstream and downstream of Units 6 & 7 from ice blockage or breaching of ice jams.

On the consideration of the plant's safety-related water supply, the design of the AP1000 reactor employs a passive containment cooling system that functions as the safety-related ultimate heat sink. This system, described in AP1000 DCD Subsection 6.2.2, is responsible for emergency cooling. The passive containment cooling system design of Units 6 & 7 does not rely on an open surface water source or groundwater source to perform its safety-related function. Therefore, its operation is not adversely affected by the interruption of plant water supply as a result of low water conditions caused by channel diversion or shoreline migration events.

2.4.9.1 References

201. Florida Department of Environmental Protection, *About the Biscayne Bay Aquatic Reserve*. Available at http://www.dep.state.fl.us/coastal/sites/biscayne/info.htm, accessed October 30, 2008.

202. Morton, R., and T. Miller, *National Assessment of Shoreline Change: Part 2: Historical Shoreline Changes and Associated Coastal Land Loss Along*

the U.S. Southeast Atlantic Coast, U.S. Geological Survey, Open-File Report 2005-1401, 2005.

203. Florida Department of Environmental Protection, Bureau of Beaches and Coastal Systems, *Strategic Beach Management Plan for the Southeast Atlantic Coast Region*. Available at http://www.dep.state.fl.us/beaches/publications/pdf/SBMP/Southeast%20Atlantic%20Coast%20Region.pdf, accessed October 31, 2008.

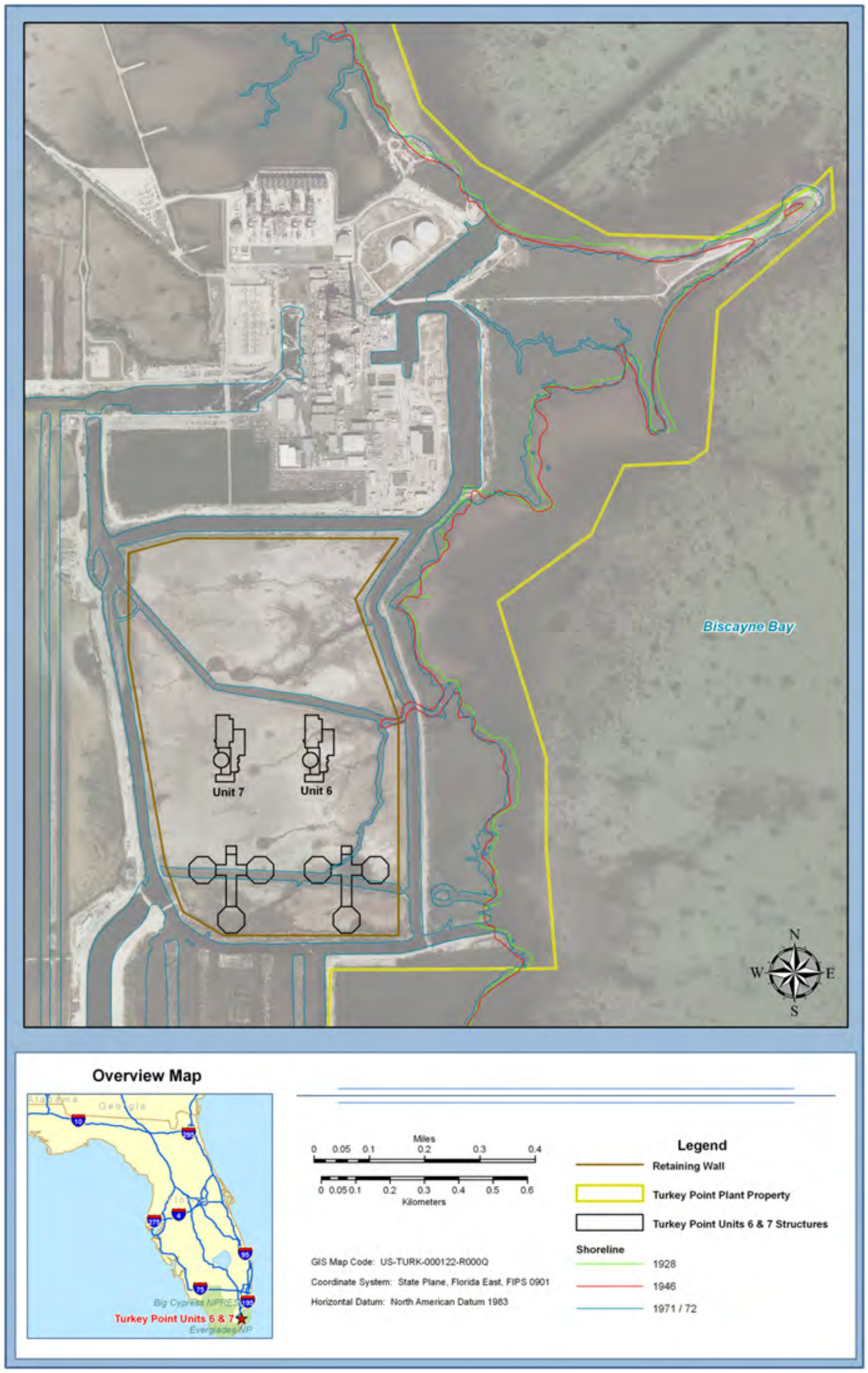
204. Florida Department of Environmental Protection, Bureau of Beaches and Coastal Systems, *Strategic Beach Management Plan for the Florida Keys Region.* Available at http://www.floridadep.org/beaches/publications/pdf/SBMP/Florida%20Keys%20Region.pdf, accessed October 31, 2008.

205. National Oceanic and Atmospheric Agency, *National Geodetic Survey, NOAA Shoreline Data Explorer.* Available at http://www.ngs.noaa.gov/newsys_ims/shoreline/index.cfm, accessed October 14, 2008.

206. Tilmant, J., T. Curry, R. Jones, A. Szmant, J. Zieman, M. Flora, M. Robblee, D. Smith, R. Snow, and H. Wanless, *Hurricane Andrew's Effects on Marine Resources*, BioScience, Vol. 44, No. 4, pp. 230–237, 1994.

PTN COL 2.4-3

Figure 2.4.9-201 Historical Shoreline Changes at Units 6 & 7



Source; Reference 205

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2.4.10 FLOODING PROTECTION REQUIREMENTS

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The design basis flood elevation for Units 6 & 7 is established at 24.8 feet NAVD 88, as presented in Subsection 2.4.2.2. The design basis flood elevation is a result of the probable maximum storm surge including wave run-up, details of which are described in Subsection 2.4.5. The elevations of floor entrances and openings of all safety-related structures (also referred to as the design plant grade elevation in the DCD, which is 100 feet, or 30.48 meters, in the DCD reference datum) are at 26 feet NAVD 88. Because the design basis flood elevation is below the entrance floor elevations of the safety-related structures, the safety functions of the plant are not affected by the design basis flood event.

Subsection 2.4.2.3 describes the flood elevation as a result of the local intense precipitation (also referred to as the local probable maximum precipitation or local PMP) for Units 6 & 7. The local PMP flood analysis is performed on the conservative basis that all underground storm drains and culverts are clogged. As indicated in Subsection 2.4.2.3, the maximum flood water level in the Units 6 & 7 power block area, where safety-related structures, systems, and components (SSCs) are located, is 24.5 feet NAVD 88 during the local PMP storm event. Consequently, the local PMP storm event does not cause flooding impacts to the safety-related SSCs.

Because none of the Units 6 & 7 safety-related SSCs are adversely affected by any of the postulated flood events, no flood protection measures are required for Units 6 & 7. Additionally, no technical specifications or emergency procedures to implement flood protection activities are required.

As addressed in DCD Subsection 3.4.1.1.1, the roofs of safety-related structures are designed to preclude accumulation and ponding of water during storms, including the local PMP event. The design basis snow and probable maximum winter precipitation load on the roofs of safety-related structures is presented in Subsection 2.3.1.3.4.

The Units 6 & 7 plant area is built up to higher elevations from the adjacent grade and is surrounded by a retaining wall structure with the top of the wall elevation varying from 20 feet to 21.5 feet NAVD 88. The safety-related structures of Unit 6 and Unit 7 are at least 750 feet and 690 feet away from the nearest retaining

wall, respectively. In addition, the retaining wall, though not a safety-related structure, is designed to withstand the hydrostatic and hydrodynamic forces from hurricane surge up to the probable maximum storm surge and coincidental wave run-up actions.

SUBSECTION 2.4.11: LOW WATER CONSIDERATIONS
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2.4.11 LOW WATER CONSIDERATIONS

PTN COL 2.4-3 The passive containment cooling system for Units 6 & 7 does not require an open surface water source to perform its safety-related function, and, therefore, its operation is not adversely affected by low flow conditions described in this section.

The dissipation of the power cycle heat from the main condensers of the circulating water system is by the cooling towers. The cooling towers of the circulating water system, including its pump intake structure, are nonsafety-related structures. The raw water system provides makeup water to the cooling tower basins to compensate for evaporation, drift, and blowdown discharge. The raw water system is nonsafety-related. The source of raw water is either reclaimed water, or saltwater withdrawn from radial collector wells, or a combination of the two types of water sources. Each of these two makeup water sources is able to provide 100 percent of the makeup water flow requirements resulting in 100 percent redundancy in the water supply system.

The reclaimed water is delivered to the plant property/site boundary from Miami-Dade County Water and Sewer Department (MDWASD) facilities. Reclaimed water requires tertiary treatment before it is used for cooling.

The saltwater is supplied from four radial collector wells with radials extending beneath the Biscayne Bay. The saltwater is delivered to the cooling tower basins.

The Miami-Dade potable water supply provides makeup water for the service water cooling towers of each unit. Additionally, the Miami-Dade potable water supply provides water for the potable water system, fire protection system, demineralized water system, and other miscellaneous uses for each unit.

2.4.11.1 Low Flow in Rivers and Streams

Conventional cooling water sources such as rivers and streams are not used for Units 6 & 7. Instead, reclaimed water and the saltwater from radial collector wells are the two main sources of makeup water for the cooling towers. Therefore, low flow conditions in rivers and streams have no impact to the plant water supply.

2.4.11.1.1 Reclaimed Water for Makeup

Units 6 & 7 use reclaimed water from MDWASD. The MDWASD provides wastewater treatment for customers within Miami-Dade County. The secondary treatment and effluent disposal are accomplished at South District Wastewater Treatment Plant (SDWWTP), with deep injection well disposal of effluent (Reference 201). The SDWWTP facility is the potential source of reclaimed water (References 202 and 203). The location of this facility is shown in Figure 2.4.11-201.

Reuse of reclaimed water is also addressed in the water use permit for the Miami-Dade consolidated public water supply, issued by the SFWMD on November 15, 2007 (Reference 202). Consistent with the permit, MDWASD will work with FPL to provide reclaimed water for additional power projects such as the gas power plant expansion and the proposed nuclear power plant (Reference 202). The MDWASD planned supply is 70 mgd of reclaimed water for Units 6 & 7 and 14 mgd for the gas-powered Unit 5 (Reference 203).

The maximum reclaimed makeup water rate required by the mechanical draft cooling towers for Units 6 & 7 is approximately 38,400 gpm or 55.3 mgd. This is based on maintaining four cycles of concentration in the cooling towers. The blowdown discharge flow rate at four cycles of concentration is approximately 10,000 gpm.

2.4.11.1.2 Saltwater for Makeup

Saltwater from radial collector wells is an alternate source of makeup water for the nonsafety-related cooling towers. The wells supply saltwater that recharges from the marine environment (Biscayne Bay). The water salinity in these formations is close to seawater due to its hydraulic connection.

The saltwater for makeup is obtained through a system of radial collector wells. A radial collector well consists of a central reinforced concrete caisson extending below the ground to the target depth. Well screens project laterally outward into the surrounding earth materials in a radial pattern at the target depth. Subsection 2.4.12 provides details of this water supply system.

The maximum saltwater flow rate required by the mechanical draft cooling towers of Units 6 & 7 is approximately 86,400 gpm or 124.4 mgd. This is based on maintaining 1.5 cycles of concentration in the cooling towers. The makeup water to the cooling tower is necessary to compensate for evaporation, drift, and

blowdown discharges from the cooling towers. The blowdown discharge flow rate at 1.5 cycles of concentration is approximately 58,000 gpm.

Units 6 & 7 incorporate four 33.3 percent capacity radial collector wells with a capacity of each well being approximately 45 mgd, based on the 100-year low seawater level of –3.5 feet NAVD 88. The location of the radial collector wells is shown in Figure 2.4.11-202.

2.4.11.1.3 Availability and Reliability of Makeup Water

Two independent sources of makeup water, each with 100 percent supply capacity, provide makeup water to the circulating water system.

The reclaimed water supply and saltwater from radial collector wells are not typical cooling water sources, and they differ from rivers and streams. The sources of these types of water are affected by infrastructure put in place, and hydrometeorological phenomena do not affect the supply of these sources. Consequently, the 100-year low flow condition for rivers and streams is not applicable to reclaimed water, and the 100-year low seawater level condition is used in the design of radial collector wells.

Radial collector wells are designed to induce seabed filtration of suspended sediments. In this manner, sediments are filtered out before reaching the laterals and point of use. This arrangement improves the raw water quality and simplifies the treatment process. One radial collector well can operate in standby mode and function as a reserve well in the event of unplanned well outages or scheduled maintenance events.

2.4.11.2 Low Water Resulting from Surges, Seiches, or Tsunamis

Plant safety-related systems, including the UHS, do not rely on the cooling tower system and are not affected by interruptions in the operation of these mechanical systems.

The hurricane-induced or tsunami-induced set-down is not anticipated to affect the makeup water supply to the cooling towers. The system safeguards include (1) the reclaimed water makeup water supply is 100 percent redundant to saltwater supply system and (2) radial collector wells are designed based on the 100-year low seawater level conditions.

As presented in Subsection 2.4.7, there are no records of ice jams due to freezing temperatures not being sustainable in this region. Consequently, the

nonsafety-related cooling tower makeup water supply systems are not affected by freezing temperatures.

2.4.11.3 Historical Low Water

The reclaimed water production in Miami-Dade County has been increasing continuously due to the increase in population and the expansion of municipalities. To promote the use of reclaimed water, the Florida legislation has passed regulations encouraging the use of reclaimed water and has prohibited the municipalities from discharge of reclaimed water to sea through ocean outfalls.

The radial collector wells are man-made water supply systems and are connected to the saltwater through underground lateral pipes/screens. Consequently, the supply of saltwater from radial collector wells is minimally affected by tide variations. The design capacity of the wells, however, is based on the 100-year low seawater level of –3.5 feet NAVD 88. Units 6 & 7 have one additional radial collector well (33.3 percent redundancy) to overcome any interruption potential.

2.4.11.4 Future Controls

The safety-related systems of Units 6 & 7, including the UHS, do not rely on surface water sources and are not affected by drought conditions. The cooling tower system is only for normal cooling, and it is a nonsafety-related system. No future controls are necessary due to low water conditions.

2.4.11.5 Plant Requirements

The normal heat sink circulating water system is a closed-cycle cooling tower system. The reclaimed water makeup intake is located on the makeup water reservoir supplying makeup water to the cooling tower basins. Reclaimed water supply is conveyed to the onsite FPL reclaimed water treatment facility before its storage in the makeup water reservoir. The intake structure on the makeup water reservoir includes necessary intake screens, pumps, and control systems. The saltwater supply to the cooling tower basins is directly from the radial collector wells.

The maximum makeup water flow requirements for reclaimed water and saltwater sources are shown in Table 2.4.11-201. The rivers and streams 100-year drought flow rates are not applicable to the reclaimed water supply, and the radial collector wells are designed for sustainable operation during a 100-year low seawater level condition.

2.4.11.6 Heat Sink Dependability Requirements

The passive containment cooling system provides emergency cooling for the plant. A continuous natural circulation flow of air removes heat from the containment vessel. The steel containment vessel conducts heat from the containment interior atmosphere to the outside. A separate passive containment cooling system consists of gravity-drained, water storage tank that provides containment wetting. The passive containment cooling system is not reliant on the source of water from the cooling towers' makeup water system. Makeup for passive containment cooling system is provided by connection to the municipal water supply. Therefore, no warning of impending low flow from the cooling tower makeup water system is required. Makeup water supply during low flow conditions would not affect the ability of emergency cooling water systems and the UHS to provide the required cooling for normal operations, anticipated operational occurrences, and emergency conditions.

A detailed description of the UHS design is provided in DCD Subsection 6.2.2, which indicates that it conforms to RG 1.27 guidance.

2.4.11.7 References

201. Miami-Dade Water and Sewer Department, *Reuse Feasibility Update*, April 2007.

202. South Florida Water Management District, *Water Use Permit No. RE-ISSUE 13-00017-W*, November 15, 2007.

203. Miami-Dade Water and Sewer Department, *Miami-Dade Consolidated PWS Water Use Permit No. 13-00017-W*, July 7, 2008.

PTN COL 2.4-3

Table 2.4.11-201
Makeup Water Flow Requirements for Units 6 & 7

Makeup Water Source	Makeup Flow Rate[(a)] (gpm)
Reclaimed Water	38,400
Saltwater	86,400

(a) Based on 100% use of water source

PTN COL 2.4-3 **Figure 2.4.11-201 Location of Reclaimed Water Source and Pipeline Route**

PTN COL 2.4-3

Figure 2.4.11-202 Location of Radial Collector Wells

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2.4.12 GROUNDWATER

This subsection contains a description of the hydrogeologic conditions present at and in the area around Units 6 & 7. Regional and site-specific data on the physical and hydrogeologic characteristics of the groundwater system and existing and potential use of groundwater is summarized.

2.4.12.1 Description and Onsite Use

This subsection contains a description of the regional and local physiography and geomorphology, groundwater aquifers, geologic formations, and groundwater sources and sinks. Onsite uses of groundwater are also described, including groundwater production wells and groundwater flow requirements for Units 6 & 7.

2.4.12.1.1 Physiography and Geomorphology

Units 6 & 7 are located in Miami-Dade County, Florida, approximately 25 miles south of Miami and approximately 9 miles southeast of Homestead. Units 6 & 7 are located in the Southern Slope sub-province of the Southern Zone of the Florida Platform (a partly submerged peninsula of the continental shelf) in the Atlantic Coastal Plain physiographic province as shown in Figure 2.4.12-201. The plant property is bordered on the east by Biscayne Bay, on the west by the FPL Everglades Mitigation Bank, and on the northeast by Biscayne National Park. The Florida Platform is underlain by approximately 4000 to 15,000 feet of clastic deposits (quartz sands, silt, marl, and clay) and nonclastic deposits of carbonate sediments (shell beds, calcareous sandstone, limestone, dolostone, dolomite, and anhydrite). The sediments range in age from Paleozoic to Recent. A detailed description of the regional and site-specific geology, physiography, and geomorphology is provided in Subsections 2.5.1.1 and 2.5.1.2.

The physiographic features near Units 6 & 7 are the Atlantic Coastal Ridge, the Everglades, and the Florida Keys. The geomorphology of Florida has been described in the literature (References 201 and 202) as having three zones: Northern, Central, and Southern. The Units 6 & 7 plant area is in the Southern Zone (Figure 2.4.12-201). The Units 6 & 7 plant area spans former coastal mangrove swamps and tidal flats along the west margin of Biscayne Bay that were altered to develop the existing units and cooling canals.

The 5900-acre industrial wastewater facility (approximately 2 miles wide and 5 miles long), of which 4370 acres is water (approximately 75 percent), is a predominant feature at the plant property (Subsection 2.4.12.1.5.3).

The surficial geology of the Units 6 & 7 plant area consisted primarily of organic muck. The organic muck is described as either light gray-dark gray to pale brown with trace amounts of shell fragments and little to no reaction to hydrochloric acid and/or black to brown with organic fibers and strong reaction to hydrochloric acid. The thickness of the muck across the plant area typically varied from 2 to 7 feet, with an average of 3.4 feet (Reference 248). The underlying Miami Limestone is a marine carbonate consisting predominately of oolitic facies of white to gray limestone with fossils (mollusks, bryozoans, and corals).

2.4.12.1.2 Regional Groundwater Aquifers

The hydrostratigraphic framework of Florida consists of a thick sequence of Cenozoic sediments that comprise three major aquifers: (1) the surficial aquifer system, (2) intermediate aquifer system/confining unit, and (3) the Floridan aquifer system (Reference 204). The hydrologic parameters and lithologies of each aquifer system vary widely across the state. A generalized hydrostratigraphic column is presented in Figure 2.4.12-202.

2.4.12.1.2.1 Surficial Aquifer System

The surficial aquifer system is defined by the Southeastern Geological Society Ad Hoc Committee (Reference 204) as the permeable hydrologic unit contiguous with the land surface that is comprised principally of unconsolidated to poorly indurated, siliciclastic deposits. Rocks making up the surficial aquifer system belong to all or part of the Upper Miocene to Holocene Series, consisting mainly of quartz sands, shell beds, and carbonates. In southern Florida, the surficial aquifer system consists of the Tamiami, Caloosahatchee, Fort Thompson, and Anastasia Formations, the Key Largo and Miami Limestones, and the undifferentiated sediments (Reference 204).

The surficial aquifer is under primarily unconfined conditions, although beds of low permeability may cause semi-confined or locally confined conditions to prevail in its deeper parts. The lower limit of the surficial aquifer system coincides with the top of the laterally extensive and vertically persistent beds of much lower permeability. The primary aquifer in the surficial aquifer system in southeastern Florida to which a name has been applied is the Biscayne aquifer, which immediately underlies the plant area. The thickness of the surficial aquifer ranges from approximately 20 to 400 feet (Figure 2.4.12-202).

The Biscayne aquifer has been declared a sole-source aquifer by the EPA. The EPA defines a sole-source aquifer as “an underground water source that supplies

at least 50 percent of the drinking water in the area overlying the aquifer. These areas have no alternative drinking water source(s) that could physically, legally, and economically supply all those who depend on the aquifer for drinking water." Figure 2.4.12-203 (Reference 205) shows the locations of sole-source aquifers in EPA Region 4, which encompasses the Units 6 & 7 plant area. The figure also contains a description of the Biscayne sole-source aquifer. The Biscayne aquifer in the area of Units 6 & 7 contains saline to saltwater and is not useable as a potable water supply.

2.4.12.1.2.2 Intermediate Aquifer System/Confining Unit

Regionally, a sequence of relatively low-permeability, largely clayey deposits up to 900 feet thick form a confining unit that separates the Biscayne aquifer from the underlying, fresh to saline water Floridan aquifer system. The confining unit also contains transmissive units that can locally act as an aquifer.

The Southeastern Geological Society (Reference 204) defines the intermediate aquifer system/confining unit as all rocks that lie between and collectively retard the exchange of water between the overlying surficial aquifer system and the underlying Floridan aquifer system. In general, the rocks of this system consist of fine-grained siliciclastic deposits interlayered with carbonate strata of Miocene or younger age. In areas where poorly yielding to non-water yielding units occur, the term intermediate confining unit is used. In areas where low to moderate yielding units are interlayered with relatively impermeable confining beds, the term intermediate aquifer system applies. The aquifer's units in this system contain water under confined conditions. The top of the intermediate aquifer system/confining unit coincides with the base of the surficial aquifer system. The base of the intermediate aquifer, or confining unit, is at the top of the vertically persistent, permeable, carbonate section that comprises the Floridan aquifer system. The sediments comprising the intermediate aquifer system/confining unit are widely variable across the state. In the southern part of the state, the Hawthorn Group sediments form both an intermediate confining unit and an intermediate aquifer system. The Hawthorn Group sediments are up to approximately 900 feet thick in southern Florida (Figure 2.4.12-202) (Reference 206). In many areas of the state, permeable carbonates occurring at the base of the Hawthorn Group may be hydraulically connected to the Floridan aquifer system and locally form the top of the Upper Floridan aquifer. The intermediate confining unit provides an effective aquiclude for the Floridan aquifer system throughout the state.

2.4.12.1.2.3 Floridan Aquifer System

The Floridan aquifer system underlies approximately 100,000 square miles in southern Alabama, southeastern Georgia, southern South Carolina, and all of Florida. Potable water is not present everywhere in the aquifer. As defined by Miller (Reference 207), the Floridan aquifer system is a vertically continuous sequence of interbedded carbonate rocks of Tertiary age that are hydraulically interconnected by varying degrees and with permeabilities several orders of magnitude greater than the hydrogeologic systems above and below. The system may occur as a continuous series of vertically connected carbonate sediments or may be separated by subregional to regional confining beds (Reference 207). The Floridan aquifer formally consists of three primary hydrogeologic units: the Upper Floridan aquifer, the middle confining unit, and the Lower Floridan aquifer (Figure 2.4.12-202). Porosity and permeability in the aquifer units vary widely depending on location and formation.

In southern Florida, the Floridan aquifer system is composed of all or parts of the Cedar Keys Formation, Oldsmar Formation, Avon Park Formation, Ocala Limestone, Suwannee Limestone and, possibly, the basal carbonates of the Hawthorn Group in limited areas.

In peninsular Florida, the top of the Floridan aquifer system ranges in elevation from approximately 0 feet National Geodetic Vertical Datum of 1929 (NGVD 29) to more than –1100 feet NGVD 29 with thicknesses ranging from approximately 2300 feet to more than 3400 feet in southern Florida (Reference 207). Throughout most of southern Florida, the Floridan aquifer system occurs under confined conditions.

2.4.12.1.3 Local Hydrogeology

Two major regional aquifers underlie the area, including all of Miami-Dade County and the Units 6 & 7 plant area: (1) the surficial aquifer system, including the Biscayne aquifer, and (2) the Floridan aquifer system consisting of the Upper Floridan aquifer, the middle confining unit, and the Lower Floridan aquifer. A generalized regional hydrostratigraphic column is presented in Figure 2.4.12-202. A site-specific hydrostratigraphic column, developed from hydrogeologic data obtained from borings drilled up to a maximum depth of approximately 615 feet bgs as part of the Units 6 & 7 geotechnical investigation, (Reference 248) is presented in Figure 2.4.12-204.

The Biscayne aquifer, as shown in Figure 2.4.12-205, extends from near surface to a depth of approximately 240 feet near Fort Lauderdale and approximately 80 to 115 feet locally (Figure 2.4.12-206). The Upper Floridan aquifer extends from approximately 1000 to 1200 feet bgs. The middle confining unit extends from approximately 1200 to 2400 feet bgs. The Lower Floridan aquifer extends from approximately 2400 feet bgs to an undetermined depth thought to be greater than 4000 feet bgs in the Miami-Dade County area (Reference 206). The Boulder Zone in the Lower Floridan aquifer extends from approximately 2800 to greater than 3000 feet bgs at the MDWASD South District Wastewater Treatment Plant (Reference 208), which is located approximately 9 miles north of Units 6 & 7.

2.4.12.1.3.1 Surficial (Biscayne) Aquifer

The surficial aquifer system comprises all the rocks and sediments from the land surface downward to the top of the intermediate confining unit. These lithologic materials consist primarily of limestones and sandstones with sands, shells, and clayey sand with minor clays and silts. The base of the system is defined by a significant change in hydraulic conductivity. Sedimentary bedrock and unconsolidated sediments in the surficial aquifer system have a wide range of hydraulic properties and locally may be divided into one or more aquifers separated by less permeable or semi-confining units. Within the surficial aquifer system, the major water producing unit is the unconfined Biscayne aquifer that underlies the Units 6 & 7 plant area and most of Miami-Dade County and parts of Broward, Monroe, and Palm Beach counties, as shown in Figure 2.4.12-205. The aquifer contains carbonate rocks, sandstones, and sands extending from an elevation –10 feet NGVD 29 in southern Miami-Dade County and deepening northward to more than –240 feet NGVD 29 in southeastern Palm Beach County and eastern Broward County (Figure 2.4.12-206). The surfical aquifer system formations include, from oldest to youngest (bottom to top): the Tamiami Formation, Caloosahatchee Formation, Fort Thompson Formation, Anastasia Formation, Key Largo Limestone, Miami Limestone, and Pamlico Sand (Reference 209). However, the entire sequence of units is not present in any one place. In the vicinity of Units 6 & 7, the formations in the Biscayne aquifer include the limestones of the Miami Limestone, Key Largo Limestone, and Fort Thompson Formation (Figure 2.4.12-204). The Fort Thompson Formation and Key Largo Limestone (interpreted as the Upper Fort Thompson Formation elsewhere) are the major water producing formations in the Biscayne aquifer (Reference 210). Site-specific boring data (Subsection 2.4.12.1.4) indicate that the maximum thickness of the Biscayne aquifer is approximately 115 feet at Units 6 & 7 (Reference 248).

The water table occurs primarily within the organic soils (muck) or the Miami Limestone and fluctuates in response to variations in tide levels, water levels in the adjacent canals, recharge, natural discharge, and well withdrawal/injection. The aquifer extends beneath Biscayne Bay and the Atlantic Ocean, and because of the aquifer's high permeability and in response to the lowering of inland groundwater levels as a result of pumpage, saltwater has migrated inland along the base of the aquifer and affects the entire coastal zone. Saltwater moves inland and upward in response to low groundwater levels and moves seaward and downward in response to high groundwater levels (Reference 211).

Biscayne aquifer groundwater use in the immediate vicinity of Units 6 & 7 has been limited as a result of its saline to saltwater composition. Figure 2.4.12-207 (Reference 212) shows the approximate location of the freshwater-saltwater interface in the area. The figure indicates that the saltwater interface at the base of the aquifer is approximately 6 to 8 miles inland of Units 6 & 7. Provisional data from the USGS (Reference 203) showing the 2008 freshwater-saltwater in southeast Florida indicates a similar pattern to that shown in Figure 2.4.12-207.

2.4.12.1.3.2 Intermediate Confining Unit

The intermediate confining unit (upper confining unit for the Upper Floridan aquifer) extends from the base of the surficial aquifer system to the top of the Floridan aquifer system and is characterized by the complex interbedded lithologies of the Hawthorn Group. These lithologies consist primarily of silty clay, calcareous sands, silts, calcareous wackestones, limestones, sandstones, and sands, and obtain a thickness of approximately 600 to 1050 feet at Turkey Point (Reference 217). Site information suggests a thickness of approximately 700 feet just to the north of Units 6 & 7 site (Unit 5 Upper Floridan aquifer production well PW-3 [Reference 251]) to approximately 1000 feet southwest of the site (Reference 214).

The top of the Hawthorn Group occurs at approximately –100 MSL southwest of the site (Reference 214) to approximately –215 feet MSL at Units 6 & 7 (Subsection 2.5.4.2.1.2.7) and production well PW-3 (Reference 251). The unit is not exposed at the land surface and is recharged primarily by downward leakage from the overlying surficial aquifer or upwards leakage from the Upper Floridan aquifer. Sand beds and limestone lenses comprise the permeable parts of the system, however, the overall hydraulic conductivity of the group is very low and provides good confinement for the underlying Floridan aquifer system.

2.4.12.1.3.3 Floridan Aquifer System

The Floridan aquifer system underlies Units 6 & 7 and all of Florida. The system formally consists of three primary hydrogeologic units: the Upper Floridan aquifer, the middle confining unit, and the Lower Floridan aquifer (Figure 2.4.12-202). In the Miami-Dade County area, the top of the Floridan aquifer system is found at a depth of approximately 900 feet bgs, is approximately 3000 feet thick, and is directly overlain by the intermediate confining unit. The Floridan aquifer system forms the deepest part of the active groundwater flow system in southeastern Florida (References 204 and 217).

Observations recorded during the construction of the Class V exploratory well EW-1 at the Turkey Point Units 6 & 7 site provide a site-specific measurement for depth to the top of the Floridan Aquifer of approximately 1010 feet bgs. All depths for well EW-1 are reported as below pad level, which represents the depth below the top of the 64-inch-diameter pit pipe. The pit pipe was surveyed and found to be at elevation 7.18 feet NAVD 88, which is approximately 0.4 feet above the final well construction ground surface (6.8 feet NAVD 88) at the exploratory well (Reference 260).

Floridan Aquifer System: Upper Floridan Aquifer

The topmost hydrogeologic unit of the Floridan aquifer system is the Upper Floridan aquifer. This unit is overlain by the surficial aquifer system and the intermediate confining unit, of which the latter acts as a confining layer to the Upper Floridan aquifer (Reference 213). The Upper Floridan aquifer consists of several thin water-bearing zones of high permeability interlayered with thick zones of low permeability. The hydrogeology of the Upper Floridan aquifer varies throughout Florida. In southeastern Florida, the aquifer has been interpreted to include a thinner Suwannee Limestone and extends down into the Avon Park Formation. Confinement is typically better between flow zones in southwestern Florida than in southeastern Florida (Reference 206). In southeastern Florida, the Upper Floridan aquifer ranges from 100 to greater than 400 feet in thickness as shown in Figure 2.4.12-208. In the vicinity of the Turkey Point plant property area, the Upper Floridan aquifer is approximately 200 feet thick.

Although the Upper Floridan aquifer is a major source of potable groundwater in much of Florida, water withdrawn from the unit in southeastern Florida, including Miami-Dade County, is brackish and variable in quality.

Floridan Aquifer System: Middle Confining Unit

The middle confining unit of the Floridan aquifer system underlies the Upper Floridan aquifer, separating it from the Lower Floridan aquifer. In many places, the middle confining unit is divided into upper and lower units separated by the Avon Park permeable zone. The middle confining unit contains beds of micritic limestone (wackestone to mudstone), dolomitic limestone, and dolomite (dolostone) that are distinctly less permeable than the strata of the Upper Floridan aquifer and Lower Floridan aquifer. The elevation of the top of the middle confining unit is approximately –1200 feet NGVD 29 and the thickness is greater than 1000 feet in the vicinity of the Turkey Point plant property (Reference 206).

Observations recorded during the construction of the Class V exploratory well EW-1 at the Turkey Point Units 6 & 7 site provide site-specific measurements for the top of the middle confining layer of approximately elevation –1923 feet NAVD 88 (pad elevation of 7.18 feet NAVD 88 –1930 feet below pad level). The thickness of the middle confining layer is approximately 985 feet (2915 feet below pad level –1930 feet below pad level) (Reference 260). The NAVD 88 datum is approximately 1.53 feet lower than the NGVD 29 datum near the Turkey Point Units 6 & 7 site (Reference 231).

Floridan Aquifer System: Lower Floridan Aquifer

The Lower Floridan aquifer in southern Florida consists of a thick sequence of low permeability rocks separated by relatively thin permeable zones (Reference 207). The aquifer underlies the middle confining unit and extends from a depth of approximately 2400 feet bgs to a depth that is undetermined, but thought to be greater than 4000 feet bgs in the Miami-Dade County area. Observations recorded during the construction of the Class V exploratory well EW-1 at the Turkey Point Units 6 & 7 site provide a site-specific measurement for the depth to the top of the Lower Floridan aquifer of approximately 2915 feet below pad level (Reference 260). The Lower Floridan aquifer includes the lower part of the Avon Park Formation, the Oldsmar Limestone, and the upper part of the Cedar Keys Formation. The base of the Lower Floridan aquifer (or the base of the Floridan aquifer system) is marked by impermeable, massive anhydrite beds of the Cedar Keys Formation (Reference 207).

A highly permeable zone in the Lower Floridan aquifer (known as the Boulder Zone) occurs in southern Florida. The Boulder Zone contains saltwater and has been permitted by FDEP as a discharge zone for treated sewage and other wastes disposed of through injection wells in South Florida.

In southern Florida, the Lower Floridan aquifer contains thick confining units above the Boulder Zone. These confining units are similar in lithology to the middle confining unit of the Floridan aquifer system (Reference 217). The base of the Lower Floridan aquifer is below the base of the Boulder Zone, with the lower section consisting of permeable dolomites or dolomitic limestones of the Cedar Keys Formation (References 215 and 217).

2.4.12.1.4 Site-Specific Hydrogeology

A subsurface investigation was conducted in the Units 6 & 7 plant area between February and June 2008 to evaluate soil, bedrock, and groundwater conditions at depths of up to a maximum of approximately 615 feet bgs. Subsurface data were collected from 94 geotechnical borings, 4 cone penetrometer tests, 2 test pits, 22 groundwater observation wells, and 2 surface water stations. A detailed description of the geotechnical investigation, including the locations of the borings, test pits, and cone penetrometer tests, and the resulting boring logs, laboratory test results, etc. is provided in Reference 248.

The surficial aquifer system within the Turkey Point plant property does not contain all of the regionally identified units. Those units identified within the plant property as a result of subsurface investigations are summarized in descending order as:

- Muck — The surface of the site consists of approximately 2 to 6 feet of organic soils called muck. The muck is composed of recent light gray calcareous silts with varying amounts of organic matter. This unit is not considered to extend into Biscayne Bay, where exposed rock and sandy material is present.

- Miami Limestone — The Pleistocene Miami Limestone is a white, porous sometimes sandy, fossiliferous, oolitic limestone.

- Upper Higher Flow Zone — At the boundary between the Miami Limestone and Key Largo Limestone is a laterally continuous relatively thin layer of high secondary porosity. The Upper Higher Flow Zone was defined based on a review of geophysical logs and drilling records. The primary identifier was the loss of drilling fluid identified at the boundary of the Key Largo Limestone and Miami Limestone. This observation was also coincident with an increase in the boring diameter as identified by caliper logging.

- Key Largo Limestone (interpreted as the Fort Thompson Formation elsewhere) — This is a coralline limestone (fossil coral reef) believed to have

formed in a complex of shallow-water, shelf-margin reefs and associated deposits along a topographic break during the last interglacial period.

- Freshwater Limestone — At the base of the Key Largo Limestone is a layer of dark-gray fine-grained limestone, referred to as the Freshwater Limestone. Where present, the limestone is generally two feet or more thick and often possesses a sharp color change from light to dark gray at its base marking the transition from the Key Largo Limestone to the Fort Thompson Formation. It is not considered to be laterally continuous across the Turkey Point plant property.

- Fort Thompson Formation — The Pleistocene Fort Thompson Formation directly underlies the Key Largo Limestone. The Fort Thompson Formation is generally a sandy limestone with zones of uncemented sand interbeds, some vugs, and zones of moldic porosity after gastropod and/or bivalve shell molds and casts.

- Lower Higher Flow Zone — The Lower Higher Flow Zone lies within the Fort Thompson Formation. At the location of Units 6 & 7, a zone of secondary porosity was evident from the drilling and geophysical logs. This occurred at a depth of approximately 15 feet below the top of the Fort Thompson Formation and was assumed to extend across the model domain. Recent regional drilling conducted by the USGS (Reference 254) did not identify a laterally persistent layer but rather more isolated zones at varying depths below the Upper Higher Flow Zone. In the groundwater flow model (Appendix 2CC), the Lower Higher Flow Zone represents an aggregation of these observations and is conservative due to the fact it is modeled as laterally extensive.

- Tamiami Formation - The Pliocene Tamiami Formation directly underlies the Fort Thompson Formation. The Tamiami Formation generally consists of well-sorted, silty sand, but is locally interlayered with clayey sand, silt and clean clay. The contact between the Tamiami Formation and the Fort Thompson Formation is an inferred contact picked as the bottom of the last lens of competent limestone encountered. The Tamiami Formation represents a semi-confining unit.

The most permeable portions of the Miami Limestone and Key Largo Limestone are considered to be acting as one hydrogeological unit and designated the “upper monitoring zone.” The underlying Fort Thompson is designated the “lower monitoring zone.” The maximum thickness of the Biscayne Aquifer is approximately 115 feet at the Units 6 & 7 plant area.

Twenty groundwater observation wells, two deep geotechnical piezometers, and the two surface water monitoring stations were installed in the Units 6 & 7 plant area as follows:

- Ten observation well pairs (or 20 individual observation wells) installed across the Units 6 & 7 plant area. These wells were completed to depths ranging from 24 to 110 feet bgs and were installed in the Miami Limestone/Key Largo Limestone (referred to as the upper monitoring zone) and the Fort Thompson Formation (referred to as the lower monitoring zone).

- Two deep geotechnical piezometers, one at each reactor site, installed to a depth of approximately 135 feet bgs. These two piezometers were installed to measure pore pressure in the Tamiami Formation and were not part of the groundwater level monitoring network.

- Two surface water monitoring stations (SW-1 and SW-2) installed in the cooling canals surrounding the Units 6 & 7 plant area. The pressure transducers were set several feet below the water level in the cooling canals to allow monitoring of surface water level variations.

Groundwater level data were collected from June 2008 through June 2010.

Figure 2.4.12-209 shows the locations of the 20 observation wells, 2 geotechnical piezometers, and 2 surface water stations in the Units 6 & 7 plant area. Table 2.4.12-201 presents construction information for the wells. The observation wells are named in three series that represent the location and screened intervals of the wells:

- OW-600 series wells and geotechnical piezometer are located in the Unit 6 power block area and include “U,” “L,” and “D” suffix wells monitoring the Key Largo Limestone, the Fort Thompson Formation, and the upper Tamiami Formation, respectively.

- OW-700 series wells and geotechnical piezometer are located in the Unit 7 power block area and include “U,” “L,” and “D” suffix wells monitoring the Key Largo Limestone, the Fort Thompson Formation, and the upper Tamiami Formation, respectively.

- OW-800 series wells are located outside the power block areas and include “U” and “L” suffix wells that monitor the Key Largo Limestone and the Fort Thompson Formation, respectively.

The boring logs, core photographs, and soil testing data are included in Reference 248, and are discussed in Subsection 2.5.1 and Subsection 2.5.4. Subsection 2.5.1.2.2 contains a detailed description of the site area stratigraphy, including a discussion of reinterpretation of the boring log formation identification. Figure 2.5.1-228 provides a plan view of the site showing the location of site-specific geologic cross sections. Figure 2.5.1-231 through Figure 2.5.1-234 show geologic cross sections through the site area. Geotechnical cross sections for Units 6 & 7 are presented in Figures 2.5.4-203 through 2.5.4-208. The location of the geotechnical cross sections are shown in Figure 2.5.4-209.

A supplemental investigation program was conducted between January and March 2009 to perform aquifer pumping tests at the Units 6 & 7 plant area. This supplemental investigation was performed to determine aquifer properties for construction dewatering evaluation, groundwater modeling, analyses of postulated accidental releases of radioactive liquids, and to support simulation of radial collector well operation. The program consisted of four test wells and fifty pumping test observation wells installed for the purpose of conducting aquifer pumping tests. Two test wells were located at each reactor site, with one well completed as an open-hole to test the upper Biscayne aquifer (Key Largo Limestone) and one well completed as an open-hole to test the lower Biscayne aquifer (Fort Thompson Formation). The constant rate pumping tests were conducted in February and March 2009. The observation wells at each reactor site consisted of five well clusters containing five wells each, installed in the following test zones:

- Upper aquitard (Miami Limestone)
- Upper Biscayne aquifer test zone (Key Largo Limestone)
- Middle aquitard (freshwater limestone unit)
- Lower Biscayne aquifer test zone (Fort Thompson Formation)
- Lower aquitard (Upper Tamiami Formation)

An additional aquifer pumping test was performed on the Turkey Point peninsula (the landmass extending out into Biscayne Bay) to evaluate the hydrogeologic suitability of that area for the installation and operation of radial collector wells. Seven observation wells and one pumping well were installed on the Turkey Point peninsula in February 2009 to support the investigation. The pumping test interval corresponds to the lower Miami Limestone, a cemented sand and the upper

portion of the Key Largo Limestone. The test zone encompassed the likely depth intervals of the radial collector laterals. The pumping and observation wells were completed as open holes. The observation well open hole intervals were located above, at and below the depth of the test interval. Step drawdown and constant rate tests were performed in April and May 2009 (Reference 255).

Descriptions and locations of the aquifer pumping test wells and observation wells are presented in Subsection 2.4.12.2.4.1. Explanation as to the classification of aquitards and aquifers is also provided in this subsection.

Groundwater level and surface water level measurements commenced in the 20 observation wells and 2 surface water stations in June 2008. Groundwater level measurements were made using In-Situ Incorporated Level Troll® model 500 and Aqua Troll® model 200 recording pressure transducers. The pressure transducers were networked together for remote reading using a Troll Link telemetry system (Reference 218).

The results of the geotechnical investigation pertaining to the hydrogeology of the Units 6 & 7 plant area and the supplemental groundwater investigation are described in detail in Subsections 2.4.12.2.2 through 2.4.12.2.5.

2.4.12.1.5 Groundwater Sources and Sinks

This subsection describes the regional, local, and site-specific discharge and recharge areas, mechanisms, and characteristics of the different aquifer units.

2.4.12.1.5.1 Groundwater Discharge

Natural discharge of groundwater in the Biscayne aquifer is by seepage into streams, canals, or the ocean, by evaporation, and by transpiration by plants. Induced discharge is through wells pumped for municipal, industrial, domestic, and agricultural supplies. Evapotranspiration, transpiration, and groundwater discharge are greatest during the wet season when water levels, temperature, and plant growth rates are high. Pumpage of groundwater constitutes a part of the total discharge from the aquifer. The effect of pumpage is amplified because it is greatest during the dry season when recharge and aquifer storage are least. Most of the water that circulates in the surficial aquifer system is discharged by canals (Reference 209). There is very little direct runoff of precipitation; however, regional discharge of the surficial aquifer into drainage canals and directly into Biscayne Bay is estimated to be approximately 15 to 25 inches per year (Reference 219). It is estimated that 20 inches of the approximately 60 inches of annual rainfall in Miami-Dade County are lost directly by evaporation, approximately 20 inches are

lost by evapotranspiration after infiltration, 16 to 18 inches are discharged by canals and by coastal seepage, and the remainder are used by humans (References 215 and 219). Nearly 50 percent of the rainfall that infiltrates the Biscayne aquifer is discharged to the ocean, a reflection of the high degree of connection between the aquifer and the canals (Reference 211).

2.4.12.1.5.2 Groundwater Recharge

There are several mechanisms affecting recharge of the surficial/Biscayne aquifer in Miami-Dade County including: (1) infiltration of rainfall or irrigation water through surface materials to the water table; (2) infiltration of surface water imported by runoff from the north in the water conservation areas or by canals; (3) infiltration of urban runoff by way of drains, wells, or ponds; and (4) groundwater inflow from southwestern Broward County (Reference 209).

Recharge by rainfall is greatest during the wet season, from June to November, and recharge by canal seepage is greatest during the dry season, from December to May. The average annual rainfall in Miami-Dade County is approximately 60 inches, of which approximately 38 inches are recharge to the aquifer and 22 inches are lost to evapotranspiration (Reference 219). Recharge occurs over most of Miami-Dade County during rainstorms. The low coastal groundwater levels and the low, but continuous, seaward gradient indicate a very high transmissivity in the aquifer, a high degree of interconnection between the aquifer and the drainage canals, and the effectiveness of the present drainage canals in rapidly dispersing floodwaters (Reference 209).

Recharge to the Floridan aquifer system is directly related to the confinement of the system. The highest recharge rates occur where the Floridan aquifer is unconfined or poorly confined, which occurs in areas where the system is at or near land surface or where the confining layers are breached by karst or other structural features. The Floridan aquifer system is confined, with upward vertical gradients in the vicinity of the Turkey Point plant property.

2.4.12.1.5.3 Interaction of Cooling Canals With Groundwater

Units 1-4 use the 5900-acre industrial wastewater facility for condenser cooling (Figure 2.4.12-210). The canals are shallow, approximately 3 feet deep, with the exception of the grand canal (main return canal), north discharge canal, south collector canal, and the east return canal, all of which are approximately 18 feet deep. The canals convey warm water south from Units 1 through 5 and return cooled water for Units 1 through 4. The canals do not directly discharge to fresh or

marine surface waters; however, because the canals are not lined, water in the canals does interact with groundwater in the unconfined Biscayne aquifer, which immediately underlies the bottom of the cooling canals. Makeup water to replace evaporative and seepage losses from the canals comes from plant process water, rainfall, stormwater runoff, and groundwater infiltration. There is a net inflow to the cooling canals from the saline Biscayne aquifer beneath the canals. The water in the canals has a salinity greater than that of seawater due to the effects of evaporation, with salinity concentrations approximately twice that of Biscayne Bay.

An interceptor ditch adjacent to the west side of the cooling canals and east of the L-31E Canal and levee was constructed at the same time as the cooling canals (Figure 2.4.12-210). The purpose of the interceptor ditch is to keep cooling canal water from influencing groundwater quality west of the canals in the upper portion of the aquifer. This is accomplished by the existence of a natural freshwater hydraulic gradient during the wet season and by pumping water as necessary from the interceptor ditch into the westernmost cooling canal (Canal 32) during the dry season when natural freshwater hydraulic gradients are low. Operation of the interceptor ditch prevents seepage from the cooling canals from moving landward toward the L-31E Canal and thereby helps to maintain existing groundwater quality in the Biscayne aquifer west of the interceptor ditch.

2.4.12.1.6 Onsite Use of Groundwater

Units 1-4 use cooling water from a closed loop system that includes the canal network adjacent to Units 6 & 7. Cooling water for Unit 5 and process water for Units 1, 2, and 5 are obtained from Upper Floridan aquifer production wells. The water is obtained from the three production wells (PW-1, PW-3, and PW-4) shown in Figure 2.4.12-211. A description of these wells is presented in Subsection 2.4.12.2. The Biscayne aquifer at Units 3 & 4 is used for the disposal of domestic wastewater. A single Class V, Group 3 gravity injection well is used to dispose of up to 35,000 gallons per day of domestic reclaimed water at the Units 3 & 4 sewage treatment plant. The well, designated IW-1, is open from 42 to 62 feet bgs and is 8 inches in diameter.

The primary source of makeup water for the circulating water cooling towers is reclaimed water supplied by the MDWASD South District Wastewater Treatment Plant as discussed in Subsection 2.4.11.1.1. When reclaimed water cannot supply the quantity and/or quality of water needed for the circulating water system, radial collector wells supplying saltwater are used to supplement the supply. The raw

water system is designed to supply 100 percent of the makeup water from either reclaimed water or saltwater, or any combination of both. The ratio of water supplied by the two makeup water sources varies depending on the availability of reclaimed water from the MDWASD South District Wastewater Treatment Plant. The circulating water system is designed to accommodate the differing water quality of the two sources. Additional description of the radial collector wells is presented in Subsection 2.4.12.2.

2.4.12.2 Groundwater Sources

This subsection contains a description of the present and projected regional groundwater use at and in the vicinity of Units 6 & 7. Specifically, the description contains information pertaining to existing users, historical groundwater levels, groundwater flow directions and hydraulic gradients, seasonal and long-term variations of groundwater levels, horizontal and vertical hydraulic conductivity and total and effective porosity of the geologic formations, reversibility of groundwater flow, the effects of water use on hydraulic gradients and groundwater levels beneath the site, and groundwater recharge areas. This information has been organized into five subcategories: (1) historical and projected groundwater use, (2) groundwater flow directions, (3) temporal groundwater trends, (4) aquifer properties, and (5) hydrogeochemical characteristics.

2.4.12.2.1 Historical and Projected Groundwater Use

Historical, current, and projected groundwater use in the vicinity of Units 6 & 7 is evaluated in the following subsections using information from the USGS and the SFWMD.

2.4.12.2.1.1 Historical Groundwater Use

Historical freshwater withdrawal of groundwater has been monitored for Miami-Dade County by the USGS (References 221 and 222). In the Miami-Dade County area, freshwater is restricted to the Biscayne aquifer. Groundwater use has shown a steady increase between the 1960s and the present as shown in Figure 2.4.12-212. The primary groundwater use in the county is for public water supply, followed by agricultural irrigation. Beginning in approximately 1985, a new category of use was introduced—recreational irrigation. This category includes golf course irrigation and other types of turf grass irrigation. Table 2.4.12-202 presents the groundwater use for each category.

The underlying Floridan aquifer typically contains saline water (greater than 250 milligrams per liter of chloride) or saltwater (greater than 19,000 milligrams per liter of chloride) as defined by the SFWMD (Reference 223). As a result, groundwater use from the Floridan aquifer is limited. In 1990 and 1995, no groundwater use was reported from the Floridan aquifer for Miami-Dade County (References 224 and 225). In 2000, a water use of 3.68 million gallons per day was reported for the county with a use category of industrial, which includes mining and power generation (Reference 226).

2.4.12.2.1.2 Current Groundwater Use

Figure 2.4.12-213 shows the current groundwater users in Miami-Dade County based on water use permits filed with the SFWMD (Reference 227). The figure does not show wells that do not require a water use permit, such as domestic wells, wells used exclusively for fire fighting, or those wells withdrawing saline or saltwater. Table 2.4.12-203 lists the public water supply systems in Miami-Dade County along with the population served (Reference 228).

In addition to the traditional uses of groundwater, other uses of groundwater are present in South Florida. These include disposal of municipal and industrial wastewater in Class I injection wells and the use of aquifer storage and recovery wells. The aquifer storage and recovery wells are used to inject raw or partially treated water into the aquifer for later extraction and use. The water must meet drinking water standards before injection. Figure 2.4.12-214 shows the typical configuration of Class I injection wells and aquifer storage and recovery wells in South Florida. Aquifer storage and recovery wells are typically completed as open-hole wells in the Upper Floridan aquifer. Class I injection wells are typically completed as open-hole wells in the Boulder Zone portion of the Lower Floridan aquifer, which is below the lowermost underground source of drinking water (USDW). Figure 2.4.12-215 and 2.4.12-216 show the locations of these wells in Florida (Reference 229).

Units 1-4 use cooling water from a closed loop system that includes the canal network adjacent to Units 6 & 7. Cooling water for Unit 5 and process water for Units 1, 2, and 5 are obtained from Upper Floridan aquifer production wells. Figure 2.4.12-211 shows the locations of the Upper Floridan production wells. These wells (PW-1, PW-3, and PW-4) were commissioned in February 2007. Figure 2.4.12-217 shows the monthly production from each of the wells. The average production of the wells is approximately 170 million gallons per month. Water supply for non-cooling water use at Units 3 & 4 comes from the potable water system of the MDWASD.

The Units 3 & 4 sewage treatment plant has a Biscayne aquifer injection well as described in Subsection 2.4.12.1.6.

2.4.12.2.1.3 Projected Groundwater Use

Projected groundwater use in Miami-Dade County was obtained from the *Lower East Coast Water Supply Plan*, 2005–2006 update (Reference 230). Figure 2.4.12-212 contains projections of groundwater use through 2025. The projections combine domestic and public water supply categories into one total value. The water use demand for power generation is expected to grow with the addition of seven planned power plants in the Lower East Coast Planning area.

The Unit 5 cooling water supply is from Upper Floridan aquifer production wells. The maximum pumping rate from the Upper Floridan aquifer is limited to a 90-day average of 14.06 million gallons per day and an annual average supply of 4599 million gallons per year.

Reclaimed water from the MDWASD or saltwater from radial collector wells are the cooling water sources for Units 6 & 7. The total makeup flow required from radial collector wells is estimated to be 86,400 gallons per minute; however, the actual amount of saltwater used will depend on the quality and quantity of reclaimed water available from the MDWASD. The source of saltwater from the radial collector wells will be the offshore portions of the Biscayne aquifer, which underlies Biscayne Bay. Water supply for potable water, service water system makeup, fire protection, and miscellaneous raw water use is from the MDWASD.

The radial collector wells consist of a central concrete caisson excavated to an optimal target depth. The caisson diameter is based on the size of the pumps and number of laterals required. The optimal target depth of the caisson is based on the available drawdown and the desired elevation of the laterals. Screened sections are incorporated along the laterals based on site conditions. Once the caisson and laterals are installed, groundwater infiltrates into the laterals and flows back to the caisson. The water is then pumped from the caisson.

Four radial collector wells, each capable of producing approximately 45 million gallons per day, are installed. Figure 2.4.12-218 shows the location of the radial collector wells. At any time, one collector well is in standby mode as a reserve well in the event of an unplanned well outage or scheduled maintenance event. Each radial collector well consists of a central reinforced concrete caisson extending below the ground surface with laterals projecting horizontally from the caisson at a depth of approximately 25 to 40 feet below the bottom of Biscayne Bay. The

laterals are advanced a distance of up to 900 feet from the caisson. The wells are designed and located to induce infiltration from Biscayne Bay.

Disposal of wastewater from Units 6 & 7 is planned to occur in Class I deep injection wells drilled at the site. The wells would inject the wastewater into the Boulder Zone of the Lower Floridan aquifer. This injection zone has been used for the underground disposal of liquid wastes since 1943 (Reference 247). The Boulder Zone is located beneath groundwater supplies that are currently or may be used in the future as a source of drinking water. Drinking water supply sources are typically not more than a few hundred feet deep and, therefore, far above the Boulder Zone (Reference 250).

The Boulder Zone is permitted by the FDEP as a zone for the discharge of treated sewage and other wastes disposed of through injection wells. The Boulder Zone meets the Florida Department of Environmental Regulations criteria for Class I injection. The Boulder Zone has the following characteristics throughout its extent:

- Deep. The top of the Boulder Zone is 2000 to 3400 feet in depth.
- Confined. There are approximately 800 to 1000 feet of confining limestone and dolomite beds between the Boulder Zone and the base of the USDW.
- Thick. The Boulder Zone is up to 700 feet thick.
- Porous. The Boulder Zone has well-developed secondary porosity.
- Highly transmissive. The transmissivity of the Boulder Zone may be up to 24.6E06 square feet per day in some locations. As discussed below, however, within approximately 10 miles of the Turkey Point site, the Boulder Zone transmissivity values are very likely between 60,000 square feet per day and 600,000 square feet per day (References 262 and 263).

  The analysis by Meyer (Reference 262) was based on tidal fluctuations in a well located over 20 miles north of the Turkey Point site, in an aquifer that was estimated to be 15 feet thick, with a porosity of 50 percent.

  The very high transmissivity value estimated by Singh, et al (Reference 263) was based on time-drawdown data from only one monitor well, during one pump test. The drawdown in the monitoring well located 107 feet from the pumped well was only approximately 10 percent of background tidal fluctuations. Therefore, accurate drawdown values were difficult to determine. Furthermore, large transient oscillations produced by the pump made the first

10 minutes of the drawdown and recovery data unusable. The early-time data was discarded and was not used in the analysis. The authors cautioned that the late-time data was "matched somewhat arbitrarily on the flattened portion of the Theis type curve."

Other tests conducted at this same location on nine different wells completed to the Boulder Zone (including nine injection tests, one withdrawal test, and one step-drawdown test) showed the average transmissivity was 351,059 square feet per day, ranging from 84,480 square feet per day to 780,000 square feet per day. The observations discussed above on the limitations of the test and the additional test results from other wells at the same site suggest considerable uncertainty in the very high transmissivity value reported by Singh, et al (Reference 263).

During the construction of the Turkey Point Units 6 & 7 exploratory well, EW-1, a Boulder Zone formation test was performed, and the results gave an average transmissivity value of 73,471 square feet per day, with an estimated range from 67,820 square feet per day to 80,151 square feet per day.

Following construction of the exploratory well and issuance of the FDEP permit to convert the exploratory well to deep injection well, DIW-1, a short-term injection test was performed. After the well injection tubing was filled with nonhazardous industrial wastewater from the Turkey Point Unit 5 cooling tower basin (original source Upper Floridan Aquifer) with a measured total dissolved solids value of 3600 mg/L, the down hole formation pressure ranged from 1327.3 to 1327.8 pounds per square inch gauge (psig) and averaged 1327.5 psig for the 24-hour period before beginning injection into DIW-1. The flow rate while injecting into DIW-1 ranged from 6743 to 7455 gpm and averaged 7099 gpm for a period of 6 hours and 37 minutes. The formation pressure ranged from 1329.2 to 1331.5 psig and averaged 1330.9 psig while injecting into DIW-1 at an average flow rate of 7099 gpm. The formation pressure differential, between the pressure during the 24-hour period before injection and the pressure while injecting into DIW-1 at an average flow rate of 7099 gpm, was approximately 4 psi. This represents the formation pressure increase due to operation of DIW-1 at a flow rate of 7099 gpm. Using the formation pressure increase of 4 psi and a flow rate of 7099 gpm yields a formation specific capacity of 768 gpm/foot (7099 gpm ÷ [4 × 2.31 feet per psig] = 768 gpm/foot).

An estimated transmissivity of the injection zone using the empirical relationship derived from the Jacob method where specific capacity is equal to transmissivity divided by 2000 (Reference 265) was calculated.

Formation specific capacity = T ÷ 2000,

where,

T = transmissivity in gallons per day per foot (gpd/foot)

T = 768 gpm/ft (formation specific capacity) × 2000 = 1,536,000 gpd/foot

T = approximately 205,000 square feet/day

A four-step injection test conducted at the Florida Keys Aqueduct Authority site (Reference 264) located approximately 10 miles west of the Turkey Point site gives transmissivity values between 53,730 square feet per day and 69,574 square feet per day. Data from Boulder Zone test wells within approximately 10 miles of the Turkey Point site suggest a range of transmissivity between 60,000 square feet per day and 600,000 square feet per day. The best estimate for the average value is approximately 250,000 square feet per day.

- Contains groundwater with total dissolved solids concentration >10,000 milligrams per liter. The average dissolved solids concentration of Boulder Zone groundwater is approximately 37,000 milligrams per liter.

Over 90 Class I injection wells are used to dispose of over 200 million gallons per day of secondary treated wastewater in southeast Florida (Reference 216).

FDEP has issued FPL permit number 0293962-001-UC, to construct a Class V Exploratory Well (EW-1) and associated Dual Zone Monitoring Well (DZMW-1) at Units 6 & 7 pursuant to Florida Statutes and Florida Administrative Codes (Reference 252). The purpose of this exploratory well (EW-1) is to investigate the geologic and hydrogeologic feasibility of disposal of non-hazardous cooling water blowdown and other plant wastewater via deep well injection into the Boulder Zone at the site. EW-1 was designed and constructed to Class I Industrial deep injection well standards. The designs for EW-1 and DZMW-1 are presented on Figures 2.4.12-245 and 2.4.12-246, respectively.

Observations recorded during the construction of the Class V exploratory well EW-1 at the Turkey Point Units 6 & 7 site provide a site-specific measurement for

the depth to the top of the injection zone or Boulder Zone of 3030 feet below pad level. Approximately 985 feet of confining limestone, dolomitic limestone, and dolomite beds are present between the injection zone and the base of the USDW (Reference 260).

The design components of the injection wells include determining the allowable injection rate and the area of review. Section 62-528.415 (1)(f)2, FAC (Reference 229) states that the hourly peak injection flow should not exceed a velocity of 10 feet per second. Based on a review of data from other deep injection well systems in southeast Florida, it is anticipated that each injection well will have a design injection capacity of up to 18.6 mgd at a peak hourly flow, corresponding to an injection velocity of 10 feet per second inside the final casing (Reference 229). However, it is anticipated that the wells will be operated at an injection rate of approximately 10 mgd. The deep well injection system is described in Subsection 9.2.12.

The wastewater disposal requirements for Units 6 & 7 are a combined total of approximately 18 million gallons per day when using only reclaimed water from the MDWASD as a cooling water source, and as high as 85 million gallons per day when using only saltwater from radial collector wells as a cooling water source. Therefore, the combined disposal volumes are between 18 and 85 million gallons per day when using a combination of reclaimed and saltwater for cooling. For purposes of providing upper bounds for the project, a disposal capacity of 85 million gallons per day is assumed. Based on this disposal capacity, the deep injection wells consist of ten primary wells and two backup wells for use during routine maintenance or in the event of unscheduled shutdowns. Exploratory well EW-1 was converted to DIW-1 as one of the Class I Industrial deep injection wells after demonstrating the geology and hydrogeology of the site was appropriate for deep well injection. As part of the injection permit, a dual-zone monitoring well was also installed. The deep injection wells will be regulated by and fully comply with the requirements of Rule 62-528 of the F.A.C. (Reference 229) and applicable FDEP rules.

For the purpose of evaluating the injected fluid buoyancy, the most important characteristics of the injected effluent are temperature and total dissolved solids (TDS), because these parameters determine fluid density. The injected effluent temperature will vary seasonally. The maximum and minimum expected temperatures are 91° F and 65° F, respectively. The expected wastewater TDS when using reclaimed water is 2721 milligrams per liter and when using saltwater from the radial collector wells is 57,030 milligrams per liter. Based on the temperature and TDS values, the density of the injected fluid is estimated to range

from 996.8 kilograms per cubic meter (100-percent reclaimed water in the summer) to 1042.2 kilograms per cubic meter (100-percent saltwater in the winter). Observations recorded during the construction of the Class V exploratory well EW-1 at the Turkey Point Units 6 & 7 site indicate the temperature and TDS concentration in the Boulder Zone are about 77.1°F and 36,200 milligrams per liter, respectively (Reference 260). The in situ density of the Boulder Zone fluid is estimated to be 1029 kilograms per cubic meter.

Tables 2.4.12-212 and 2.4.12-213 present the estimated concentrations for injected effluent when using reclaimed water from the MDWASD and for saltwater when using the radial collector wells as makeup water sources.

2.4.12.2.2 Groundwater Flow Directions

2.4.12.2.2.1 Biscayne Aquifer

Regional groundwater flow in the Biscayne aquifer is generally toward the east-southeast. Figures 2.4.12-219 and 2.4.12-220 (Reference 212) show potentiometric surface maps of the Biscayne aquifer for May and November of 1993. The potentiometric maps show localized effects from surface water canals and cones of depression associated with groundwater well fields. Based on the regional data, the hydraulic gradient in the vicinity of the Turkey Point plant property is approximately 0.00002 foot per foot. The elevations in NGVD 29 used by the USGS are approximately 1.53 feet higher than the North American Vertical Datum of 1988 (NAVD 88) elevations used for the plant area data (Reference 231).

Potentiometric surface maps for the upper and lower monitoring zones of the Biscayne aquifer in the immediate vicinity of the Units 6 & 7 plant area are shown in Figures 2.4.12-221 through 2.4.12-228 and Figures 2.4.12-248 through 2.4.12-253. A separate map was prepared for each high- and low-tide time sequence for the upper (Miami and Key Largo Limestones) and lower (Fort Thompson Formation) monitoring zones. For the purposes of this analysis, high and low tides refer to the approximate local highs and lows obtained from the observation well hydrographs. The water levels were corrected to equivalent reference heads. Also shown on these figures is the flow direction. Appendix 2AA describes the data evaluation process for the transducer generated water level data and the calculation of reference heads from observed head data. The results of this evaluation indicate that the presented data is sufficient.

These maps indicate that the highest portion of the potentiometric surface in the lower monitoring zone generally runs from the southwestern portion of the Units 6 & 7 plant area near OW-735L to the central portion of the Units 6 & 7 plant area near OW-706L. Flow patterns extend radially in multiple directions from this high spot, but flow patterns are not symmetrically arrayed. The lower zone potentiometric surfaces for the June 2010 data indicate a general southwest to northeast flow pattern. The lower monitoring zone potentiometric surfaces and resulting flow patterns are similar for all high and low tide conditions examined.

In the upper monitoring zone, a relative high spot in the potentiometric surface runs from the northwest near OW-812U to the center of the Units 6 & 7 plant area near OW-706U. A second high spot in the potentiometric surface is evident in the southeast corner of the Units 6 & 7 plant area near OW-636U. A relatively low region in the potentiometric surface extends from the southwest near OW-735U to the east-central portion of the Units 6 & 7 plant area near OW-805U and OW-606U. The upper zone potentiometric surfaces for the June 2010 data indicate a general east to west flow pattern.

Because of the complexity of the observed flow patterns in the upper and lower monitoring zones, one to three flow path lines were used to calculate horizontal gradients for each potentiometric surface shown in Figures 2.4.12-221 through 2.4.12-228 and Figures 2.4.12-248 through 2.4.12-253. The average horizontal gradient in the upper monitoring zone across all examined tidal conditions is 0.0003 ft/ft, and the average horizontal gradient in the lower monitoring zone is 0.001 ft/ft.

Vertical hydraulic gradients were computed for selected observation well pairs on the site. Table 2.4.12-204 presents the vertical hydraulic gradients determined from these well pairs. The overall vertical hydraulic gradient is generally upward across the plant area. The vertical hydraulic gradients do not vary significantly between high and low tidal cycles.

In general the groundwater flow conditions in the Biscayne aquifer at the Units 6 & 7 plant area can be summarized as follows:

- The upper and lower monitoring zones exhibit complex flow patterns.
- Flow conditions in the upper monitoring zone indicate flow directions from the high spots in the potentiometric surface in the northwest and southeast towards the relative low region in the potentiometric surface that runs from the southwest to the east-central of the Units 6 & 7 plant area.

- Flow conditions in the lower monitoring zone indicate a high spot in the potentiometric surface that extends from the southwestern portion of the Units 6 & 7 plant area to the center of the Units 6 & 7 plant area. Flow patterns extend in multiple directions from this high spot but the patterns are not symmetrical. Potentiometric surfaces for the January and June 2010 data indicate a general southwest to northeast flow pattern.

- Vertical hydraulic gradients indicate upward flow potential.

- The vertical (upward) gradient is approximately an order of magnitude larger than the horizontal gradient in the lower monitoring zone. The average horizontal gradient in the lower monitoring zone is, in turn, approximately a factor of three larger than the average horizontal gradient in the upper monitoring zone.

2.4.12.2.2.2 Floridan Aquifer

Regional groundwater flow in the Upper Floridan aquifer is generally toward the east. Figure 2.4.12-229 shows a potentiometric surface map of the Upper Floridan aquifer for May 1980 (Reference 215). The apparent hydraulic gradient in the vicinity of the Turkey Point plant property is approximately 0.00006 foot per foot. As indicated in Figure 2.4.12-229, South Florida is in the brackish to saline portion of the aquifer, and groundwater development has generally been restricted to industrial water supplies.

Determination of groundwater flow directions and hydraulic heads in the Boulder Zone has been unreliable due to the lack of good head data and the transitory effects of ocean tides, Earth tides, and atmospheric tides (Reference 215). Regional groundwater movement in the Lower Floridan aquifer in southern Florida is estimated to follow the circulation pattern described as follows: 1) cold seawater moves inland through the Lower Floridan aquifer, 2) heating of the seawater in the Lower Floridan aquifer during inland movement results in lower fluid density, 3) upwelling of this seawater from the Lower Floridan aquifer occurs through the middle confining unit, and 4) dilution of the seawater (further reducing fluid density) results in its transport back to the ocean by seaward flowing groundwater in the Upper Floridan aquifer. Figure 2.4.12-243 illustrates this circulation pattern (Reference 215). This circulation is generally very slow due to the low permeability of the middle confining unit.

2.4.12.2.3 Temporal Groundwater Trends

Regional temporal trends in the Biscayne aquifer groundwater levels are monitored by the USGS (Reference 232) and the SFWMD (Reference 233). Figure 2.4.12-230 presents a map of wells and surface water control structures in the vicinity of the Turkey Point plant property used for long-term monitoring of groundwater and surface water levels. Figures 2.4.12-231 and 2.4.12-232 show the hydrographs for these locations. The hydrographs show varying degrees of short-term tidal influence and fluctuations associated with precipitation events. The long-term trends in the wells and surface water indicate a generally steady water level over the period examined. Well G-1183 shows the largest magnitude of fluctuation with water level elevations ranging from –0.59 to 6.38 feet NGVD 29. The remaining wells show a range of fluctuation of less than 3.5 feet.

Figure 2.4.12-233 shows hydrographs of the Biscayne aquifer monitoring wells at Units 6 & 7. Over the period of record, the maximum groundwater elevation in the upper monitoring zone was 0.62 feet NAVD 88 (OW-636U) and the minimum was –3.42 feet NAVD 88 (OW-809U). The maximum groundwater elevation in the lower monitoring zone was 2.15 feet NAVD 88 (OW-735L) and the minimum was –3.06 feet NAVD 88 (OW-606L). A partial listing of water level data from the transducers is presented in Appendix 2AA.

The water level record contains data gaps, which were a result of loss of transducer data due to storm preparation activities, or equipment malfunction. Data telemetry and measurement issues were identified with the In-Situ transducers. The data were reviewed for consistency and accuracy of the water level readings. At the conclusion of this evaluation, a portion of the data were rejected. The causes for data rejection include erratic behavior indicative of a transducer malfunction, and poor agreement between manual and transducer measurements.

Regional temporal trends in the Floridan aquifer have been monitored by the USGS (Reference 234). A hydrograph of a well completed in the Upper Floridan aquifer is shown in Figure 2.4.12-234. The wellhead elevation is 4.50 feet NGVD 29 and the head inside the well ranges from 30 to 42.6 feet MSL (NGVD 29), indicating that the potentiometric surface in this area is above the ground surface.

2.4.12.2.4 Aquifer Properties

This subsection provides a summary of the regional, local, and site-specific hydrogeologic parameters for the different aquifer units. These parameters

include transmissivity, storativity (storage coefficient), specific yield, hydraulic conductivity (permeability), and leakage coefficient (leakance). The following are definitions of these properties:

- Transmissivity — The rate at which a fluid of a specified density and viscosity is transmitted through a unit width of an aquifer or confining bed under a unit hydraulic gradient and is a function of the properties of the fluid, the porous medium, and the thickness of the porous medium (Reference 235).
- Storativity (Storage Coefficient) — The volume of water released from or taken into storage per unit surface area of the aquifer per unit change in head (Reference 235).
- Specific Yield — The ratio of the volume of water a rock or soil will yield by gravity drainage to the volume of the rock or soil (Reference 235).
- Hydraulic Conductivity (permeability) — A coefficient of proportionality describing flow per unit time under a unit hydraulic gradient through a unit area of a porous medium and is a function of the properties of the fluid and the porous medium (Reference 235).
- Leakage Coefficient (Leakance) — The quantity of water that flows across a unit area of the boundary between the main aquifer and its semi-confining bed, typically expressed as seconds^{-1}or days^{-1}, derived from the relationship K'/b' where K' is the hydraulic conductivity of the semi-confining unit and b' is its thickness (Reference 236).

Typical values of hydraulic conductivity, porosity, and thickness for different formations in Miami-Dade County are shown on Table 2.4.12-205 (Reference 237). The values are based on weighted averages for management of treated wastewater. The weighted average values presented in Table 2.4.12-205 were developed by the EPA to support a risk assessment of wastewater disposal. The data were based on a literature review of published values of the hydrogeologic parameters used to characterize the hydrologic units in Miami-Dade County. The weighted means of the data were calculated to determine representative values to be used in the risk assessment. The weighted mean method essentially reduces the effect of extreme data outliers and may not be representative of actual conditions. These values were not used in the hydrogeologic analysis of site conditions.

Table 2.4.12-206 presents aquifer test results for tests performed within 15 miles of Units 6 & 7. Figure 2.4.12-235 shows the locations of these tests. The data were obtained from the SFWMD DBHYDRO database and the Dames & Moore site investigation report (References 233 and 238). The tests were performed in the Biscayne aquifer, the Floridan aquifer, and confining layers. The tests include standard aquifer performance tests and packer tests used for assessment of the injection and confining layers for deep injection well permitting. The Boulder Zone packer tests listed in Table 2.4.12-206 show transmissivities lower than those reported for other regional testing of the Boulder Zone (Subsection 2.4.12.2.4.3). The depths given on the table suggest that the tests were performed in the interval between the top of the Lower Floridan aquifer and the top of the Boulder Zone as determined from cross section Y-Y' in Reference 206.

2.4.12.2.4.1 Surficial/Biscayne Aquifer

Hydrogeologic properties in the Biscayne aquifer vary due to lithology. Along the coast, where the Biscayne aquifer is the thickest, transmissivities are lower because of the silty sand/sandy lithology. In central and south Miami-Dade County, the aquifer is thinner with higher hydraulic conductivity due to the occurrence of cavernous limestone (Reference 211). The permeable limestone content in the aquifer decreases northward and the overall transmissivity of the aquifer decreases with increased sand content.

Transmissivities for the highly permeable limestones and less permeable sandstones and sands of the aquifer in the vicinity of Units 6 & 7 have been estimated to range from less than 1.0E06 gallons per day per foot to 3.0E06 gallons per day per foot (Reference 238). Along the coast, where the Biscayne aquifer is the thickest, transmissivities are lower due to the presence of sandy material. In central and south Miami-Dade County, the aquifer is thinner with higher hydraulic conductivity due to the occurrence of vuggy and highly porous limestone (Reference 211).

According to Parker et al. (Reference 219), the Biscayne aquifer is the most productive of the shallow non-artesian aquifers in the area and is one of the most permeable with transmissivity values (hydraulic conductivity x saturated thickness) for the highly permeable limestones ranging from 4.0E06 to 15.0E06 gallons per day per foot (5.4E05 to 2.0E06 square feet per day) with a median value of 5.0E06 gallons per day per foot (6.7E05 square feet per day) and storage coefficients ranging from 0.047 to 0.247. In Broward County, transmissivities are reported to range from approximately 4.0E05 gallons per day per foot (5.4E04 square feet per day) to 4.0E06 gallons per day per foot (5.4E05 square feet per

day) with storage coefficients as high as 0.34 (Reference 239). A generalized distribution of the transmissivities in the Biscayne aquifer is presented in Figure 2.4.12-236 (Reference 240).

Large-capacity municipal wells are commonly completed as open holes and yield from 500 to more than 7000 gpm with only small drawdowns. Specific capacities obtained from pumping tests are on the order of 1000 gpm per foot of draw-down in Miami-Dade County (Reference 211).

A study performed by the USGS (Reference 240) included estimates of specific yield in the Biscayne aquifer based on water level responses to individual rainfall events between the years 1933 and 1966. The results of this study suggested that a range between 20 and 25 percent specific yield may be representative of the Biscayne aquifer. The main focus of this study was the development of a groundwater flow model of the Biscayne aquifer. The results of the model calibration suggested that a specific yield of 20 percent provided the best match between observed and modeled groundwater levels.

Two studies performed northwest of Turkey Point by the USGS (References 241 and 242) examined the vertical variations in aquifer properties of the Biscayne aquifer. Table 2.4.12-207 presents the results of testing core samples. The locations of the core samples are shown in Figure 2.4.12-235. Figure 2.4.12-237 is a plot of the core properties versus elevation. The core samples were tested for horizontal air permeability, vertical air permeability, porosity, and grain density. The horizontal air permeability test included a maximum permeability and a permeability at 90 degrees to the maximum permeability direction to assess horizontal anisotropy. The studies included a detailed examination of the core samples to determine lithology and fossil assemblages. As a result of this examination, the USGS subdivided the Biscayne aquifer into a series of high frequency depositional cycles that ranged from a freshwater to a marine depositional environment. These depositional cycles control the permeability and porosity of the aquifer. The freshwater and transitional portions of the depositional cycles are characterized by lower permeability (<1000 milliDarcies) and porosity (<20 percent), while the marine portions of the depositional cycles exhibit higher permeability (>1000 milliDarcies) and porosity (20–40 percent). This general observation appears to support the site-specific findings regarding the freshwater limestone layer and the other marine and transitional units identified at the Units 6 & 7 plant area.

The vertical changes in properties as a result of these depositional cycles can be seen on the figure. Figure 2.4.12-238 presents a plot of the vertical anisotropy

ratio ($K_{vertical}$:$K_{horizontal}$) versus elevation using the vertical permeability and maximum horizontal permeability determined from the USGS laboratory core testing. The graph indicates that the central tendency of the anisotropy measurements is approximately 1. This value was used as a starting point for groundwater model calibration.

As part of the Units 6 & 7 investigation, ten observation wells were installed in the upper part of the Biscayne aquifer in the Miami Limestone/Key Largo Limestone ("U" suffix wells) and ten observation wells were installed in the lower part of the Biscayne aquifer in the Fort Thompson Formation ("L" suffix wells). The screen depths for the upper (U) wells range from 14 to 28 feet bgs and for the lower ("L") wells range from 85 to 110 feet bgs. The location and installation details of the wells are provided in Figure 2.4.12-209 and Table 2.4.12-201, respectively.

Thirty-one in situ hydraulic conductivity tests (slug tests) were conducted in these wells. These data were imported into AQTESOLV™ for Windows version 4.5 (Reference 243) and evaluated using either the Butler, KGS (Kansas Geologic Survey), McElwee-Zenner, or Springer-Gelhar solution methods. Hydraulic conductivity values obtained for wells screened in the upper part ("U" wells) of the Biscayne aquifer range from 3 feet per day to 319 feet per day with a geometric mean of 61.3 feet per day.

For the wells screened in the lower part ("L" wells) of the aquifer, hydraulic conductivity values range from 1.0 feet per day to 120 feet per day with a geometric mean of 20.1 feet per day. The results of the tests are summarized in Table 2.4.12-208. The results suggest that the rate-limiting recharge of the well filter pack may be influencing the results of the tests. The rate-limiting recharge effect is caused by the formation having a higher hydraulic conductivity than the filter pack material; this results in the filter pack controlling the slug test response rather than the formation. This interpretation is supported by the Units 6 & 7 aquifer pumping tests described below, site vicinity aquifer tests (Reference 238), and other regional studies (Table 2.4.12-206) that suggest much higher hydraulic conductivity values for the aquifer.

Four aquifer pumping tests were conducted in 2009 at Units 6 & 7. These tests were performed to determine the hydrogeologic properties of the Biscayne aquifer units and the overlying or underlying aquitards for use in the design and implementation of the construction dewatering system, development of the site groundwater flow model, and simulation of radial collector well operation in the groundwater model. Two test zones were identified within the Biscayne aquifer: the upper zone, which is located in the Key Largo Limestone; and the lower zone,

which is located in the Fort Thompson Formation. The muck and Miami Limestone units are interpreted to have a lower hydraulic conductivity than the underlying Key Largo Limestone. The freshwater limestone layer is interpreted to have a lower hydraulic conductivity than either the overlying Key Largo Limestone or the underlying Fort Thompson Formation. The Tamiami Formation is also interpreted to have a lower hydraulic conductivity than the overlying Fort Thompson Formation. Thus, the Miami Limestone, the freshwater limestone unit, and the Tamiami Formation were treated as aquitards in the subsurface profile. For the conditions at Units 6 & 7, the term aquitard is amended from its usual definition as a low permeability unit to a unit that has a much lower permeability than the aquifer units.

A total of four pumping wells and fifty observation wells were installed for aquifer characterization. Two pumping wells and twenty-five observation wells were installed at each reactor site. The pumping wells at Unit 6 were designated PW-6U and PW-6L and at Unit 7 were designated PW-7U and PW-7L with the U/L suffix indicating completion in either the upper (U) or lower (L) Biscayne aquifer test zone. The pumping wells were nominally 30-inches in diameter and were completed as open holes in the test intervals. The upper test zone wells (PW-6U and PW-7U) were both completed to a total depth of 45 feet. The lower test zone wells (PW-6L and PW-7L) were completed to a total depth of 105 feet and 87 feet, respectively. Each aquifer test location had two observation well clusters of five wells each installed at right angles to and approximately 10 feet from the pumping well. Additionally, a shared well cluster of five wells was installed between the two pumping wells at each reactor site at a distance of approximately 25 feet. The observation well clusters at Unit 6 (C6-1 through C6-5) and Unit 7 (C7-1 through C7-5) each included wells designated as A through E that were completed in the following zones:

- Miami Limestone/upper aquitard (A)
- Key Largo Limestone/upper test zone (D)
- Freshwater limestone/middle aquitard (B)
- Fort Thompson Formation/lower test zone (E)
- Tamiami Formation/lower aquitard (C)

Figure 2.4.12-239 presents the configuration of the pumping and observation wells for Units 6 & 7. The construction data for the pumping and observation wells is presented in Appendix 2BB in Table 2BB-201.

Each pumping test was conducted at a constant discharge rate and drawdown data was collected for a period of eight hours, followed immediately by the recovery period during which water level data were collected for an additional eight hours. The discharge rate for each test was selected based on data collected during a step-drawdown test conducted on each pumping well prior to initiation of the 8-hour drawdown test. Discharge rates for the tests ranged from approximately 3300 gpm to 5100 gpm.

The pumping test results were interpreted using the AQTESOLV™ (Reference 243) computer program. This program contains solution options for different hydrogeologic conditions such as unconfined, confined, and leaky conditions. Two interpretation methods were used: the Theis method and the Hantush leaky aquifer with aquitard storage method. The Theis method was applied to the time-drawdown data, to provide an upper bound on transmissivity, because the Theis method assumes no leakage. The Hantush leaky method with aquitard storage was used to evaluate the distance-drawdown and time-drawdown relationships in the pumping zone observation wells ("D" or "E" series wells). Table 2.4.12-209 presents a summary of the averages of the aquifer test results. Based on these analyses, the average transmissivity for the upper Biscayne aquifer is approximately 2.3E06 gallons per day per foot and for the lower Biscayne aquifer it is approximately 1.3E05 gallons per day per foot. Details of the pumping tests and the analytical methods are provided in Appendix 2BB.

An additional aquifer pumping test was performed on the Turkey Point peninsula to evaluate the hydrogeologic suitability of that area for the installation and operation of radial collector wells. A single test zone in the upper portion of the Biscayne aquifer was targeted as the production interval. The test zone was completed as a 26 inch diameter open hole in pumping well PW-1 and extended from 22 feet bgs to 46 feet bgs. This interval corresponds to the lower Miami Limestone, a cemented sand and the upper portion of the Key Largo Limestone and encompasses the likely depth intervals of the radial collector well laterals. A plan and geologic cross section at the Turkey Point peninsula from the exploratory drilling and aquifer testing program is presented as Figure 2CC-207. Note that the cemented sand indicated in Figure 2CC-207 was not observed in the borings located within the Units 6 & 7 plant area.

Seven observation wells were installed at the site. Four observation wells (MW-2 through MW-5) were installed at distances ranging from 925 feet to 2704 feet from pumping well PW-1. These wells were completed as open holes in the production zone interval. Observation well location MW-1 consisted of three wells. MW-1 DZ was a dual zone observation well constructed to monitor the production zone interval and a zone below the production zone interval in the Fort Thompson Formation (65 ft bgs to 75 ft bgs). Observation well MW-1 IS monitored the upper portion of the production zone interval (24 ft bgs to 35 ft bgs), and MW-1 SS monitored a zone in the Miami Limestone above the production zone interval (12.7 ft bgs to 17.7 ft bgs). The configuration of the pumping and observation wells is shown on Figure 2CC-207.

The pumping test was conducted at a constant discharge rate, and drawdown data was collected for a period of 7 days, followed immediately by the recovery period during which water level data were collected for an additional 7 days. The discharge rate for the test was selected based on data collected during a step-drawdown test conducted in the pumping well prior to initiation of the 7-day constant rate test. The discharge rate for the constant rate test averaged 7100 gpm, and drawdown stabilized in the pumped well at approximately 11 ft bgs (Reference 255).

The analyses of the drawdown and recovery data were performed with the AquiferWin32® software (Reference 256) and AQTESOLV® (Reference 243). Well hydraulic equations for unconfined aquifers, confined aquifer with leaky conditions and partial penetration, and recovery data were applied. The analytical models that appeared to best fit the observed time drawdown data were the Hantush (Reference 257) and Walton (Reference 258) solutions, indicating a leaky aquifer. Results from the Turkey Point peninsula pumping test indicate a leaky aquifer system with a mean transmissivity value ranging from 700,000 to 1,200,000 ft^2/day (5.2E06 to 8.9E06 gallons per day per foot) (Reference 255).

2.4.12.2.4.2 Intermediate Aquifer System/Confining Unit

The overall hydraulic conductivity of the intermediate confining group (upper confining unit of the Floridan aquifer) is very low and provides good confinement for the underlying Floridan aquifer system. The leakage coefficient of this confining unit is highly variable, especially in the semi-confined areas where the confining beds may be either sandy or clayey. Leakage coefficient values of the upper confining unit, derived from computer model simulations, range from less than 0.01 inches per year per foot in tightly confined areas to more than 1.0 inches per year per foot in semi-confined areas (Reference 220). According to

Bush and Johnston (Reference 220), leakage coefficients calculated from aquifer test data, in general, are much larger than those obtained from simulation, ranging from 0.44 to 88 inches per year per foot. Their analyses indicate that in the majority of locations, leakage coefficients from aquifer test data are too large to realistically represent the exchange of water between the surficial aquifer and the Upper Floridan aquifer. The values obtained from aquifer test data can reflect not only downward leakage from the surficial aquifer, but upward leakage from permeable rocks beneath the pumped interval, as well as leakage from beds of relatively low permeability that might exist in the pumped interval. These upper confining unit leakage coefficients derived from Floridan aquifer test data are a composite of leakage from all of these sources.

2.4.12.2.4.3 Floridan Aquifer System

The Floridan aquifer system is a confined series of aquifer zones, separated by aquicludes, that is approximately 3000 feet thick in southeastern Florida. Porosity and permeability in the aquifer vary widely depending on location and formation. High permeability values are the result of both fractured limestone and extensive secondary porosity derived from dissolution of carbonates. At the base of the Floridan aquifer system is the Boulder Zone, a highly permeable zone containing saline water used for underground injection of industrial and domestic wastes in South Florida.

Floridan Aquifer System: Upper Floridan Aquifer

Hydraulic parameters of the Upper Floridan aquifer vary considerably as a result of the wide variation in hydrogeologic conditions encountered at different locations. According to Johnson and Bush (Reference 244), conditions that most affect transmissivity are the degree of solution development in the aquifer and, to a lesser extent, aquifer thickness. High transmissivities are usually found in the areas having less confinement because circulation of flow helps to develop solution openings in the aquifer.

Transmissivities are lowest (less than 50,000 square feet per day) in the Florida panhandle and southernmost Florida (where the aquifer is confined by thick clay sections and contains thick sections of low-permeability limestone) and are highest (greater than 1 million square feet per day) in the karst areas of central and northern Florida where the aquifer is generally unconfined or semi-confined (Reference 244). Based on data obtained from 114 aquifer tests, computer simulation, and geologic conditions, Johnson and Bush (Reference 244)

developed the areal distribution of the probable ranges of transmissivity in the Upper Floridan aquifer shown in Figure 2.4.12-240.

Regional storage coefficients calculated from aquifer tests conducted in the Upper Floridan aquifer range from a low of 1.0E-05 to a high of 2.0E-02 with most values in the 1.0E-03 to 1.0E-04 range (Reference 244).

Dames & Moore (Reference 214) installed a test production well, designated W-12295 as shown in Figure 2.4.12-235, and four observation wells southwest of the Units 6 & 7 plant area. They conducted a 90-day continuous pumping test of the principal artesian water-bearing zone (Upper Floridan aquifer). The test production well was completed as an open hole between approximately 1130 feet and 1400 feet bgs. Calculated average values for transmissivity, storage coefficient, and leakance obtained from graphical solutions of the test data were 400,000 gallons per day per foot (53,600 square feet per day), 6.0E-04, and 0.002 gallons per day per cubic foot, respectively. Bush and Johnston (Reference 220) report a transmissivity of approximately 232,000 gallons per day per foot (31,000 square feet per day) for the Upper Floridan aquifer near Units 6 & 7.

The most transmissive zone is generally found at the top of the unit and is estimated to range between 10,000 to 60,000 square feet per day. According to Bush and Johnston (Reference 220), wells S-1532 and S-1533 have a calculated transmissivity of 31,000 square feet per day (Reference 217). Transmissivity of the Upper Floridan aquifer is highest in west central Florida (greater than 100,000 square feet per day) with lower transmissivities (less than 10,000 square feet per day) in central Florida (Reference 206).

The Upper Floridan aquifer water supply wells used for Unit 5 cooling water and Units 1 & 2 process water included the performance of an aquifer pumping test as part of the well installation process. The results of this test indicate a transmissivity of 244,000 gallons per day per foot, a storage coefficient of 2.0E-04, and a leakance of 5.0E-03 gallons per day per cubic foot (6.7E-04 day^{-1}). These values are consistent with the values reported from other nearby tests in the Upper Floridan aquifer.

Floridan Aquifer System: Middle Confining Unit

The middle confining unit of the Floridan aquifer system includes most of the Avon Park Formation (Reference 206). Reese (Reference 217) places the base of the middle confining unit at the top of the first permeable zone, which in general is in the Oldsmar Formation, however this permeable zone has been identified in

places to be within the lower Avon Park Formation, above the top of the Oldsmar Formation. The base of the middle confining unit is encountered at a depth of approximately 2460 feet in a well (MDS-I12) drilled in southeastern Miami-Dade County, 230 feet below the top of the Oldsmar Formation (Reference 206). Based on core sample analysis, packer tests, and aquifer tests conducted at the MDWASD South District Wastewater Treatment Plant site, the hydraulic conductivity of the middle to lower part of the confining unit ranges from 3.0E-03 to 3.0 feet per day (Reference 217). Vertical hydraulic conductivity measured in eight core samples from a well drilled in eastern Broward County, reported in Reese (Reference 217), ranged from 1.3E-04 to 0.24 feet per day. Core analyses of the low porosity (<15%) dolostones from the Floridan aquifer middle confining unit in Palm Beach County gave vertical hydraulic conductivities of less than or equal to 1.7E-08 centimeters per second. The lowest recorded value was 2.7E-09 centimeters per second (Reference 247).

Observations recorded during the construction of the Class V exploratory well EW-1 at the Turkey Point Units 6 & 7 site provide site-specific measurements for the vertical hydraulic conductivity of core samples from the middle confining unit of the Floridan aquifer system that range from 1.1E-06 to 5.5E-04 centimeters per second. The horizontal hydraulic conductivity of the core samples ranged from 3.2E-06 to 7.8E-04 centimeters per second (Reference 260 Table 5). Packer tests performed in the middle confining unit have specific capacities ranging from 0.003 to 0.24 gallons per minute per foot (Reference 260 Table 6).

Floridan Aquifer System: Lower Floridan Aquifer

The Lower Floridan aquifer underlies the middle confining unit and extends from a depth of approximately 2400 feet bgs to a depth that is undetermined, but thought to be greater than 4000 feet bgs in the Miami-Dade County area. This thick sequence of carbonate rocks contains several permeable zones separated by thick confining units (Reference 207). These confining units are similar in lithology to the middle confining unit of the Floridan aquifer system (Reference 217). Underlying the confining beds in the lower part of the Lower Floridan aquifer is the highly transmissive Boulder Zone, which is of varying thickness. The base of the Lower Floridan aquifer extends below the base of the Boulder Zone with the lower section consisting of permeable dolomites or dolomitic limestones of the Cedar Keys Formation (References 207, 215, and 217). Because the Lower Floridan aquifer is deeply buried in southern Florida and contains saltwater, the unit has not been intensively drilled or tested; therefore, the hydraulic characteristics are not well known (Reference 207).

Boulder Zone

The Boulder Zone is a highly transmissive zone of limestones and dolomites found in the lower Oldsmar Limestone in the Lower Floridan aquifer in southeastern Florida. However, locally the Boulder Zone may range upward to the middle of the Oldsmar Limestone or downward to the top of the Cedar Keys Formation (Reference 207). It consists mostly of massively bedded dolostones within which secondary permeability has been extensively developed. The term “Boulder Zone” is a misnomer because no boulders are present other than large chunks occasionally broken off during drilling. The difficult slow drilling and rough bit behavior, similar to that observed drilling in boulders, encountered while drilling the dolostone, gave rise to the term “Boulder Zone” (Reference 207). The Boulder Zone can be up to 700 feet in thickness (Reference 206). Based on previous studies in the region (References 206, 207, 208, and 214), the Boulder Zone underlies a 13-county area in southern Florida with the elevation of the top of the zone ranging from about –2000 feet NGVD 29 to about –3400 feet NGVD 29, Figure 2.4.12-241 (Reference 210). The Boulder Zone is found at a depth of approximately 2800 feet at Turkey Point.

Transmissivities ranging from 3.2E06 to 24.6E06 square feet per day have been reported for the Boulder Zone (Reference 215). A measured hydraulic conductivity value of approximately 4250 feet per day was obtained from an injection well at the SDWTP, operated by the MDWASD in Miami-Dade County. This value is approximately two orders of magnitude larger than measured values in the overlying portion of the Lower Floridan aquifer and the middle confining unit (Reference 208).

2.4.12.2.5 Hydrogeochemical Characteristics

The state of Florida has conducted an extensive characterization of the background water quality in the major aquifer systems (Reference 245). These data have been subdivided into properties for each of the water management districts. Tables 2.4.12-210 and 2.4.12-211 present typical geochemical parameters for the surfical aquifer, the Floridan aquifer, and precipitation at the Everglades National Park.

Groundwater in the vicinity of the Turkey Point property is not used as a potable water source because of its salinity. The state of Florida has classified these as Class G-III waters to identify groundwater that has no reasonable potential as a future source of drinking water due to high total dissolved solids content (Reference 240). Field-measured groundwater quality indicator parameters

(temperature, pH, dissolved oxygen, specific conductance, turbidity, and oxidation-reduction potential) obtained during the collection of water samples from observation wells (installed in the Biscayne aquifer as part of the site characterization investigation) are summarized in Table 2.4.12-210. The results of laboratory analyses of the water samples are presented in Table 2.4.12-211.

Water quality data were collected as part of the Turkey Point peninsula pumping test activities. Grab samples, collected at various time intervals, were taken from the test well, monitoring wells, Biscayne Bay and the Industrial Wastewater Facility. The analytes include cations, anions, and stable isotopes. A summary of the water quality data collected as part of the Turkey Point pumping test is presented in Table 2.4.12-214. Additional data and information regarding these water quality analyses can be found in Reference 255.

Although the Upper Floridan aquifer is a major source of potable groundwater in much of Florida, water withdrawn from the unit in southeastern Florida, including Miami-Dade County, is brackish and variable with chloride and dissolved solid concentrations greater than 1000 milligrams per liter. Groundwater samples from the Upper Floridan aquifer production wells at Unit 5 (Table 2.4.12-211) show an average chloride concentration of 2900 milligrams per liter. Chemically, the water in the middle confining unit is similar to seawater, but salinity varies greatly at the top of the unit as the upward moving saline water from the Lower Floridan is blended with the seaward flowing freshwater in the Upper Floridan aquifer (Reference 215).

Average dissolved solids concentration of Boulder Zone groundwater is approximately 37,000 milligrams per liter total dissolved solids (Reference 215). There is also a pronounced temperature anomaly present in the Boulder Zone with the lowest observed temperature (approximately 50°F) occurring along the southeastern coast. The temperature increases from the Straits of Florida toward the center of the Florida Plateau, suggesting recharge from cold seawater through the lower part of the Floridan aquifer system. The groundwater circulation pattern is shown on Figure 2.4.12-243 (Reference 215).

Observations recorded during the construction of the Class V exploratory well EW-1 at the Turkey Point Units 6 & 7 site provide site-specific measurements for a total dissolved solids concentration of 36,200 milligrams per liter, a chloride concentration of 24,000 milligrams per liter, a specific conductance of 55,270 microsiemens per centimeter, and a temperature of 25.05°C (77.1°F) in the Boulder Zone (Reference 260 Appendix S). Additional analytical data for the Boulder Zone are presented in Reference 260.

Figure 2.4.12-242 presents a Piper trilinear diagram of the site and regional geochemical data. Examination of the diamond field on the diagram indicates that the site groundwater, Biscayne Bay, and the cooling canals data all plot together on the diagram indicating similar geochemical compositions. These waters are classified as a sodium-chloride type.

PTN COL 2.4-5

2.4.12.3 Subsurface Pathways

Subsurface pathways are described below for the two major aquifers beneath the Units 6 & 7 plant area: the Biscayne aquifer and the Floridan aquifer system.

2.4.12.3.1 Biscayne Aquifer

Regional groundwater flow in the Biscayne aquifer is generally toward the east-southeast in Miami-Dade County (Reference 209). The Biscayne aquifer groundwater flow direction in the Units 6 & 7 plant area is described in Subsection 2.4.12.2.2.1.

The hydrogeologic conditions at Units 6 & 7 indicate two potential pathways for offsite migration of a postulated accidental release of radionuclides. The most likely pathway is through the Key Largo Limestone, with discharge to the cooling canals and then migration from the cooling canals to Biscayne Bay. An alternate pathway would be through the Fort Thompson Formation with discharge into Biscayne Bay. Neither of these release scenarios would threaten groundwater or surface water supplies. Further description of these pathways, source radionuclides, analytical methods, and subsurface properties is provided in Subsection 2.4.13.

The ground surface at Units 6 & 7 was at approximately sea level. The Biscayne aquifer is generally present within 5 feet of the ground surface, with up to 7 feet of muck deposits covering the aquifer. As part of plant construction, the muck deposits were removed and engineered fill was placed to raise the finish grade to El. 25.5 feet NAVD 88. Additionally, as part of the construction process, a reinforced concrete diaphragm wall and grouting program was used to control groundwater inflow into the excavation (Subsection 2.5.4.5.4 and 2.5.4.6.2).

In order to account for the changes to the pre-construction groundwater flow system, a three-dimensional numerical groundwater flow model was used. The model code used was MODFLOW-2000 (Reference 246) as implemented in the Visual MODFLOW modeling software. The MODFLOW model is a

constant-density, three-dimensional finite-difference model, with modular capability to add various equation solvers and boundary conditions to the basic model. The model developed for Units 6 & 7 used a geometric multigrid (GMG) solver.

The Biscayne aquifer is represented in the model by fourteen layers. The fourteen model layers are included as follows:

- Model Layer 1 — Onshore: organic soils, referred to as muck and marl. Offshore: sand/sediment and Miami Limestone.
- Model Layers 2/3 — Marine limestone, referred to as the Miami Limestone.
- Model Layer 4 — Marine limestone, referred to as the Upper Higher Flow Zone.
- Model Layers 5/6 — Marine limestone, referred to as the Key Largo Limestone (divided into two areal zones based on prior information).
- Model Layer 7 — Freshwater limestone, referred to as the Freshwater Limestone, and where this is absent the Key Largo Limestone.
- Model Layers 8/9 and 11/12/13 — Marine limestone, referred to as the Fort Thompson Formation.
- Model Layer 10 — Marine limestone, referred to as the Lower Higher Flow Zone.
- Model Layer 14 — Marine limestone or sandstone, referred to as the Tamiami Formation.

The Upper and Lower Higher Flow Zones are relatively thin zones of high secondary porosity. These zones were defined based on a review of geophysical logs and drilling records and are assumed to be continuous across the model domain. The Upper Higher Flow Zone was primarily identified from the loss of drilling fluid at the boundary of the Key Largo Limestone and Miami Limestone. This observation was also coincident with an increase in the boring diameter as identified by the caliper logging. The Lower Higher Flow Zone was identified at a depth of approximately 15 feet below the top of the Fort Thompson Formation from the 2008 subsurface investigation borings within the Units 6 & 7 plant area. In 2010, 14 borings were drilled in and around the Turkey Point plant area as part of the FPL Unit 3 & 4 Uprate Conditions of Certification (Reference 254). These

borings did not identify a laterally persistent layer corresponding to the Lower Flow Zone identified within the Units 6 & 7 plant area, but rather more isolated zones at varying depths. As represented in the model, the Lower Higher Flow Zone represents an aggregation of these observations and is conservative due to the fact it is modeled as laterally extensive. The location and lateral persistence of the Upper Higher Flow Zone is generally confirmed by the 2010 borings (Reference 254). Cunningham et al (Reference 253) discuss the presence and origin of high flow zones in the Biscayne aquifer.

The horizontal discretization for most simulations in the model is represented by a telescopic grid that ranges from a coarse grid (100 by 100 feet) at the model perimeter to a fine grid (3 by 3 feet) in the immediate area of Units 6 & 7.

Hydrological features are represented in the model as boundary conditions. The river boundary condition is used to represent the cooling canals and the regional water management canals. Recharge and evapotranspiration boundaries are assigned to the top layer of the model, with properties varying depending on the surface conditions. The perimeter of the model is represented by a general head boundary. The general head boundary represents the influence of conditions beyond the model area, primarily recharge from the Everglades. Biscayne Bay is represented as a general head boundary in the model. This boundary condition allows for limiting the exchange of water between Biscayne Bay and the underlying aquifer based on the material properties of the sea floor sediments. A horizontal flow barrier boundary was used to simulate the effects of the excavation cut-off walls surrounding the power blocks for Units 6 & 7 for construction dewatering and the mechanically stabilized earth (MSE) retaining wall surrounding the plant area. The bottom layer of the model (Tamiami Formation) is represented as a no flow boundary condition. The vertical seepage upwards or downwards through the Tamiami Formation and the Hawthorn Group is assumed to be negligible relative to the horizontal flow in the Biscayne aquifer.

The calibration of the model was performed by adjusting the hydraulic conductivity of the hydrostratigraphic units comprising the Biscayne aquifer as well as the conductance values of the various head-dependent boundary conditions. The calibration targets for the model were the measured groundwater levels from three pumping tests conducted in the Units 6 & 7 plant area. A validation of the model calibration was performed by comparing the observed drawdown values of a fourth pumping test (not used in model calibration) to those predicted with the model.

Qualitative comparisons of model results were made to regional potentiometric surface maps (Reference 212) and the interaction of groundwater with the cooling canal system. The interaction of groundwater with the cooling canal system was assessed by comparing model results against estimates obtained from an independent steady-state water balance model (Reference 259).

The calibrated model was used to simulate the impacts of construction dewatering, construction of Units 6 & 7 (site grade increase and use of diaphragm walls and grout plug for groundwater control), and operation of the radial collector wells. The results of these model simulations are presented in Appendix 2CC.

2.4.12.3.2 Floridan Aquifer System

Regional groundwater movement in the Floridan aquifer system in southern Florida is estimated to occur in the following circulation pattern: 1) inland movement of cold seawater through the Lower Floridan aquifer, 2) heating of the seawater in the Lower Floridan aquifer during inland movement, which results in lower fluid density, 3) upwelling of seawater from the Lower Floridan aquifer through the middle confining unit, and 4) dilution of seawater (further reducing fluid density) and transport of the seawater back to the ocean by seaward flowing groundwater in the Upper Floridan aquifer. Figure 2.4.12-243 illustrates this circulation pattern (Reference 215). This is generally a very slow circulation pattern due to the low permeability of the middle confining unit.

Over the past 30 years, deep well injection has become an accepted technology for the disposal of liquid wastes in Florida. There are approximately 125 active Class I injection wells in the state (Reference 229). In south Florida, the primary injection unit is the Boulder Zone, which is part of the Lower Floridan aquifer. In 2006, there were 32 active Class I injection wells in southeast Florida (Miami-Dade, Broward, and Palm Beach counties). All Class I injection wells are required to have a dual-zone monitoring system that consists of a zone below the deepest USDW and a zone in the USDW (USDW is defined as an aquifer that contains water with a total dissolved solids concentration of less than 10,000 milligrams/liter). Of the 32 injection systems, 3 systems have documented upward migration (Seacoast Utilities, and Miami-Dade North and South District Regional Wastewater Treatment Plants) into the USDW and 7 other injection systems have upward migration that has remained below the USDW. This upward migration is considered to potentially indicate failure of the well construction methods and not geologically related. The remaining injection wells have no detected vertical migration of injection fluids (Reference 247). A typical injection well system is shown on Figure 2.4.12-244.

PTN COL 2.4-4

2.4.12.4 Monitoring or Safeguard Requirements

Groundwater levels at Units 6 & 7 were determined through the use of groundwater observation wells installed in 2008 as part of the site subsurface investigation, and through periodic review of USGS and SFWMD monitoring stations to evaluate changes in groundwater or canal conditions in the general vicinity of the Units 6 & 7.

Consistent with RG 4.21 and the Nuclear Energy Institute (NEI) groundwater initiatives, the groundwater observation well network will be evaluated and an environmental monitoring program developed as part of detailed design activities for Units 6 & 7. The groundwater monitoring program will consider the following components:

- Biscayne aquifer — Periodic water level measurements in observation wells and geochemical sampling and analysis of the radial collector wells will detect changes in the Biscayne aquifer that may impact groundwater supply or the accidental release analysis.

- Floridan aquifer — Geochemical and pressure monitoring will be conducted in the Floridan aquifer as mandated by underground injection control regulations Chapter 62-528 FAC (Reference 229). The underground injection control permit requirements are expected to include monthly reporting of the average, minimum, and maximum injection pressure; flow rate; volume; and annular pressure. The requirement for mechanical integrity tests in the injection well to be performed every five years would also be expected in the permit. The monitoring program will include dual-zone monitor wells located less than 150 feet from the injection wells. The upper zone monitors just above or at the base of the USDW and the lower zone monitors below the base of the USDW and just above the primary confining unit in order to detect any vertical migration of injected fluids into the overlying Upper Floridan and Biscayne aquifers.

- Operational accident monitoring — The effluent and process monitoring program is addressed in Subsections 11.5.3 and 11.5.4 and will be implemented in accordance with the schedule in Subsection 13.3.

Groundwater level measurements in Biscayne aquifer observation wells (existing or future) are made during construction and after plant startup. Selection of

observation wells included in the program is made before the start of operation based on well condition, position relative to plant site and other observation wells (provide optimal spatial distribution for potentiometric map preparation and vertical hydraulic gradient assessment), and long-term viability of the observation well (likelihood that the well will not be damaged or destroyed).

Geochemical sampling and analysis of the Biscayne and Floridan aquifers are performed during construction and after startup. Analysis includes field parameters (pH, temperature, specific conductance, oxidation-reduction potential, and dissolved oxygen), major cations, major anions, total dissolved solids, silica, and any additional water use or injection well permit-required parameters. Sampling is performed in site water supply wells, selected observation wells, and dual-zone monitoring wells as part of the UIC permit.

Operational accident monitoring will be initiated in the unlikely event of a release of liquid effluent from the plant. Quarterly groundwater samples will be collected from downgradient Biscayne aquifer observation wells as needed to identify impact. Selection of downgradient observation wells will be based on flow directions determined from the most recent groundwater level measurements and post-construction groundwater modeling.

Safeguards will be used to minimize the potential for adverse impacts to the groundwater caused by construction and operation of the new units. These safeguards include the use of emergency cleanup procedures to capture and remove surface contaminants, and other measures deemed necessary to prevent or minimize adverse impacts to the groundwater beneath the site.

2.4.12.5 Site Characteristics for Subsurface Hydrostatic Loading

Subsurface hydrostatic loading estimates for Units 6 & 7 structures were evaluated using two approaches. First, a conservative maximum groundwater level of 0.6 meters (2 feet) below grade was evaluated as specified in DCD Table 2-1. The finish grade in the power block area at Units 6 & 7 is El. 25.5 feet NAVD 88. The maximum acceptable groundwater elevation at the site is El. 23.5 feet NAVD 88, which is over 20 feet higher than the current or predicted groundwater levels. The second approach uses the simulated post-construction groundwater level elevation from the numerical groundwater flow model (Appendix 2CC). The model results for post-construction groundwater conditions indicate groundwater levels remain below an elevation of 3 feet NAVD 88 in the power block area. The maximum hydrostatic loading was estimated using the following formula:

$$\rho_w = z_w \times \gamma_w$$

Where,

ρ_w = hydrostatic pressure (pounds per square foot)

z_w = depth below groundwater level (feet)

γ_w = unit weight of water (64.6 pounds per cubic foot for site groundwater in the upper monitoring zone)

Figure 2.4.12-247 presents a graph of subsurface hydrostatic loading. Two lines are provided on the graph: the first represents the upper boundary condition using the DCD maximum groundwater level, and the second represents the predicted water level in the power block area from the calibrated groundwater flow model.

Subsurface hydrostatic loading on safety-related structures during construction is anticipated to be less than that predicted above as a result of the implementation of construction groundwater control measures.

Construction-related excavation dewatering or groundwater control is required to a depth of approximately 35 feet below pre-construction grade for the reactor building. A discussion of this dewatering is provided in Subsections 2.5.4.5.4 and 2.5.4.6.2.

Groundwater level recovery following backfilling around the plant structures is conducted in a controlled manner to prevent rapid hydrostatic pressure buildup or damage to the backfill materials. Before the start of excavation, a groundwater control and recovery plan will be prepared to describe the system design, installation, and removal.

In summary, based on the groundwater level elevations and the groundwater computer modeling activities, the groundwater depth in both power block areas is below the maximum groundwater level of 2 feet below design grade as specified in DCD Table 2-1. Based on this observation, a permanent dewatering system is not a design feature for Units 6 & 7.

2.4.12.6 References

201. White, W., *The Geomorphology of the Florida Peninsula*, Geological Bulletin 51, Florida Bureau of Geology, Florida Department of Natural Resources, 1970.

202. Randazzo, A. and D. Jones, *The Geology of Florida*, University Press of Florida, Gainesville, Florida, 1997.

203. U.S. Geological Survey, *Manual Water-Level Measurements in the Homestead, FL Area, as of March 2009, Groundwater Conditions in Southern Florida*. Available at http://www.sflorida.er.usgs.gov/edl_data/text/hstd_gov.html, accessed May 22, 2009.

204. Southeastern Geological Society, *Hydrogeological Units of Florida*, Special Publication 28, Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986.

205. U.S. Environmental Protection Agency, *Region 4: Ground Water Protection, Sole Source Aquifers in the Southeast*. Available at http://www.epa.gov/region4/water/groundwater/r4ssa.html, accessed January 21, 2011.

206. Reese, R. and E. Richardson, *Synthesis of the Hydrogeologic Framework of the Floridan Aquifer System and Delineation of a Major Avon Park Permeable Zone in Central and Southern Florida*, U.S. Geological Survey, Scientific Investigations Report 2007-5207, 2008.

207. Miller, J., *Hydrologic Framework of the Floridan Aquifer System in Florida and in Parts of Georgia, Alabama, and South Carolina*, U.S. Geological Survey, Professional Paper 1403-B, 1986.

208. Starr, R., T. Green, and L. Hull, *Evaluation of Confining Layer Integrity Beneath the South District Wastewater Treatment Plant*, *Miami-Dade Water and Sewer Department, Dade County, Florida*, Idaho National Engineering and Environmental Laboratory Geosciences Research Department, 2001.

209. Fish, J. and M. Stewart, *Hydrogeology of the Surficial Aquifer System, Dade County, Florida*, U.S. Geological Survey, Water-Resources Investigations Report 90-4108, 1991.

210. Miller, J., *The Groundwater Atlas of the United States: Alabama, Florida, Georgia and South Carolina*, U.S. Geological Survey, HA 730-G, 1990.

211. Klein, H. and J. Hull, *Biscayne Aquifer, Southeast Florida,* U.S. Geological Survey, Water-Resources Investigation 78-107, 1978.

212. Langevin, C., *Simulation of Ground-Water Discharge to Biscayne Bay, Southeastern Florida*, U.S. Geological Survey, Water-Resources Investigations Report 00-4251, 2001.

213. Stewart, J., *Areas of Natural Recharge to the Floridan Aquifer in Florida*, Map Series 98, U.S. Geological Survey in cooperation with the Florida Department of Environmental Regulations, Florida Geological Survey, 1980.

214. Dames & Moore, *Floridan Aquifer Water Supply Investigation Turkey Point Area Dade County, Florida,* Prepared for Florida Power & Light Company, 1975.

215. Meyer, F., *Hydrogeology, Ground-Water Movement, and Subsurface Storage in the Floridan Aquifer System in Southern Florida, Regional Aquifer-System Analysis-Floridan Aquifer System*, U.S. Geological Survey, Professional Paper 1403-G, 1989.

216. Bloetscher, F. and A. Muniz, *Ground Water Protection Council 2006 Annual Meeting: Preliminary Modeling of Class I Injection Wells In Southeast Florida,* 2006.

217. Reese, R., *Hydrogeology and the Distribution and Origin of Salinity in the Floridan Aquifer System, Southeastern Florida*, U.S. Geological Survey, Water-Resources Investigations Report 94-4010, 1994.

218. In-Situ Incorporated, *In-Situ Inc., ISI Data Center, Site Index.* Available at http://www.isi-data.com/SiteIndex.aspx, (restricted access), accessed September 22, 2008.

219. Parker, G., G. Ferguson, S. Love, et al., *Water Resources of Southeast Florida*, U.S. Geological Survey, Water Supply Paper 1255, 1955.

220. Bush, P. and R. Johnston, *Groundwater Hydraulics, Regional Flow and Groundwater Development of the Floridan Aquifer System in Florida and in Parts of Georgia, South Carolina and Alabama,* U.S. Geological Survey, Professional Paper 1403-C, 1988.

221. Marella, R., *Water Withdrawals, Use, Discharge, and Trends in Florida, 2000,* U.S. Geological Survey, Scientific Investigations Report 2004-5151,

prepared in cooperation with the Florida Department of Environmental Protection, 2005.

222. Marella, R., *Water Use in Florida, 2005 and Trends 1950–2005*, Fact Sheet 2008-3080, prepared in cooperation with the Florida Department of Environmental Protection and the Florida Water Management Districts, U.S. Geological Survey, September 2008.

223. South Florida Water Management District, *Basis of Review for Water Use Applications within the South Florida Water Management District*, Rules of the South Florida Water Management District, February 2008.

224. Marella, R., *Water Withdrawals, Use, and Trends in Florida, 1990,* U.S. Geological Survey, Water-Resources Investigations Report 92-4140, 1992.

225. Marella, R., *Water Withdrawals, Use, Discharge, and Trends in Florida, 1995*, U.S. Geological Survey, Water-Resources Investigations Report 99-4002, prepared in cooperation with the Florida Department of Environmental Protection, 1999.

226. Marella, R. and M. Berndt, *Water Withdrawals and Trends from the Floridan Aquifer System in the Southeastern United States, 1950–2000*, U.S. Geological Survey, Circular 1278, 2005.

227. South Florida Water Management District, *Water Use Regulation Facility Site*. Available at http://my.sfwmd.gov/gisapps/sfwmdxwebdc/dataview.asp?query=unq_id=1576, accessed January 12, 2011.

228. Florida Department of Environmental Protection, *Drinking Water, Basic Facility Reports.* Available at http://www.dep.state.fl.us/water/drinking water/bfr.htm, accessed December 13, 2010.

229. Florida Department of Environmental Protection, *Underground Injection Control Program.* Available at http://www.dep.state.fl.us/water/uic/index.htm, accessed September 6, 2008 and December 21, 2010.

230. South Florida Water Management District, *Lower East Coast Water Supply Plan 2005–006 Update*, 2006.

231. National Oceanic and Atmospheric Administration, *Orthometric Height Conversion.* Available at http://www.ngs.noaa.gov/cgi-bin/VERTCON/vert_con.prl, accessed September 24, 2008.

232. U.S. Geological Survey, *USGS Ground-Water Daily Data for Florida.* Available at http://waterdata.usgs.gov/fl/nwis/dv/?referred_module=gw, accessed December 17, 2010.

233. South Florida Water Management District, *DBHYDRO Browser Menu.* Available at http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.main_menu, accessed September 9, 2008 and December 20, 2010.

234. U.S. Geological Survey, *Ground-Water Levels for Florida*. Available at http://nwis.waterdata.usgs.gov/fl/nwis/gwlevels?county_cd=12086&format=station_list&sort_key=site_no&group_key=NONE&sitefile_output_format=html_table&column_name=agency_cd&column_name=site_no&column_name=station_nm&begin_date=&end_date=&TZoutput=0&date_format=YYYY-MM-DD&rdb_compression=file&list_of_search_criteria=county_cd, accessed September 13, 2008.

235. Fetter, C., *Applied Hydrogeology*, 2d ed., Macmillan Publishing Company, New York, 1988.

236. Davis, S. and R. DeWeist, *Hydrogeology*, John Wiley & Sons, Incorporated, 1966.

237. U.S. Environmental Protection Agency, *Relative Risk Assessment of Management Options for Treated Wastewater in South Florida*, Office of Water, EPA 816-R-03-010, pp. 4–9, April 2003.

238. Dames & Moore, *Geohydrologic Conditions Related to the Construction of Cooling Ponds Florida Power & Light Company Steam Generating Station, Turkey Point, Florida*, prepared for Brown and Root, Inc., July 1971.

239. Sherwood, C., H. McCoy, and C. Galliher, *Water Resources of Broward County*, Florida Bureau of Geology Report of Investigations 65, 1973.

240. Merritt, M., *Simulation of the Water-Table Altitude in the Biscayne Aquifer, Southern Dade County Florida, Water Years 1945–89*, U.S. Geological Survey, Water Supply Paper 2458, 1996.

241. Cunningham, K., J. Carlson, G. Wingard, E. Robinson, and M. Wacker, *Characterization of Aquifer Heterogeneity Using Cyclostratigraphy and Geophysical Methods in the Upper Part of the Karstic Biscayne Aquifer, Southeastern Florida*, U.S. Geological Survey, Water-Resources Investigations Report 2003-4208, 2004.

242. Cunningham, K., M. Wacker, E. Robinson, J. Dixon, and G. Wingard, *A Cyclostratigraphic and Borehole-Geophysical Approach to Development of a Three-Dimensional Conceptual Hydrogeologic Model of the Karstic Biscayne Aquifer, Southeastern Florida*, U.S. Geological Survey, Scientific Investigations Report 2005-5235, 2006.

243. Duffield, G., *AQTESOLV™ for Windows Version 4.5 User's Guide*, HydroSOLVE, Inc., Reston, Virginia, 2007.

244. Johnston, R. and P. Bush, *Summary of the Hydrology of the Floridan Aquifer System in Florida and Parts of Georgia, South Carolina, and Alabama*, U.S. Geological Survey, Professional Paper 1403-A, 1988.

245. Florida Geological Survey, *Florida's Ground Water Quality Monitoring Program - Background Hydrogeochemistry*, Special Publication 34, 1992.

246. Harbaugh, A., E. Banta, M. Hill, and M. McDonald, *MODFLOW-2000, The U.S. Geological Survey Modular Ground-Water Model — User Guide to Modularization Concepts and the Ground-Water Flow Process*, U.S. Geological Survey, Open-File Report 00-92, 2000. Available at http://pubs.er.usgs.gov/usgspubs/ofr/ofr200092, accessed September 30, 2008.

247. Maliva, R., W. Guo, and T. Missimer, *Vertical Migration of Municipal Wastewater in Deep Injection Well Systems, South Florida, USA*, Hydrogeology Journal, Springer-Verlag, 2007.

248. MACTEC Engineering and Consulting, Inc., *Final Data Report—Geotechnical Exploration and Testing: Turkey Point COL Project Florida City, Florida,* Rev. 2, included in COL Application Part 11, October 6, 2008.

249. Florida Power & Light Company*, Construction Permit Application to Construct a Class V Exploratory Well and Dual-Zone Monitor Well at the Florida Power & Light Company Turkey Point Units 6 & 7*, January 2009.

250. U.S. Environmental Protection Agency, *EPA Proposes A New Rule to Protect Underground Sources of Drinking Water from Wastewater Disposal in South Florida*, Office of Water, EPA 816-F-00-022, June 2000.

251. JLA Geosciences, Inc., *Well Completion Report for Floridan Aquifer Wells PW-1, PW-3, and PW-4, FPL Turkey Point Expansion Project (Unit 5) Homestead, Florida,* Prepared for Florida Lakes Power Partners and Florida Power & Light Company, June 2006, accessed from the DBHYDRO database March 29, 2010.

252. Florida Department of Environmental Protection Letter to Mr. Randall LaBauve at Florida Power & Light Company, *Notice of Permit*, File #247895-007-UC, dated May 1, 2008.

253. Cunningham, K., M. Sukop, H. Huang, P. Alvarez, H. Curran, R. Renken, and J. Dixon, *Prominence of Ichnologically Influenced Macroporosity in the Karst Biscayne Aquifer: Stratiform "Super-K" Zones,* Geological Society of America Bulletin, Vol. 121, No. 1/2, pp. 164–180, 2009.

254. JLA Geosciences Inc., *Geology and Hydrogeology Report for FPL Turkey Point Plant Groundwater, Surface Water, & Ecological Monitoring Plan,* 2010. Available at http://www.sfwmd.gov/portal/page/portal/xrepository/sfwmd_repository_pdf/fpl_tp_geo_and_h2ogeo_rept.pdf, accessed October 17, 2011.

255. HDR Engineering, Inc., *Turkey Point Exploratory Drilling and Aquifer Performance Test Program*, prepared for Florida Power & Light Company, August 2009. Available at: http://publicfiles.dep.state.fl.us/Siting/Outgoing/FPL_Turkey_Point/Units_6_7/Completeness/Plant_Associated_Facilities/1st_round_Completeness/FPL_Response_1st_Incompleteness/Attached%20Reports/HDR/Aquifer%20Performance%20Test_August-2009/Report_HDR%20APT_FPL_081909.pdf, accessed October 17, 2011.

256. Rumbaugh, D. and J. Rumbaugh, *AquiferWin32, WinFlow-Wintran, Ver. 3*, Environmental Simulations, Inc., Reinholds, Pennsylvania, 2003.

257. Hantush, M., *Hydraulics of Wells,* V. Chow (ed). Advances in Hydroscience, Vol. I, pp. 281–432, Academic Press, New York and London, 1964.

258. Walton, W., *Selected Analytical Methods for Well and Aquifer Evaluation*, Illinois State Water Survey Bull. No. 49, 1962.

259. Golder Associates, Inc., *Cooling Canal System Modeling Report,* 2008. Available at:http://publicfiles.dep.state.fl.us/Siting/Outgoing/FPL_Turkey_Point/Units_6_7/Completeness/Plant_Associated_Facilities/2nd_round_Completeness/FPL_Response_Part_A_Information/Attachments/2nd%20Round%20Attachments/Attachment%202SFWMD-B-40(33)_Cooling%20Canal%20System%20Report.pdf, accessed October 17, 2011.

260. McNabb Hydrogeologic Consulting, Inc., Report on the Construction and Testing of Class V Exploratory Well EW-1 at the Florida Power & Light Company Turkey Point Units 6 & 7, Vol. 1, in *Turkey Point Units 6 & 7 Site Certification Application Amendment Rev. 2*, September 2012. Available at http://publicfiles.dep.state.fl.us/Siting/Outgoing/FPL_Turkey_Point/Units_6_7/Amendment _Application_Rev2/08_APPENDIX %2010.2.8.pdf, accessed January 10, 2013.

261. McNabb Hydrogeologic Consulting, Inc., *Report on the Construction and Testing of Dual-Zone Monitor Well DZMW-1 at the Florida Power & Light Company Turkey Point Units 6 & 7*, prepared by McNabb Hydrogeologic Consulting, Inc. and ASRUS, LLC, September 2012.

262. Meyer, F., *Evaluation of Hydraulic Characteristics of a Deep Artesian Aquifer from Natural Water-Level Fluctuations, Miami, Florida,* Report of Investigations No. 75, U.S. Geological Survey and Bureau of Geology, Florida Department of Natural Resources, Tallahassee, Florida, 1974.

263. Singh U., G. Eichler, C. Sproul, and J. Garcia, *Pump Testing Boulder Zone Aquifer, South Florida,* Journal Hydraulic Engineering, Vol. 109, No. 8, pp. 1152–1160, August 1983.

264. AECOM, *Engineer Report on the Construction & Testing of Deep Injection Well IW-1 and Dual Zone Monitoring Well MW-1 at J. Robert Dean WTP, Florida City, FL,* Prepared for Florida Keys Aqueduct Authority, December 2009.

265. Driscoll, F., *Groundwater and Wells,* 2d ed., Johnson Filtration Systems, St. Paul, Minnesota, 1986.

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Table 2.4.12-201
Summary of Units 6 & 7 Observation Well Construction Data

Well Number	Borehole Depth (feet bgs)	Well Depth (feet bgs)	Coordinates (Florida East State Plane) in feet		Screened Interval (feet bgs)	Top of Casing Elevation (feet NAVD 88)	Height of casing (feet ags)	Pad Elevation (feet NAVD 88)
			Northing	Easting				
OW-606D	137.0	136.0	396962.8	876712.9	125–135	1.70	3.2	–1.6
OW-606L	110.0	108.0	396979.9	876732.6	97–107	1.31	2.8	–1.5
OW-606U	30.2	29.0	396938.0	876734.8	18–28	1.37	3.2	–1.8
OW-621L	110.0	109.6	97364.5	876970.0	98.6–108.6	3.07	3.0	0.1
OW-621U	30.0	28.4	397375.8	876930.0	17.4–27.4	3.88	3.3	0.6
OW-636L	111.0	108.1	395290.8	877257.2	97.1–107.1	2.89	3.4	–0.4
OW-636U	29.8	28.0	396960.1	875864.4	17–27	2.82	3.4	–0.6
OW-706D	138.4	135.1	396960.1	875864.4	123.8–133.8	2.22	3.3	–1.1
OW-706L	112.0	111.0	396978.2	875904.6	100–110	2.26	3.2	–1.0
OW-706U	29.0	28.0	396940.1	875895.7	17–27	1.70	3.2	–1.5
OW-721L	109.0	107.0	397321.5	876120.3	96–106	2.06	3.2	–1.2
OW-721U	26.0	25.0	397361.2	876121.4	14–24	2.07	3.1	–1.1
OW-735L	110.0	107.9	395824.3	875669.5	96.9–106.9	2.70	3.4	–0.7
OW-735U	28.0	27.0	395823.3	875709.2	16–26	2.82	3.3	–0.5
OW-802L	110.0	109.0	398817.1	876255.7	98–108	2.16	3.3	–1.2
OW-802U	27.0	26.0	398820.2	876243.7	15–25	2.23	3.4	–1.2
OW-805L	97.0	96.0	396883.0	877239.5	85–95	2.25	3.7	–1.5
OW-805U	30.0	29.0	396842.8	877240.9	18–28	1.28	2.8	–1.6
OW-809L	110.0	106.5	397007.9	875152.3	95.5–105.5	2.38	3.3	–0.9
OW-809U	27.0	26.0	397045.8	875152.4	15–25	2.55	3.2	–0.7
OW-812L	109.0	108.0	368892.8	875045.5	97–107	2.15	3.3	–1.2
OW-812U	27.0	26.0	398933.9	875043.5	15–25	2.22	3.0	–0.8

bgs = Below ground surface
ags = Above ground surface

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Table 2.4.12-202
Historical and Projected Groundwater Use in Miami-Dade County

Year	Groundwater Use/Projected Use in million gallons per day					
	Public Supply	Domestic	Commercial	Agricultural	Recreational	Power Generation
1965	202.3	9.6	5	67.9	—	0.3
1970	212.1	9.13	7.7	44.8	—	0.04
1975	270.5	9.5	3.38	87.66	—	0.04
1977	280.15	3.98	6.73	101.06	—	0
1980	314.29	18.38	19.73	86.98	—	0
1985	339.77	13.32	15.78	103.68	13.5	0
1990	337.69	10.75	40.34	115.01	20.55	2.26
1995	386.6	12.71	38.82	95.95	14.24	2.1
2000	394.29	4.85	41.65	86.55	8.51	2.08
2005	400.01	2.78	40.08	58.06	13.4	0.42
2010	407.8[a]		41.7	92.1	10.4	14.2
2015	435.2[a]		41.7	91.5	12	14.2
2020	459.6[a]		41.7	90.8	13.6	14.2
2025	483.1[a]		41.7	90.2	15.1	69.8

(a) Projected use includes Public Supply and Domestic as a single value.
Sources:
1965–2000 Reference 221
2005 Reference 222
2010–2025 Reference 230

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Table 2.4.12-203 (Sheet 1 of 4)
Public Water Supply Systems in Miami-Dade County

Pws Id	Type	Mailing Name	City	Owner Type	Pop Served	Sells to Pop	Design Cap
4130077	Community	Bal Harbour Village	Bal Harbour	Municipality	3,299	0	0
4130089	Community	Bay Harbor Islands Town of	Bay Harbor Islands	Municipality	5,146	0	0
4130255	Community	Florida City	Florida City	Municipality	9,445	0	4,000,000
4130588	Community	Redlands Mobile Home Park	Miami	Investor	160	0	100,000
4130604	Community	Hialeah City of	Hialeah	Municipality	210,000	0	40,000,000
4130645	Community	Homestead City of	Homestead	Municipality	39,000	385	19,200,000
4130662	Community	Indian Creek Village	Miami Beach	Authority/Commission/District	103	0	0
4130833	Community	Jones' Trailer Park	Miami	Investor	120	0	100,000
4130871	Community	Mdwasa - Main System	Miami	Municipality	2,100,000	427,754	442,740,000
4130901	Community	Miami Beach City of	Miami Beach	Municipality	87,933	3,299	0
4130970	Community	North Bay Village City of	North Bay Village	Municipality	6,733	0	6,480,000
4130977	Community	North Miami City of	North Miami	Municipality	80,000	4,799	9,300,000
4131001	Community	Opa Locka City of	Opa Locka	Municipality	15,250	0	6,900,000
4131202	Community	Mdwasa/Rex Utilities	Miami	Investor	41,500	0	12,030,000
4131206	Community	Rex Utilities Inc/Redavo	Homestead	Municipality	385	0	0
4131312	Community	Silver Palm Mobile Homes	Miami	Investor	250	0	122,000
4131403	Community	Americana Village	Miami	Investor	2,100	0	500,000
4131424	Community	Surfside Town of	Surfside	Municipality	5,600	103	1,512,000
4131474	Community	Medley Water Department	Miami	Municipality	1,098	0	1,800,000
4131531	Community	Virginia Gardens Village of	Virginia Gardens	Municipality	2,212	0	0
4131558	Community	West Miami City of	West Miami	Municipality	5,863	0	0
4131618	Community	North Miami Beach	North Miami Beach	Municipality	170,000	8,000	32,000,000
4134357	Community	Fkaa J. Robert Dean W.T.P.	Florida City	State	86,000	0	29,800,000
4134358	Community	Dade Juvenile Residential Facility	Florida City	Investor	50	0	35,000
4134365	Community	Hialeah Gardens	Hialeah Gardens	Municipality	19,297	0	0
4130048	Noncommunity	Anderson's Corner Grocery	Miami	Investor	35	0	8,000
4130053	Noncommunity	Hightailin' It	Miami	Investor	205	0	28,000
4130112	Noncommunity	Benson Lighting	Miami	Investor	25	0	36,000
4130159	Noncommunity	Brooks (J R) & Son	Homestead	Investor	100	0	80,000
4130320	Noncommunity	Camp Owaissa Bauer	Miami	Municipality	146	0	183,000
4130496	Noncommunity	Franksher Building	Miami	Investor	25	0	64,000
4130721	Noncommunity	Miami Everglades Campground	Miami	Unknown	562	0	122,000

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Table 2.4.12-203 (Sheet 2 of 4)
Public Water Supply Systems in Miami-Dade County

Pws Id	Type	Mailing Name	City	Owner Type	Pop Served	Sells to Pop	Design Cap
4130793	Noncommunity	Deluxe Motel	Leisure City	Investor	50	0	46,000
4130811	Noncommunity	De Leon Harvesting	Homestead	Investor	30	0	36,000
4130823	Noncommunity	Dan Lewis Properties	Miami	Investor	25	0	15,000
4130891	Noncommunity	Roberts Air	Homestead	Municipality	25	0	28,000
4130893	Noncommunity	Dade Homestead Gaa - Admin.	Homestead	Municipality	25	0	3,200
4130894	Noncommunity	Dade Homestead Gaa Skydive	Homestead	Municipality	25	0	6,400
4130897	Noncommunity	Dade Landscape Nursery	Miami	Municipality	40	0	86,000
4130933	Noncommunity	Monkey Jungle	Miami	Investor	300	0	122,000
4130951	Noncommunity	Last Chance Lounge	Florida City	Investor	100	0	5,000
4131080	Noncommunity	Kimre Inc.	Miami	Investor	25	0	17,000
4131185	Noncommunity	Grove Inn	Miami	Investor	25	0	36,000
4131192	Noncommunity	Redland Golf & Country Club	Homestead	Investor	25	0	19,200
4131217	Noncommunity	Cemex Cement Mill	Miami	Investor	130	0	720,000
4131250	Noncommunity	America’s Best Inn	Homestead	Investor	50	0	61,000
4131313	Noncommunity	Silver Palms Methodist Church	Homestead	Other	200	0	36,000
4131961	Noncommunity	Redland Fruit and Spice Park	Miami	County	55	0	46,000
4131962	Noncommunity	Castellow Hammock Park	Miami	County	68	0	1,700
4134228	Noncommunity	Chevron Krome	Homestead	Investor	25	0	5,000
4134234	Noncommunity	Cemex Materials - Sweetwater	Miami	Investor	50	0	5,000
4134237	Noncommunity	Jack’s Bait & Tackle	Florida City	Investor	200	0	3,200
4134301	Noncommunity	Iglesia Buen Samaritano	Miami	Investor	100	0	12,000
4134328	Noncommunity	Diamond R. Fertilizer	Homestead	Investor	40	0	1,000
4134334	Noncommunity	Costa Nursery II	Miami	Investor	25	0	1,000
4134338	Noncommunity	Benito Juarez Park	Homestead	County	100	0	1,700
4134363	Noncommunity	Homestead Jehovah’s Witness	Homestead	Other	100	0	8,000
4134379	Noncommunity	Bernecker’s Nursery	Miami	Investor	25	0	5,000
4134430	Noncommunity	Tom Thumb #122	Miami 33170	Investor	25	0	5,000
4134431	Noncommunity	Redland Exxon	Miami	Investor	25	0	5,000
4134434	Noncommunity	Community Asphalt	Hialeah	Investor	25	0	5,000
4134439	Noncommunity	Cemex-F.E.C. Office	Hialeah	Investor	160	0	3,000
4134442	Noncommunity	Redland Community Church	Miami	Investor	500	0	3,000
4134382	Noncommunity	Butler's Nursery	Miami	Investor	25	0	5,000
4134387	Noncommunity	Coconut Palm Trading Post	Homestead	Investor	300	0	50,000
4134388	Noncommunity	Coffey's Market	Miami	Investor	35	0	5,000
4134393	Noncommunity	Coopertown	Miami	Investor	100	0	5,000
4134394	Noncommunity	Costa Nursery	Miami	Investor	150	0	5,000

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Table 2.4.12-203 (Sheet 3 of 4)
Public Water Supply Systems in Miami-Dade County

Pws Id	Type	Mailing Name	City	Owner Type	Pop Served	Sells to Pop	Design Cap
4134400	Noncommunity	El Nopal	Miami	Investor	25	0	5,000
4134402	Noncommunity	Greenleaf Nursery	Homestead	Investor	25	0	5,000
4134417	Noncommunity	Redland Tavern	Goulds	Investor	40	0	200
4134420	Noncommunity	Safari Restaurant	Miami	Investor	150	0	5,000
4134443	Noncommunity	Comcast Cable	Miami	Other	225	0	3,000
4134446	Noncommunity	Kent Motel	Goulds	Investor	50	0	3,000
4134448	Noncommunity	Palms Professional Center	Miami	Investor	25	0	3,000
4134451	Noncommunity	Farm Credit Service	Homestead Fl 33090	Investor	25	0	2,720
4134453	Noncommunity	Cemex-F.E.C. Shop	Hialeah	Investor	35	0	16,000
4134459	Noncommunity	Circle D Farms	Homestead	Investor	25	0	3,000
4134462	Noncommunity	Redlands Grocery	Homestead	Investor	200	0	3,000
4134464	Noncommunity	Sunrise Adult Group Home (15190)	Homestead	Investor	25	0	3,000
4134465	Noncommunity	Sunrise Adult Services (29800)	Homestead	Investor	80	0	2,000
4134468	Noncommunity	U-Haul Rental & Services	Miami	Investor	25	0	3,000
4134499	Noncommunity	Our Lady of Mercy Cemetery	Doral	Investor	50	0	2,000
4134506	Noncommunity	First Baptist Church Redland	Homestead	Other	120	0	2,000
4134508	Noncommunity	Aviary Bird Shop	Goulds	Investor	25	0	2,000
4134512	Noncommunity	De Leon Bromeliads	Miami	Investor	54	0	5,000
4134516	Noncommunity	Tom Thumb #127	Hialeah	Investor	25	0	24,000
4134519	Noncommunity	Okeechobee Barrier	Miami	State	39	0	9,600
4134522	Noncommunity	1st Baptist Church of Homestead	Homestead	Other	300	0	5,000
4134523	Noncommunity	Women's Club of Homestead	Homestead	Other	25	0	3,300
4134524	Noncommunity	Krome Avenue Church	Miami	Other	150	0	7,200
4134525	Noncommunity	Cemex Hydro-Conduit	Miami	Investor	28	0	1,400
4134527	Noncommunity	Cemex Employees	Miami	Investor	150	0	3,750
4134528	Noncommunity	Fruitcuba	Miami	Investor	50	0	3,200
4134531	Noncommunity	Tom Thumb 131	Homestead	Investor	25	0	1,000
4134532	Noncommunity	Sunoco Krome Ave	Miami	Investor	25	0	5,000
4134533	Noncommunity	Gator Park	Miami	Investor	25	0	3,000
4134535	Noncommunity	Vila & Sons	Medley	Investor	25	0	50
4134537	Noncommunity	Mannheime Foundation	Homestead	Investor	50	0	0
4134538	Noncommunity	Bt South Dba Boody Trap	Homestead	Investor	30	0	120
4134540	Noncommunity	Chevron Gas Station	Miami	Investor	80	0	320

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Table 2.4.12-203 (Sheet 4 of 4)
Public Water Supply Systems in Miami-Dade County

Pws Id	Type	Mailing Name	City	Owner Type	Pop Served	Sells to Pop	Design Cap
4134543	Noncommunity	Schnebly Winery	Homestead	Investor	25	0	4,800
4130322	Nontransient Noncommunity	Redland Jr. High School	Homestead	Municipality	1,496	0	144,000
4130445	Nontransient Noncommunity	Tropical Research & Education Center	Homestead	State	100	0	38,400
4130934	Nontransient Noncommunity	Montessori Country School	Homestead	Investor	120	0	38,000
4131958	Nontransient Noncommunity	Sunrise Community	Miami	Investor	120	0	150,000
4134300	Nontransient Noncommunity	Redland Christian Academy	Homestead	Other	300	0	10,000
4134385	Nontransient Noncommunity	Unitarian Universal Congr'n of Miami	Miami	Investor	75	0	5,000
4134498	Nontransient Noncommunity	Creative Years	Miami	Investor	100	0	2,000
4134502	Nontransient Noncommunity	Christian Family Worship Center	Homestead	Investor	200	0	9,600
4134513	Nontransient Noncommunity	Miami Intl Airport	Miami	County	26,800	0	0
4130900	Noncommunity	Homestead Executive Jet Center	Homestead	Municipality	75	0	3,200
4134520	Noncommunity	Rancho Gaspar	Miami	Investor	90	0	9,600
4134539	Noncommunity	Grandma's U-Pick	Miami	Investor	40	0	1,000
4134547	Noncommunity	Glaser Farms	Miami	Investor	35	0	43,000
4134548	Noncommunity	Sunshine Organic Farms	Miami	Investor	50	0	43,000
4134549	Noncommunity	Robert Is Here	Florida City	Investor	25	0	1,000
4134550	Noncommunity	Coral Reef Driver License Office	Miami	State	100	0	0
4134551	Noncommunity	Tropical Village Farm (Wintergreen NUR)	Miami	Investor	25	0	0
4134553	Noncommunity	United Miami Orchids	Homestead	Investor	40	0	0
4134546	Nontransient Noncommunity	My Little Angels Daycare	Homestead	Investor	100	0	30,000

Pop = Population note
Cap = Capacity
Source: Reference 228

Table 2.4.12-204 (Sheet 1 of 4)
Vertical Hydraulic Gradients

Well Pair	Date/Time	Tide Condition	Upper Screened Interval Midpoint (feet NAVD 88)	Lower Screened Interval Midpoint (feet NAVD 88)	ΔL (feet)	Upper Reference Head (feet NAVD 88)	Lower Reference Head (feet NAVD 88)	ΔL (feet)	Vertical Hydraulic Gradient i (feet/feet)
OW-606U/L	6/29/08 7:00	High	-24.8	-103.5	78.7	-0.55	0.12	0.67	0.008
OW-606U/L	6/29/08 14:00	Low	-24.8	-103.5	78.7	-0.84	-0.17	0.67	0.008
OW-606U/L	8/15/08 10:00	High	-24.8	-103.5	78.7	-0.22	0.34	0.56	0.007
OW-606U/L	8/15/08 17:00	Low	-24.8	-103.5	78.7	-0.64	-0.09	0.54	0.007
OW-606U/L	1/20/09 19:00	High	-24.8	-103.5	78.7	-1.74	-1.27	0.47	0.006
OW-606U/L	1/21/09 2:00	Low	-24.8	-103.5	78.7	-2.36	-1.89	0.47	0.006
OW-606U/L	7/15/09 7:00	High	-24.8	-103.5	78.7	-0.22	0.32	0.54	0.007
OW-606U/L	7/15/09 14:00	Low	-24.8	-103.5	78.7	-0.38	0.16	0.54	0.007
OW-606U/L	6/15/10 2:00	High	-24.8	-103.5	78.7	0.11	0.39	0.29	0.004
OW-606U/L	6/15/10 9:00	Low	-24.8	-103.5	78.7	-0.20	0.08	0.28	0.004
OW-621U/L	6/29/08 7:00	High	-21.8	-103.5	81.7	-0.39	0.81	1.19	0.015
OW-621U/L	6/29/08 14:00	Low	-21.8	-103.5	81.7	-0.70	0.49	1.19	0.015
OW-621U/L	8/15/08 10:00	High	-21.8	-103.5	81.7	-0.04	1.12	1.16	0.014
OW-621U/L	8/15/08 17:00	Low	-21.8	-103.5	81.7	-0.49	0.68	1.17	0.014
OW-621U/L	10/5/08 1:00	High	-21.8	-103.5	81.7	1.22	2.34	1.11	0.014
OW-621U/L	10/5/08 8:00	Low	-21.8	-103.5	81.7	0.75	1.86	1.10	0.013
OW-621U/L	1/20/09 19:00	High	-21.8	-103.5	81.7	-1.58	-0.31	1.28	0.016
OW-621U/L	1/21/09 2:00	Low	-21.8	-103.5	81.7	-2.22	-0.93	1.29	0.016
OW-621U/L	7/15/09 7:00	High	-21.8	-103.5	81.7	0.07	0.49	0.42	0.005
OW-621U/L	7/15/09 14:00	Low	-21.8	-103.5	81.7	-0.10	0.32	0.42	0.005
OW-621U/L	1/15/10 11:00	High	-21.8	-103.5	81.7	0.64	1.07	0.43	0.005
OW-621U/L	1/15/10 18:00	Low	-21.8	-103.5	81.7	0.24	0.66	0.42	0.005
OW-621U/L	6/15/10 2:00	High	-21.8	-103.5	81.7	-0.08	0.43	0.52	0.006
OW-621U/L	6/15/10 9:00	Low	-21.8	-103.5	81.7	-0.41	0.09	0.50	0.006
OW-636U/L	6/29/08 7:00	High	-22.6	-102.5	79.9	-0.32	0.02	0.34	0.004
OW-636U/L	6/29/08 14:00	Low	-22.6	-102.5	79.9	-0.65	-0.28	0.37	0.005

Table 2.4.12-204 (Sheet 2 of 4)
Vertical Hydraulic Gradients

Well Pair	Date/Time	Tide Condition	Upper Screened Interval Midpoint (feet NAVD 88)	Lower Screened Interval Midpoint (feet NAVD 88)	ΔL (feet)	Upper Reference Head (feet NAVD 88)	Lower Reference Head (feet NAVD 88)	ΔL (feet)	Vertical Hydraulic Gradient i (feet/feet)
OW-636U/L	8/15/08 10:00	High	-22.6	-102.5	79.9	0.01	0.35	0.34	0.004
OW-636U/L	8/15/08 17:00	Low	-22.6	-102.5	79.9	-0.43	-0.05	0.38	0.005
OW-636U/L	10/5/08 1:00	High	-22.6	-102.5	79.9	1.20	1.48	0.29	0.004
OW-636U/L	10/5/08 8:00	Low	-22.6	-102.5	79.9	0.72	1.01	0.30	0.004
OW-636U/L	7/15/09 7:00	High	-22.6	-102.5	79.9	0.18	0.46	0.28	0.004
OW-636U/L	7/15/09 14:00	Low	-22.6	-102.5	79.9	0.01	0.29	0.28	0.004
OW-636U/L	1/15/10 11:00	High	-22.6	-102.5	79.9	0.49	1.00	0.51	0.006
OW-636U/L	1/15/10 18:00	Low	-22.6	-102.5	79.9	0.12	0.66	0.54	0.007
OW-636U/L	6/15/10 2:00	High	-22.6	-102.5	79.9	-0.13	0.63	0.76	0.009
OW-636U/L	6/15/10 9:00	Low	-22.6	-102.5	79.9	-0.48	0.29	0.77	0.010
OW-706U/L	1/15/10 11:00	High	-23.5	-106	82.5	0.46	0.95	0.48	0.006
OW-706U/L	1/15/10 18:00	Low	-23.5	-106	82.5	0.23	0.72	0.49	0.006
OW-706U/L	6/15/10 2:00	High	-23.5	-106	82.5	-0.17	0.66	0.84	0.010
OW-706U/L	6/15/10 9:00	Low	-23.5	-106	82.5	-0.34	0.50	0.84	0.010
OW-735U/L	6/29/08 7:00	High	-21.5	-102.6	81.1	-0.12	2.18	2.30	0.028
OW-735U/L	6/29/08 14:00	Low	-21.5	-102.6	81.1	-0.24	2.07	2.31	0.028
OW-735U/L	8/15/08 10:00	High	-21.5	-102.6	81.1	0.15	2.44	2.28	0.028
OW-735U/L	8/15/08 17:00	Low	-21.5	-102.6	81.1	-0.12	2.18	2.30	0.028
OW-735U/L	10/5/08 1:00	High	-21.5	-102.6	81.1	1.48	3.54	2.06	0.025
OW-735U/L	10/5/08 8:00	Low	-21.5	-102.6	81.1	1.26	3.33	2.07	0.025
OW-735U/L	7/15/09 7:00	High	-21.5	-102.6	81.1	0.93	1.21	0.28	0.003
OW-735U/L	7/15/09 14:00	Low	-21.5	-102.6	81.1	0.82	1.10	0.28	0.003
OW-735U/L	1/15/10 11:00	High	-21.5	-102.6	81.1	1.67	2.05	0.38	0.005
OW-735U/L	1/15/10 18:00	Low	-21.5	-102.6	81.1	1.47	1.86	0.39	0.005
OW-735U/L	6/15/10 2:00	High	-21.5	-102.6	81.1	0.62	0.78	0.17	0.002
OW-735U/L	6/15/10 9:00	Low	-21.5	-102.6	81.1	0.47	0.64	0.18	0.002
OW-802U/L	6/15/10 2:00	High	-21.2	-104.2	83.0	-0.43	0.30	0.73	0.009

Table 2.4.12-204 (Sheet 3 of 4)
Vertical Hydraulic Gradients

Well Pair	Date/Time	Tide Condition	Upper Screened Interval Midpoint (feet NAVD 88)	Lower Screened Interval Midpoint (feet NAVD 88)	ΔL (feet)	Upper Reference Head (feet NAVD 88)	Lower Reference Head (feet NAVD 88)	ΔL (feet)	Vertical Hydraulic Gradient i (feet/feet)
OW-802U/L	6/15/10 9:00	Low	-21.2	-104.2	83.0	-0.66	0.08	0.73	0.009
OW-805U/L	6/29/08 7:00	High	-24.6	-91.5	66.9	-0.51	0.45	0.96	0.014
OW-805U/L	6/29/08 14:00	Low	-24.6	-91.5	66.9	-0.86	0.09	0.95	0.014
OW-805U/L	8/15/08 10:00	High	-24.6	-91.5	66.9	-0.18	0.71	0.89	0.013
OW-805U/L	8/15/08 17:00	Low	-24.6	-91.5	66.9	-0.66	0.29	0.95	0.014
OW-805U/L	10/5/08 1:00	High	-24.6	-91.5	66.9	1.03	1.95	0.92	0.014
OW-805U/L	10/5/08 8:00	Low	-24.6	-91.5	66.9	0.52	1.44	0.93	0.014
OW-805U/L	1/20/09 19:00	High	-24.6	-91.5	66.9	-1.69	-0.79	0.90	0.013
OW-805U/L	1/21/09 2:00	Low	-24.6	-91.5	66.9	-2.32	-1.41	0.90	0.013
OW-805U/L	7/15/09 7:00	High	-24.6	-91.5	66.9	-0.08	0.45	0.54	0.008
OW-805U/L	7/15/09 14:00	Low	-24.6	-91.5	66.9	-0.25	0.28	0.54	0.008
OW-805U/L	1/15/10 11:00	High	-24.6	-91.5	66.9	0.59	1.13	0.54	0.008
OW-805U/L	1/15/10 18:00	Low	-24.6	-91.5	66.9	0.15	0.70	0.55	0.008
OW-805U/L	6/15/10 2:00	High	-24.6	-91.5	66.9	0.07	0.49	0.43	0.006
OW-805U/L	6/15/10 9:00	Low	-24.6	-91.5	66.9	-0.29	0.13	0.42	0.006
OW-809U/L	6/29/08 7:00	High	-20.7	-101.4	80.7	-0.42	0.57	0.99	0.012
OW-809U/L	6/29/08 14:00	Low	-20.7	-101.4	80.7	-0.50	0.49	0.99	0.012
OW-809U/L	8/15/08 10:00	High	-20.7	-101.4	80.7	-0.17	0.71	0.88	0.011
OW-809U/L	8/15/08 17:00	Low	-20.7	-101.4	80.7	-0.39	0.49	0.88	0.011
OW-809U/L	10/5/08 1:00	High	-20.7	-101.4	80.7	1.26	2.06	0.80	0.010
OW-809U/L	10/5/08 8:00	Low	-20.7	-101.4	80.7	1.11	1.90	0.79	0.010
OW-809U/L	1/20/09 19:00	High	-20.7	-101.4	80.7	-1.67	-0.89	0.78	0.010
OW-809U/L	1/21/09 2:00	Low	-20.7	-101.4	80.7	-2.28	-1.51	0.77	0.010
OW-809U/L	7/15/09 7:00	High	-20.7	-101.4	80.7	-0.06	0.85	0.91	0.011
OW-809U/L	7/15/09 14:00	Low	-20.7	-101.4	80.7	-0.15	0.75	0.90	0.011
OW-809U/L	6/15/10 2:00	High	-20.7	-101.4	80.7	-0.13	0.70	0.82	0.010
OW-809U/L	6/15/10 9:00	Low	-20.7	-101.4	80.7	-0.19	0.63	0.82	0.010

Table 2.4.12-204 (Sheet 4 of 4)
Vertical Hydraulic Gradients

Well Pair	Date/Time	Tide Condition	Upper Screened Interval Midpoint (feet NAVD 88)	Lower Screened Interval Midpoint (feet NAVD 88)	ΔL (feet)	Upper Reference Head (feet NAVD 88)	Lower Reference Head (feet NAVD 88)	ΔL (feet)	Vertical Hydraulic Gradient i (feet/feet)
OW-812U/L	6/29/08 7:00	High	-20.8	-103.2	82.4	-0.19	0.70	0.89	0.011
OW-812U/L	6/29/08 14:00	Low	-20.8	-103.2	82.4	-0.29	0.58	0.87	0.011
OW-812U/L	8/15/08 10:00	High	-20.8	-103.2	82.4	0.05	0.95	0.89	0.011
OW-812U/L	8/15/08 17:00	Low	-20.8	-103.2	82.4	-0.18	0.71	0.89	0.011
OW-812U/L	7/15/09 7:00	High	-20.8	-103.2	82.4	0.47	0.71	0.24	0.003
OW-812U/L	7/15/09 14:00	Low	-20.8	-103.2	82.4	0.38	0.61	0.24	0.003
OW-812U/L	1/15/10 11:00	High	-20.8	-103.2	82.4	1.27	1.27	0.00	0.000
OW-812U/L	1/15/10 18:00	Low	-20.8	-103.2	82.4	1.12	1.10	-0.01	0.000
OW-812U/L	6/15/10 2:00	High	-20.8	-103.2	82.4	0.09	0.27	0.17	0.002
OW-812U/L	6/15/10 9:00	Low	-20.8	-103.2	82.4	0.02	0.16	0.14	0.002

Δh = Lower Reference Head – Upper Reference Head
ΔL = Lower Screened Interval Midpoint – Upper Screened Interval Midpoint
i = Δh/ΔL (negative value indicates downward flow potential and positive value indicates upward flow potential)
Vertical hydraulic gradients were calculated using the environmental head as discussed in Appendix 2AA.

PTN COL 2.4-4

Table 2.4.12-205
Representative Hydrogeologic Properties in Miami-Dade County[(a)]

Hydrogeologic Unit or Subunit	Hydraulic Conductivity (feet per day)		Porosity	Approximate Depth (feet bgs)	Unit Thickness (feet)
	Horizontal	Vertical			
Biscayne aquifer	1524	15	0.31	0–230	230
Intermediate confining unit	90	0.1–2.38	0.1–0.31	230–840	610
Upper Floridan aquifer	42	0.42–2.38	0.1–0.32	840–2060	1220
Middle confining unit	4.7	0.04–1.50[(b)]	0.1–0.43	2060–2550	490
Lower Floridan aquifer	0.01	0.1	0.1–0.4	2550–2750	200[(c)]
Boulder Zone	6540	65	0.2	2750–>3250	500

(a) Values in this table represent weighted averages for risk assessment for management of treated wastewater and thus may not be representative of actual conditions.
(b) The vertical hydraulic conductivity included here may be two to three orders of magnitude higher than other measurements in South Florida. Reference 247 indicates a vertical hydraulic conductivity range of 3E-04 to 3E-05 feet per day based on core measurements.
(c) The Lower Floridan aquifer extends below the Boulder Zone; the thickness presented is only for the portion above the Boulder Zone.

Adapted from Reference 237

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 1 of 8) Regional Aquifer Properties

Site	Test Type[(a)]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Florida Keys Aqueduct Auth Jr Dean WTP-Florida City[(b)]	APT	10/08/2003 0000	FKAAFCEW 1	818,318	403,673	280	10,790	72	—	880	1,353	—	—	—	Upper Floridan Aquifer	Specific capacity: 15 gpm/ft **Water was blended with raw water from Biscayne aquifer well field and apt initiated as step test to accommodate discharge to sewer system. Initial pump rate of 280 gpm; increased to 500 gpm and 750 gpm for first 24 hours. Rate decreased to 600 gpm for remainder of test as TDS concentration rose at 750 gpm.
Florida Keys Aqueduct Auth Jr Dean WTP-Florida City [(b)]	Packer	07/02/2003 0000	FKAAFCEW 1	818,318	403,673	25	29	—	—	1,050	1,150	—	—	—	Upper Floridan Aquifer	Packer test #1 Specific capacity: 0.3 gpm/ft Salt plug in well was not completely purged prior to start of test- the initial static water level assumed to be the level to which the water level in the drill stem recovered at conclusion of test.

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 2 of 8)
Regional Aquifer Properties

Site	Test Type[(a)]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Florida Keys Aqueduct Auth Jr Dean WTP-Florida City[(b)]	Packer	07/09/2003 0000	FKAAFCEW 1	818,318	403,673	85	—	—	—	1,220	1,283	—	—	—	Upper Floridan Aquifer	Packer test #2 Specific capacity: 12 gpm/ft Parameters not analyzed- no typical pump or recovery curves-water level responded so quickly to the start and stop of test.
Florida Keys Aqueduct Auth Jr Dean WTP-Florida City[(b)]	Packer	07/10/2003 0000	FKAAFCEW 1	818,318	403,673	82	2,200	—	—	1,150	1,213	—	—	—	Upper Floridan Aquifer	Packer test #3 Specific capacity: 3 gpm/ft.
Florida Keys Aqueduct Auth Jr Dean WTP-Florida City[(b)]	Packer	07/22/2003 0000	FKAAFCEW 1	818,318	403,673	60	492	—	—	880	1,040	—	—	—	Upper Floridan Aquifer	Packer test #4 Specific capacity: 2 gpm/ft.
Homestead Airforce Base[(b)]	Step-Draw-down	12/25/1991 0000	G-3314	801,450	426,168	—	1,000,000	—	—	21	48	37,000	—	—	Surficial Aquifer System	Step drawdown test. Limits of the aquifer testing resulted in the transmissivity and conductivity values being greater than the values listed. For example the transmissivity may say 1,000,000 but it was actually 1,000,000+.

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 3 of 8) Regional Aquifer Properties

Site	Test Type[a]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Camp Owaissa-Bauer[b]	Step-Draw-down	12/25/1991 0000	G-3315	833,217	432,443	—	1,000,000	—	—	32	69	27,000	—	—	Surficial Aquifer System	Step drawdown test. Limits of the aquifer testing resulted in the transmissivity and conductivity values being greater than the values listed. For example the transmissivity may say 1,000,000 but it was actually 1,000,000+.
Camp Owaissa-Bauer[b]	Other	12/25/1991 0000	G-3315	833,217	432,443	—	65	—	—	94	111.5	3.7	—	—	Surficial Aquifer System	Specific capacity test.
Levee 31w (At Structure 175)[b]	Other	12/25/1991 0000	G-3319	796,786	394,757	—	1,000,000	—	—	21	39.3	55,000	—	—	Surficial Aquifer System	Step drawdown test. Limits of the aquifer testing resulted in the transmissivity and conductivity values being greater than the values listed. For example the transmissivity may say 1,000,000 but it was actually 1,000,000+.
Naval Station[b]	Other	12/25/1991 0000	G-3320	831,332	399,726	—	1,000,000	—	—	32	80	21,000	—	—	Surficial Aquifer System	Step drawdown test. Limits of the aquifer testing resulted in the transmissivity and conductivity values being greater than the values listed. For example the transmissivity may say 1,000,000 but it was actually 1,000,000+.

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 4 of 8)
Regional Aquifer Properties

Site	Test Type[(a)]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Homestead Airforce Base Well Field 2[(b)]	Specific Capacity	01/01/2000 0000	HAFB-1	852,589	423,035	900	60,000	—	—	—	30	—	—	—	Surficial Aquifer System	Transmissivity value was estimated from specific capacity value. Prepared in cooperation with the SFWMD, this data was compiled from Metro-Dade Water and Sewer Authority or from SFWMD files.
Miami-Dade Water and Sewer Auth. So. District Regional WWTP[(b)]	Packer	08/25/1977 0812	MDWSA_I5	876,304	442,461	50	8.54	0.7	—	2,737	2,759	—	1	—	Boulder Zone	Packer test 1 of 10 Leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional [(b)]	Packer	08/25/1977 1225	MDWSA_I5	876,304	442,461	4	12.47	3.2	—	2,697	2,727	—	—	—	Boulder Zone	Packer test 2 of 10 Pump adjusted to 7.9 gpm at time 1310 and to 23 gpm at time 1424 leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional WWTP[(b)]	Packer	08/25/1977 2317	MDWSA_I5	876,304	442,461	24.5	18.97	3.31	—	2,367	2,397	—	—	—	Boulder Zone	Packer test 3 of 10 (parts 1 & 2)--pumped was stopped at 42 min into pumping at rate of 12.8 gpm (part 1); began pumping again at rate of 24.5 gpm for 2.6 hours--transmissivity is average of the two tests. Leakance was not determined due to very small drawdown in Boulder Zone.

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 5 of 8)
Regional Aquifer Properties

Site	Test Type[(a)]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Miami Dade Water and Sewer Auth. So. District Regional WWTP[(b)]	Packer	08/26/1977 0747	MDWSA_I5	876,304	442,461	61	47.43	1.55	—	2,407	2,759	—	—	—	Boulder Zone	Packer test 4 of 10 Leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional WWTP[(b)]	Packer	08/26/1977 1558	MDWSA_I5	876,304	442,461	42.5	23.98	1.28	—	1,968	1,998	—	—	—	Boulder Zone	Packer test 5 of 10 Leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional WWTP[(b)]	Packer	08/26/1977 1814	MDWSA_I5	876,304	442,461	61	88.48	0.5	—	2,008	2,759	—	—	—	Boulder Zone	Packer test 6 of 10 Leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional WWTP[(b)]	Packer	08/27/1977 1150	MDWSA_I5	876,304	442,461	55	19.38	1.88	—	2,543	2,573	—	—	—	Boulder Zone	Packer test 7 of 10 Leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional WTPP[(b)]	Packer	08/27/1977 1628	MDWSA_I5	876,304	442,461	33	44.17	1.78	—	2,583	2,759	—	—	—	Boulder Zone	Packer test 8 of 10 pumping rate was increased to 60 gpm at time 1733 Leakance was not determined due to very small drawdown in Boulder Zone.

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 6 of 8) Regional Aquifer Properties

Site	Test Type[a]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Miami Dade Water and Sewer Auth. So. District Regional WWTP[b]	Packer	08/28/1977 0130	MDWSA_I5	876,304	442,461	12	35.77	2.8	—	2,692	2,759	—	—	—	Boulder Zone	Packer test 9 of 10 Leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional WWTP[b]	Packer	08/28/1977 0554	MDWSA_I5	876,304	442,461	20	13.01	2.4	—	2,652	2,682	—	—	—	Boulder Zone	Packer test 10 of 10 Leakance was not determined due to very small drawdown in Boulder Zone.
Florida City[b]	Specific Capacity	01/01/2000 0000	S-3051	826,078	407,075	900	220,000	—	—	—	47.5	—	—	—	Surficial Aquifer System	Transmissivity value was estimated from specific capacity value. Prepared in cooperation with the SFWMD, this data was compiled from Metro-Dade Water and Sewer Authority or from SFWMD files.
Florida City[b]	Specific Capacity	01/01/2000 0000	S-3052	825,987	406,974	590	160,000	—	—	40	60	—	—	—	Surficial Aquifer System	Trasmissivity value was estimated from specific capacity value. Prepared in cooperation with the SFWMD, this data was compiled from Metro-Dade Water and Sewer Authority or from SFWMD files.

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 7 of 8) Regional Aquifer Properties

Site	Test Type[a]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Harris Park Power Plant[b]	Specific Capacity	01/01/200 0 0000	S-3060	833,747	414,778	3,000	240,000	4	—	40	60	—	—	—	Surficial Aquifer System	Trasmissivity value was estimated from specific capacity value. Prepared in cooperation with the SFWMD, this data was compiled from Metro-Dade Water and Sewer Authority or from SFWMD files.
Harris Park Power Plant[b]	Specific Capacity	01/01/200 0 0000	S-3061	833,105	41,4775	3,000	110,000	9	—	40	60	—	–	—	Surficial Aquifer System	Trasmissivity value was estimated from specific capacity value. Prepared in cooperation with the SFWMD, this data was compiled from Metro-Dade Water and Sewer Authority or from SFWMD files.
Turkey Point Area – FAS[b]	APT	04/24/200 6 0000	TKPT-PW1	874,572	402,532	4,500	33,062	72	0.0002	1003	1242	—	3	0.005	Upper Floridan Aquifer	Average of results from Hantush-Jacob, leaky confined aquifer solution. Tidal effects negligible.

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 8 of 8)
Regional Aquifer Properties

Site	Test Type[(a)]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Turkey Point Area - FAS[(b)]	APT	10/16/197 4 1000	W-12295	851,079	370,735	5,000	67,750.68	2,160	0.005	1126	1,400	—	5	6.68 E-06	Floridan Aquifer System	Very long-term (90 day) test. Barometric eff. Est. = 100%. Graphical plots of drawdown vs time indicated that despite the very long duration of the test full equilibrium had not been reached. Recommended values based on drawdowns from the furthest observation wells (r=2000' & r=45,000'). Leakance values are based on drawdown in lower monitor zone (so leakance for middle confining unit). Estimated effective porosity = 0.30.
Turkey Point Area[(c)]	APT	06/1971	GH-11 (GH-11B)	864,80	384,465	13,80	401,070	4	0.35	15	50	—	5		Biscayne Aquifer	No apparent tidal influence during the test.
Turkey Point Area [(c)]	APT	06/1971	GH-14 (GH-14A)	873,673	400,465	1,380	133,690	4	0.35	15	40	—	6		Biscayne Aquifer	Tidal fluctuations observed during the test.
Turkey Point Area[(c)]	APT	06/1971	GH-14 (GH-14B)	873,673	400,465	1,380	200,535	2	0.2	15	50	—	6	—	Biscayne Aquifer	Tidal fluctuations observed during the test.

(a) APT = Aquifer pumping test
(b) Reference 233
(c) Reference 238
FAS = Floridan aquifer system

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 1 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maximum Horizontal	Horizontal 90°	Vertical				
G-3672	16	20	4	HFC5	0.69	NM	NM	NM	27.4	2.68	core plug	1
G-3672	17	20	3	HFC5	96.3	NM	NM	NM	33.9	2.68	core plug	1
G-3672	18.25–18.75	20	1.5	HFC5	175	NM	NM	NM	37.0	2.66	core plug	1
G-3673	17–17.5	20	2.75	HFC5	654	NM	NM	NM	37.1	2.66	core plug	1
G-3674	4.25–5	10	5.63	HFC5	515	NM	NM	NM	37.5	2.67	core plug	1
G-3675	4.25–4.5	8	3.62	HFC5	98.1	NM	NM	NM	22.0	2.69	core plug	1
G-3675	4.5–5	8	3.25	HFC5	599	NM	NM	NM	29.5	2.67	core plug	1
G-3711	4	10	6	HFC5	NM	25,764	12,875	13,372	46.7	2.69	whole core	1
G-3712	6.21	10	3.79	HFC5	NM	NM	NM	14,159	47.8	2.70	whole core	1
G-3714	9.46	13	3.54	HFC5	NM	NM	NM	9,494	49.3	2.67	whole core	1
G-3770	4.05–4.22	6.7	2.61	HFC5	NM	4,564	1,531	7,099	41.6	2.66	whole core	2
G-3778	8.46–8.73	16.4	7.76	HFC5	NM	1,684	79	220	40.4	2.70	whole core	2
G-3778	9.4–9.67	16.4	6.82	HFC5	NM	11,659	10,201	1,990	45.4	2.70	whole core	2
G-3778	9.92–10.11	16.4	6.39	HFC5	NM	1,116	966	14,750	46.1	2.70	whole core	2
G-3778	11.03–11.24	16.4	5.27	HFC5	NM	19,355	19,355	2,291	41.6	2.67	whole core	2
G-3778	13.08–13.48	16.4	3.12	HFC5	NM	10,178	9,159	3,605	43.2	2.69	whole core	2
G-3778	13.48–13.90	16.4	2.71	HFC5	NM	8,638	5,757	6,157	43.2	2.69	whole core	2
G-3778	13.90–14.28	16.4	2.31	HFC5	NM	10,356	10,356	3,727	44.7	2.69	whole core	2
G-3778	14.28–14.70	16.4	1.91	HFC5	NM	8,357	7,312	2,687	44.7	2.68	whole core	2
G-3778	15.03–15.36	16.4	1.21	HFC5	NM	10,155	8,884	6,520	45.9	2.71	whole core	2
G-3779	14.93–15.26	16.2	1.07	HFC5	NM	2,703	2,101	2,121	47.0	2.72	whole core	2
G-3779	15.26–15.55	16.2	0.8	HFC5	NM	4,178	4,178	2,107	46.7	2.72	whole core	2
G-3779	15.75–15.96	16.2	0.35	HFC5	NM	17,818	9,646	1,347	44.2	2.70	whole core	2
G-3779	16.25–16.63	16.2	–0.23	HFC5	NM	7,566	3,360	3,195	45.5	2.72	whole core	2
G-3779	16.63–17.09	16.2	–0.66	HFC5	NM	7,805	6,829	2,973	47.6	2.72	whole core	2

Table 2.4.12-207 (Sheet 2 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

PTN COL 2.4-4

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[a]	Sample Type	Source
					Steady State	Maximum Horizontal	Horizontal 90°	Vertical				
G-3779	17.51–17.93	16.2	–1.52	HFC5	NM	6,717	4,797	3,023	44.3	2.71	whole core	2
G-3779	17.93–18.39	16.2	–1.96	HFC5	NM	7,101	4,436	2,239	44.4	2.71	whole core	2
G-3779	18.39–18.77	16.2	–2.38	HFC5	NM	8,022	5,728	2,168	44.5	2.70	whole core	2
G-3791	6.42–6.8	8	1.39	HFC5	NM	10,733	10,733	4,357	44.5	2.71	whole core	2
G-3791	7.05–7.38	8	0.78	HFC5	NM	12,695	12,695	4,423	49.4	2.69	whole core	2
G-3794	6.68–7.10	9	2.11	HFC5	NM	2,257	1544	2,044	42.6	2.70	whole core	2
G-3675	6.0	8	2.00	HFC4	NM	9,080	2054	NM	34.7	2.70	whole core	1
G-3683	12.5	12	–0.5	HFC4	NM	13.8	2.56	11.3	16.7	2.72	whole core	1
G-3689	15.3	9	–6.3	HFC4	NM	950	337	0.03	18.6	2.72	whole core	1
G-3692	10.8	9	–1.8	HFC4	221.32	NM	NM	NM	23.3	2.71	core plug	1
G-3694	16	10	–6	HFC4	NM	83.2	42.5	11.8	17.3	2.71	whole core	1
G-3696	19	10	–9	HFC4	NM	1,035	680	5,624	12.5	2.71	whole core	1
G-3697	12.9	9	–3.9	HFC4	NM	0.67	0.5	0.18	18.9	2.72	whole core	1
G-3697	13	9	–4	HFC4	NM	18.2	0.05	0.02	8.3	2.72	whole core	1
G-3713	9.28	10	0.72	HFC4	NM	2,204	1835	922	27.3	2.70	whole core	1
G-3717	11.75	9	–2.75	HFC4	NM	7,017	4302	248	11.0	2.69	whole core	1
G-3721	9.75	10	0.25	HFC4	NM	82.5	21.1	10.6	16.4	2.70	whole core	1
G-3725	9.92	6	–3.92	HFC4	NM	6,964	3731	758	14.8	2.69	whole core	1
G-3730	9	6	–3	HFC4	NM	1,319	47.3	262	13.7	2.68	whole core	1
G-3731	9.67	6.7	–2.97	HFC4	NM	144	0.03	201	5.9	2.69	whole core	1
G-3770	4.38-4.59	6.7	2.22	HFC4	NM	2	0.3	0.02	10.1	2.70	whole core	2
G-3770	4.76-5.01	6.7	1.82	HFC4	NM	1,067	949	1090	27.3	2.69	whole core	2
G-3771	6.85-7.1	6	–0.98	HFC4	NM	0.04	0.04	13,108	15.0	2.68	whole core	2
G-3771	7.1–7.4	6	–1.25	HFC4	NM	831	215	2,463	10.1	2.68	whole core	2
G-3771	7.4–7.7	6	–1.55	HFC4	NM	0.02	0.02	0.01	7.8	2.68	whole core	2
G-3771	7.8–8.1	6	–1.95	HFC4	NM	694	600	1	16.9	2.68	whole core	2

Table 2.4.12-207 (Sheet 3 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

PTN COL 2.4-4

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[a]	Sample Type	Source
					Steady State	Maximum Horizontal	Horizontal 90°	Vertical				
G-3789	10.29–10.46	8	–2.38	HFC4	NM	10,040	7529	2,118	37.2	2.73	whole core	2
G-3790	11.6-11.85	8	–3.72	HFC4	NM	11,017	9,442	1,727	16.8	2.70	whole core	2
G-3790	17.43–17.72	8	–9.58	HFC4	NM	43	28	31	11.2	2.69	whole core	2
G-3790	18.17–18.42	8	–10.3	HFC4	NM	708	567	359	15.0	2.70	whole core	2
G-3790	18.55–18.71	8	–10.63	HFC4	NM	3,813	1,670	997	26.0	2.72	whole core	2
G-3791	14.11-14.36	8	–6.24	HFC4	NM	734	291	1,750	21.6	2.68	whole core	2
G-3791	15.45–15.68	8	–7.56	HFC4	NM	560	453	255	24.6	2.69	whole core	2
G-3792	13.15–13.35	8	–5.25	HFC4	NM	1	0.05	0.01	6.9	2.69	whole core	2
G-3794	6.82–7.09	9	2.04	HFC4	NM	31	19	16	16.1	2.71	whole core	2
G-3794	7.42–7.67	9	1.46	HFC4	NM	799	671	348	21.4	2.71	whole core	2
G-3794	8.65–8.92	9	0.22	HFC4/3	NM	366	40	19	13.1	2.70	whole core	2
G-3794	9.38–9.63	9	–0.5	HFC4	NM	869	810	391	16.2	2.72	whole core	2
G-3672	20.5	20	–0.5	HFC3	NM	750	280	0.2	13.5	2.75	whole core	1
G-3672	24	20	-4	HFC3	3098	NM	NM	NM	32.1	2.71	core plug	1
G-3673	20-20.75	20	-0.38	HFC3	1,699	NM	NM	NM	19.1	2.70	core plug	1
G-3673	23.5-24	20	-3.75	HFC3	3,704	NM	NM	NM	30.9	2.68	core plug	1
G-3673	24.5-25	20	-4.75	HFC3	80.6	NM	NM	NM	14.6	2.71	core plug	1
G-3673	27.25-27.75	20	-7.5	HFC3	4,657	NM	NM	NM	28.8	2.70	core plug	1
G-3673	30.75-31.25	20	-11	HFC3	9,443	NM	NM	NM	20.6	2.69	core plug	1
G-3673	32–32.3	20	–12.15	HFC3	10.1	NM	NM	NM	19.3	2.68	core plug	1
G-3674	15.5–6	10	–5.75	HFC3	5,222	NM	NM	NM	27.4	2.69	core plug	1
G-3674	18	10	-8	HFC3	NM	2,428	1,582	0.05	21.0	2.70	whole core	1
G-3674	18.5–19	10	–8.75	HFC3	0.01	NM	NM	NM	20.8	2.70	core plug	1
G-3675	8	8	0	HFC3	NM	856	847	0.52	21.3	2.70	whole core	1
G-3675	9–9.5	8	–1.25	HFC3	112	NM	NM	NM	21.4	2.70	core plug	1
G-3678	23.3	9	–14.3	HFC3	NM	3,758	1,754	8,662	19.7	2.71	whole core	1

Table 2.4.12-207 (Sheet 4 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

PTN COL 2.4-4

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maximum Horizontal	Horizontal 90°	Vertical				
G-3679	14.6	9	–5.6	HFC3	8,818	NM	NM	NM	46.6	2.71	core plug	1
G-3679	15.6	9	–6.6	HFC3	NM	3,410	1,101	14000	20.9	2.71	whole core	1
G-3681	15.6	9	–6.6	HFC3	NM	20.1	2.56	0.72	12.8	2.72	whole core	1
G-3688	13.3	9.5	–3.8	HFC3	NM	0.15	0.07	<0.01	6.5	2.71	whole core	1
G-3689	28.5	9	-19.5	HFC3	NM	19,323	19,323	15,112	25.8	2.72	whole core	1
G-3690	11.7	9	-2.7	HFC3	NM	202	20.8	235	10.2	2.73	whole core	1
G-3691	22.3	8	–14.3	HFC3	NM	6,501	4,332	7,474	32.4	2.71	whole core	1
G-3695	15.5	9.5	–6	HFC3	NM	0.14	0.11	0.02	10.6	2.70	whole core	1
G-3695	20	9.5	–10.5	HFC3	NM	58.5	13.7	532	16.7	2.72	whole core	1
G-3696	19.5	10	–9.5	HFC3	NM	355	291	0.12	13.9	2.71	whole core	1
G-3710	19.25	10	–9.25	HFC3	NM	11,227	11,227	12,900	22.6	2.72	whole core	1
G-3710	24.33	10	–14.33	HFC3	NM	1,315	998	9,754	14.7	2.71	whole core	1
G-3710	26.3	10	–16.3	HFC3	34400	NM	NM	NM	35.2	2.72	core plug	1
G-3711	27.33	10	–17.33	HFC3	NM	1,031	1,007	6.18	25.9	2.71	whole core	1
G-3713	22.5	10	–9.83	HFC3	NM	27.5	0.18	840	16.0	2.71	whole core	1
G-3713	23.75	10	–13.75	HFC3	NM	31,148	29,419	8,171	32.3	2.72	whole core	1
G-3714	18.83	9	–9.83	HFC3	NM	13,356	11,685	11,642	36.6	2.71	whole core	1
G-3715	16.88	9	–7.88	HFC3	NM	2,606	1,968	2,226	31.1	2.71	whole core	1
G-3717	20.29	9	–11.29	HFC3	NM	20,592	18,303	13,217	23.4	2.71	whole core	1
G-3717	21.25	9	–12.25	HFC3	NM	16.3	10.5	92.3	20.3	2.70	whole core	1
G-3717	23.58	9	–14.58	HFC3	NM	8,458	4,229	12,213	21.8	2.70	whole core	1
G-3719	8.75	9	0.25	HFC3	NM	4.1	0.12	4.13	10.4	2.71	whole core	1
G-3719	14.57	9	–5.57	HFC3	NM	8,067	6,054	8,532	34.8	2.72	whole core	1
G-3720	18.71	9	–9.71	HFC3	NM	16,478	16,478	11,878	38.0	2.73	whole core	1
G-3722	15.62	10	–5.62	HFC3	NM	1,867	1,787	2,273	37.1	2.65	whole core	1
G-3722	17.33	10	–7.33	HFC3	NM	5,263	4,426	7,190	41.7	2.72	whole core	1

Table 2.4.12-207 (Sheet 5 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

PTN COL 2.4-4

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maximum Horizontal	Horizontal 90°	Vertical				
G-3724	9.67	9	–0.67	HFC3	NM	673	597	404	12.6	2.69	whole core	1
G-3724	14.08	9	–5.08	HFC3	NM	18,308	7,891	5,100	44.6	2.72	whole core	1
G-3725	18.83	6	–12.83	HFC3	NM	12,191	8,125	6,354	41.1	2.72	whole core	1
G-3728	9	7	–2	HFC3	NM	1,200	1,200	607	20.5	2.70	whole core	1
G-3730	21.58	6	–15.58	HFC3	NM	8,452	6,500	15,894	15.5	2.70	whole core	1
G-3731	11.75	10	–1.75	HFC3	NM	2,595	1,842	1,839	31.0	2.71	whole core	1
G-3734	9.13	8	–1.13	HFC3	NM	15.5	10.9	20.2	13.1	2.70	whole core	1
G-3770	9–9.29	6.7	–2.45	HFC3	NM	0.2	0.03	0.02	12.5	2.70	whole core	2
G-3770	9.46–9.67	6.7	–2.86	HFC3	NM	20	11	167	14.9	2.69	whole core	2
G-3770	9.94–10.23	6.7	–3.39	HFC3	NM	1,345	1,125	1142	22.7	2.69	whole core	2
G-3770	10.86–11.19	6.7	–4.32	HFC3	NM	1,637	1,059	648	26.4	2.70	whole core	2
G-3770	13.9–14.34	6.7	–7.42	HFC3	NM	2,389	2,296	20,140	46.8	2.70	whole core	2
G-3770	14.34–14.74	6.7	–7.84	HFC3	NM	3,471	2,726	18,802	45.8	2.70	whole core	2
G-3770	14.74-15.07	6.7	–8.2	HFC3	NM	3,389	3,389	17,827	48.3	2.70	whole core	2
G-3770	18.49-–8.78	6.7	–11.94	HFC3	NM	3,278	3,278	13,992	26.6	2.69	whole core	2
G-3771	8.60–8.85	6	–2.72	HFC3	NM	5	0.2	258	12.2	2.69	whole core	2
G-3771	8.85–9.1	6	–2.98	HFC3	NM	1,511	1151	3,152	15.7	2.68	whole core	2
G-3771	9.5–9.77	6	–3.64	HFC3	NM	263	188	194	14.5	2.69	whole core	2
G-3771	9.89–10.1	6	–4	HFC3	NM	1,717	1,552	1,277	19.7	2.69	whole core	2
G-3771	10.23–10.56	6	–4.4	HFC3	NM	667	601	370	19.7	2.69	whole core	2
G-3771	10.56–10.85	6	–4.7	HFC3	NM	2,350	2,268	13,272	29.7	2.68	whole core	2
G-3771	11.15–11.4	6	–5.28	HFC3	NM	329	270	317	24.1	2.70	whole core	2
G-3771	11.65–11.94	6	–5.8	HFC3	NM	1,427	1,366	363	25.9	2.70	whole core	2
G-3771	12.52–12.71	6	–6.62	HFC3	NM	2,459	2,346	8,483	25.2	2.70	whole core	2
G-3771	12.98–13.19	6	–7.08	HFC3	NM	1,528	1,251	4,877	26.9	2.71	whole core	2
G-3771	13.60–13.89	6	–7.74	HFC3	NM	3,391	3,391	14,564	40.3	2.73	whole core	2

Table 2.4.12-207 (Sheet 6 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

PTN COL 2.4-4

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maximum Horizontal	Horizontal 90°	Vertical				
G-3771	14.06–14.4	6	–8.23	HFC3	NM	2,731	1,306	16,468	42.1	2.72	whole core	2
G-3771	16.5-16.85	6	–10.68	HFC3	NM	2,783	2,783	15,965	17.6	2.69	whole core	2
G-3771	16.88–17.09	6	–10.98	HFC3	NM	3,427	3,182	9,885	17.6	2.69	whole core	2
G-3778	15.86–16.15	16.4	0.4	HFC3	NM	0.02	0.001	0.001	7.2	2.70	whole core	2
G-3778	16.15–16.44	16.4	0.1	HFC3	NM	0.02	0.02	0.3	6.1	2.71	whole core	2
G-3778	16.69–16.82	16.4	–0.36	HFC3	NM	19	0.3	8	7.2	2.73	whole core	2
G-3778	17.24–17.59	16.4	–1.02	HFC3	NM	2,713	2,469	301	19.3	2.70	whole core	2
G-3778	26.01–26.18	16.4	–9.7	HFC3	NM	NM	NM	1,569	48.4	2.75	whole core	2
G-3778	31.06–31.16	16.4	–14.71	HFC3	NM	11,797	5,363	951	39.7	2.75	whole core	2
G-3778	31.75–31.65	16.4	–15.3	HFC3	NM	22,704	22,704	2,213	40.8	2.73	whole core	2
G-3778	35-35.17	16.4	–18.68	HFC3	NM	3,993	2,966	2,253	41.5	2.71	whole core	2
G-3778	35.54-35.87	16.4	–19.3	HFC3	NM	217	4	602	24.3	2.70	whole core	2
G-3779	21.6-21.85	16.2	–5.52	HFC3	NM	0.001	0.001	0.001	5.5	2.71	whole core	2
G-3779	21.95-22.25	16.2	5.9	HFC3	NM	0.2	0.02	0.3	7.1	2.71	whole core	2
G-3779	24.38-24.57	16.2	–8.28	HFC3	NM	5,268	4,811	1,652	46.9	2.79	whole core	2
G-3779	25.53-26.03	16.2	–9.58	HFC3	NM	7,228	6,424	4,169	50.2	2.81	whole core	2
G-3779	26.95-27.18	16.2	–10.86	HFC3	NM	14,754	NM	2,103	45.5	2.76	whole core	2
G-3779	35.06-35.37	16.2	–19.02	HFC3	NM	9,319	6,211	3,806	28.1	2.72	whole core	2
G-3789	13.68-13.93	8	–5.8	HFC3	NM	2,470	1,082	159	8.6	2.70	whole core	2
G-3789	14.59-14.76	8	–6.68	HFC3	NM	7,529	6,694	1,333	31.4	2.72	whole core	2
G-3789	15.85-16.08	8	–7.96	HFC3	NM	1,249	1,067	512	26.0	2.71	whole core	2
G-3789	19.63-19.94	8	–11.78	HFC3	NM	12,974	12,974	3,645	31.1	2.74	whole core	2
G-3789	20.15-20.44	8	–12.3	HFC3	NM	12,213	10,855	2,566	21.5	2.72	whole core	2
G-3789	20.86-21.24	8	–13.05	HFC3	NM	5,315	4,961	3,274	32.6	2.74	whole core	2
G-3789	21.49-21.93	8	–13.71	HFC3	NM	4,336	3,716	4,770	29.3	2.74	whole core	2
G-3789	22.06-22.56	8	–14.31	HFC3	NM	7,484	6,235	4,189	33.5	2.75	whole core	2

Table 2.4.12-207 (Sheet 7 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

PTN COL 2.4-4

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-mum Hori-zontal	Hori-zontal 90°	Vertical				
G-3789	25.32-25.47	8	–17.4	HFC3	NM	54	1	1,578	17.9	2.71	whole core	2
G-3790	22.79-23	8	–14.9	HFC3	NM	4,478	4,277	507	27.0	2.73	whole core	2
G-3790	24-24.33	8	–16.16	HFC3	NM	10,076	7,195	2,084	27.7	2.73	whole core	2
G-3790	31.5-31.88	8	-–3.69	HFC3	NM	2,566	1,970	2,765	30.2	2.72	whole core	2
G-3790	31.88–32.25	8	–24.19	HFC3/2	NM	3,335	3,160	3,661	32.6	2.72	whole core	2
G-3791	16.06–16.28	8	–8.17	HFC3	NM	0.02	0.02	0.02	12.7	2.69	whole core	2
G-3791	16.47–16.80	8	–8.64	HFC3	NM	476	0.2	7	14.7	2.70	whole core	2
G-3791	19.3–19.59	8	–11.74	HFC3	NM	5,258	4,343	2,439	29.7	2.71	whole core	2
G-3791	23.28–23.74	8	–15.51	HFC3	NM	4,338	4,049	3,037	30.0	2.72	whole core	2
G-3791	24.41–24.66	8	–16.54	HFC3	NM	15,535	13,980	2,858	30.0	2.72	whole core	2
G-3791	24.91–25.24	8	–17.08	HFC3	NM	8,994	8,994	3,097	32.7	2.72	whole core	2
G-3791	27.93–28.30	8	–20.1	HFC3	NM	10,831	10,831	4,639	29.6	2.72	whole core	2
G-3791	29.25–29.67	8	–21.46	HFC3	NM	6,663	3,805	4,054	19.7	2.70	whole core	2
G-3792	14.41–14.58	8	–6.5	HFC3	NM	4,247	4,106	769	17.4	2.70	whole core	2
G-3793	6.98–7.27	10	2.88	HFC3	NM	283	271	463	13.6	2.71	whole core	2
G-3794	12.7–12.89	9	–3.8	HFC3	NM	5,268	2,401	533	20.2	2.71	whole core	2
G-3794	17.63–18.01	9	–8.82	HFC3	NM	10,356	692	1,032	12.8	2.71	whole core	2
G-3794	20.18–20.60	9	–11.39	HFC3	NM	4,333	3,999	1,930	23.2	2.70	whole core	2
G-3673	46.5–47.25	20	–26.88	HFC2	<0.01	NM	NM	NM	12.8	2.69	core plug	1
G-3674	26.5–27	10	–16.75	HFC2	5,011	NM	NM	NM	19.6	2.70	core plug	1
G-3675	20.4	20	–0.4	HFC2	<0.01	NM	NM	NM	6.6	2.68	core plug	1
G-3675	23.5	8	–15.5	HFC2	NM	0.12	0.06	<0.01	11.3	2.69	whole core	1
G-3675	24.5–25	8	–16.75	HFC2	5027	NM	NM	NM	22.9	2.68	core plug	1
G-3675	31.75–32	8	–23.88	HFC2	<0.01	NM	NM	NM	12.5	2.70	core plug	1
G-3675	50.75–51	8	–42.88	HFC2	1688	NM	NM	NM	27.8	2.68	core plug	1
G-3679	28.3	9	–19.3	HFC2	0.3	NM	NM	NM	25.7	2.72	core plug	1

Table 2.4.12-207 (Sheet 8 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

PTN COL 2.4-4

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-mum Hori-zontal	Hori-zontal 90°	Vertical				
G-3681	43.3	9	–34.3	HFC2	NM	0.08	0.05	0.02	11.6	2.72	whole core	1
G-3685	28.5	9	–19.5	HFC2	NM	10.6	0.71	1,949	13.9	2.71	whole core	1
G-3690	22	9	–13	HFC2	NM	670	638	711	13.8	2.71	whole core	1
G-3697	27.5	9	–18.5	HFC2	NM	0.45	0.4	0.16	23.2	2.72	whole core	1
G-3710	30.33	10	–20.33	HFC2	NM	4,754	1,357	92.5	33.7	2.72	whole core	1
G-3718	24.4	9	–15.4	HFC2	9.49	NM	NM	NM	24.1	2.72	core plug	1
G-3718	24.38	9	–15.38	HFC2	NM	47	11.3	179	24.3	2.70	whole core	1
G-3720	22	9	–13	HFC2	NM	7.33	0.61	10,875	17.0	2.71	whole core	1
G-3721	20.5	10	–10.5	HFC2	NM	0.14	0.04	0.62	20.5	2.81	whole core	1
G-3722	29.42	10	–19.42	HFC2	NM	9,580	6,385	9,704	25.2	2.70	whole core	1
G-3727	23.29	8	–14.29	HFC2	NM	0.19	0.14	0.01	15.2	2.71	whole core	1
G-3729	24.12	6	–18.12	HFC2	NM	4.51	1.03	570	21.8	2.71	whole core	1
G-3731	30.71	10	-20.71	HFC2	NM	7.23	0.53	10,038	18.2	2.72	whole core	1
G-3732	25.5	6	–19.5	HFC2	NM	28.7	22.9	206	11.5	2.71	whole core	1
G-3734	24	8	–16	HFC2	NM	667	332	17,567	23.4	2.72	whole core	1
G-3733	46.25-46.44	6	–40.34	HFC2	NM	138	94	66	17.4	2.70	whole core	2
G-3733	48.63-48.79	6	–42.71	HFC2	NM	101	18	202	23.6	2.71	whole core	2
G-3733	49.04-49.42	6	–43.23	HFC2	NM	3,932	2,449	59	26.1	2.70	whole core	2
G-3733	49.67-49.92	6	–43.8	HFC2	NM	1,432	249	112	21.7	2.70	whole core	2
G-3770	20.5-20.79	6.7	–13.94	HFC2	NM	3,830	3,458	13,701	34.2	2.70	whole core	2
G-3770	24.26-24.47	6.7	–17.66	HFC2	NM	11,232	11,232	10,294	47.7	2.70	whole core	2
G-3770	25.03-25.34	6.7	–18.48	HFC2	NM	5,616	5,616	14,886	32.6	2.70	whole core	2
G-3770	25.63-25.92	6.7	–19.08	HFC2	NM	1,742	1,421	12,891	24.9	2.71	whole core	2
G-3770	29.47-29.87	6.7	–22.97	HFC2	NM	361	2	18,551	22.2	2.71	whole core	2
G-3770	30.04-30.27	6.7	-23.46	HFC2	NM	3,073	1,634	10,694	28.9	2.70	whole core	2
G-3770	37.69-38.02	6.7	-31.16	HFC2	NM	4,917	4,917	7,419	35.1	2.70	whole core	2

Table 2.4.12-207 (Sheet 9 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

PTN COL 2.4-4

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[a]	Sample Type	Source
					Steady State	Maxi-mum Hori-zontal	Hori-zontal 90°	Vertical				
G-3770	40.93-41.28	6.7	-34.4	HFC2	NM	4,470	2,037	5,524	30.8	2.68	whole core	2
G-3770	44.88–45.21	6.7	–38.34	HFC2	NM	NM	0.6	NM	30.7	2.69	whole core	2
G-3770	45.4–45.63	6.7	–38.82	HFC2	NM	7,375	3,361	2,481	27.8	2.70	whole core	2
G-3770	50.9–51.13	6.7	–44.32	HFC2	NM	0.2	0.2	3	17.0	2.70	whole core	2
G-3770	51.3–51.72	6.7	–44.81	HFC2	NM	14	0.2	0.1	17.7	2.71	whole core	2
G-3770	51.72–52.14	6.7	–45.23	HFC2	NM	0.2	0.1	0.1	16.6	2.69	whole core	2
G-3770	52.29–52.62	6.7	–45.76	HFC2	NM	20	0.3	0.1	21.1	2.70	whole core	2
G-3771	18.0–18.38	6	–12.19	HFC2	NM	983	248	5	19.2	2.71	whole core	2
G-3771	18.38–18.67	6	–12.52	HFC2	NM	18	0.07	1	18.6	2.71	whole core	2
G-3771	18.67–19.02	6	–12.84	HFC2	NM	10	0.5	1,925	23.3	2.71	whole core	2
G-3771	19.29–19.64	6	–13.46	HFC2	NM	2,135	813	16,070	24.6	2.70	whole core	2
G-3771	19.64–20.02	6	–13.83	HFC2	NM	11,534	11,534	15,745	24.9	2.70	whole core	2
G-3771	20.15–20.48	6	–14.32	HFC2	NM	11,316	11,316	16,068	31.7	2.71	whole core	2
G-3771	20.61–20.98	6	–14.8	HFC2	NM	10,615	10,615	17,158	30.3	2.71	whole core	2
G-3771	25.77–26.14	6	–19.96	HFC2	NM	10,341	5,168	17,428	15.9	2.70	whole core	2
G-3771	27.94–28.27	6	–22.1	HFC2	NM	11,646	11,646	15,674	25.9	2.70	whole core	2
G-3771	29.57–29.84	6	–23.7	HFC2	NM	1	0.04	1	13.1	2.71	whole core	2
G-3771	29.84–30.07	6	–23.96	HFC2	NM	0.04	0.04	0.5	13.2	2.71	whole core	2
G-3771	30.42–30.57	6	–24.5	HFC2	NM	0.2	0.1	634	13.8	2.69	whole core	2
G-3771	30.61–30.76	6	–24.68	HFC2	NM	7	0.3	2,057	17.5	2.70	whole core	2
G-3771	31.58–31.91	6	–25.74	HFC2	NM	527	41	787	20.1	2.69	whole core	2
G-3771	32.16–32.41	6	–26.28	HFC2	NM	7,887	7,887	5,732	22.7	2.70	whole core	2
G-3771	32.7–32.95	6	–26.82	HFC2	NM	215	37	456	17.3	2.70	whole core	2
G-3771	32.95–33.24	6	–27.1	HFC2	NM	314	70	492	18.5	2.71	whole core	2
G-3771	33.24–33.53	6	–27.38	HFC2	NM	6,446	6,446	7,001	17.7	2.71	whole core	2
G-3771	34.18–34.47	6	–28.32	HFC2	NM	14,112	14,112	6,410	34.9	2.71	whole core	2

Table 2.4.12-207 (Sheet 10 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

PTN COL 2.4-4

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maximum Horizontal	Horizontal 90°	Vertical				
G-3771	40.49–40.72	6	–34.6	HFC2	NM	922	665	749	25.1	2.71	whole core	2
G-3771	40.91-41.12	6	–35.02	HFC2	NM	NM	76	NM	30.2	2.72	whole core	2
G-3771	47.93–48.03	6	–41.98	HFC2	NM	4	1	81	22.2	2.70	whole core	2
G-3771	48.23–48.52	6	–42.38	HFC2	NM	315	70	394	27.6	2.72	whole core	2
G-3771	49.06–49.27	6	–43.16	HFC2	NM	109	49	38	29.2	2.71	whole core	2
G-3771	49.27–49.5	6	–43.38	HFC2	NM	4,106	2,878	803	31.0	2.71	whole core	2
G-3771	49.65–49.88	6	–43.76	HFC2	NM	5,789	5,789	5,235	34.3	2.71	whole core	2
G-3771	50.09–50.15	6	–44.12	HFC2	NM	4,550	3,327	136	25.7	2.71	whole core	2
G-3778	38.6–38.88	16.4	–22.34	HFC2	NM	109	80	100	38.5	2.71	whole core	2
G-3778	39.2–39.37	16.4	–22.88	HFC2	NM	87	81	273	35.6	2.72	whole core	2
G-3778	40.96–41.25	16.4	–24.7	HFC2	NM	5,985	5,129	4,145	42.6	2.73	whole core	2
G-3778	52.27–52.52	16.4	–36	HFC2	NM	2,726	1,890	2,321	21.3	2.71	whole core	2
G-3778	54.16–54.43	16.4	–37.9	HFC2	NM	28	4	588	22.2	2.71	whole core	2
G-3778	55.13–55.23	16.4	–38.78	HFC2	NM	77	42	310	20.0	2.72	whole core	2
G-3778	59.2–59.47	16.4	–42.94	HFC2	NM	20,467	20,467	2,452	23.5	2.70	whole core	2
G-3778	59.8–60.05	16.4	–43.52	HFC2	NM	18,720	18,720	3,490	21.5	2.70	whole core	2
G-3779	46.8–46.97	16.2	–30.68	HFC2	NM	114	91	574	37.1	2.73	whole core	2
G-3779	47.39–47.6	16.2	–31.3	HFC2	NM	358	26	801	35.4	2.75	whole core	2
G-3779	47.6–47.81	16.2	–31.5	HFC2	NM	873	680	57	36.0	2.73	whole core	2
G-3779	49.18–49.31	16.2	–33.04	HFC2	NM	4,595	3,201	1,682	29.6	2.72	whole core	2
G-3779	49.5–49.63	16.2	–33.36	HFC2	NM	10,813	7,053	893	25.6	2.73	whole core	2
G-3779	49.88–50.07	16.2	–33.78	HFC2	NM	2,137	2,137	1,647	32.2	2.73	whole core	2
G-3779	52.19–52.57	16.2	–36.18	HFC2	NM	2,165	1,866	4,821	16.8	2.71	whole core	2
G-3779	54.3–54.68	16.2	–38.26	HFC2	NM	49	33	365	24.1	2.72	whole core	2
G-3779	54.94–55.06	16.2	–38.8	HFC2	NM	16	16	926	18.4	2.69	whole core	2
G-3779	58.21–58.42	16.2	–42.12	HFC2	NM	17,621	17,621	4,697	26.7	2.71	whole core	2

Table 2.4.12-207 (Sheet 11 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

PTN COL 2.4-4

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maximum Horizontal	Horizontal 90°	Vertical				
G-3779	58.75–58.92	16.2	–42.64	HFC2	NM	26,236	26,236	2,252	23.5	2.70	whole core	2
G-3779	59.09–59.26	16.2	–42.98	HFC2	NM	25,120	268	2,588	12.0	2.69	whole core	2
G-3779	59.59–60.01	16.2	–43.6	HFC2	NM	9,599	8,638	5,542	29.4	2.72	whole core	2
G-3789	27.67–28	8	–19.84	HFC2	NM	1,529	782	2,465	23.1	2.72	whole core	2
G-3789	28-28.27	8	–20.14	HFC2	NM	2,784	2,784	1,966	23.1	2.71	whole core	2
G-3789	28.27–28.58	8	–20.42	HFC2	NM	5,618	5,185	2,975	22.8	2.72	whole core	2
G-3789	28.88-29.07	8	–20.98	HFC2	NM	5,784	3,439	2,170	20.8	2.72	whole core	2
G-3789	29.24-29.39	8	–21.32	HFC2	NM	9,142	8,230	1,615	22.9	2.72	whole core	2
G-3789	29.68-30.03	8	–21.86	HFC2	NM	506	250	495	22.6	2.73	whole core	2
G-3789	31.61-32.15	8	–23.88	HFC2	NM	77	46	4	29.4	2.73	whole core	2
G-3789	32.23-32.56	8	–24.4	HFC2	NM	214	184	255	32.0	2.73	whole core	2
G-3789	33.86-34.19	8	–26.08	HFC2	NM	41	0.4	0.1	22.1	2.73	whole core	2
G-3789	34.4-34.73	8	–26.56	HFC2	NM	696	365	184	25.1	2.72	whole core	2
G-3789	34.9-35.15	8	–27.02	HFC2	NM	1,096	888	1,232	30.0	2.73	whole core	2
G-3789	37.33-37.54	8	–29.44	HFC2	NM	0.4	0.2	0.05	18.4	2.71	whole core	2
G-3789	40.66-40.87	8	–32.76	HFC2	NM	38	0.4	61	18.1	2.73	whole core	2
G-3789	42.57-42.92	8	–34.74	HFC2	NM	0.02	0.001	2,840	13.5	2.71	whole core	2
G-3789	52-52.17	8	–44.08	HFC2	NM	28	23	89	17.9	2.69	whole core	2
G-3789	53.10-53.56	8	–45.33	HFC2	NM	1,874	1,055	238	25.8	2.69	whole core	2
G-3790	32.25-32.54	8	–24.4	HFC2	NM	2,016	1,328	3,268	28.2	2.72	whole core	2
G-3790	34.2-34.45	8	–26.32	HFC2	NM	952	713	299	37.4	2.72	whole core	2
G-3790	39.31-39.69	8	–31.5	HFC2	NM	0.2	0.2	0.2	26.7	2.72	whole core	2
G-3790	40.54-40.96	8	–32.75	HFC2	NM	0.08	0.08	4,391	19.4	2.71	whole core	2
G-3790	41.21-41.5	8	–33.36	HFC2	NM	0.02	0.02	4	13.0	2.72	whole core	2
G-3790	41.68-41.95	8	–33.82	HFC2	NM	9	9	12	19.3	2.72	whole core	2
G-3790	42.38-42.71	8	–34.54	HFC2	NM	3,539	0.05	1,796	22.5	2.72	whole core	2

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Table 2.4.12-207 (Sheet 12 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[a]	Sample Type	Source
					Steady State	Maximum Horizontal	Horizontal 90°	Vertical				
G-3790	44.63-44.8	8	–36.72	HFC2	NM	24	7	273	14.5	2.71	whole core	2
G-3790	49.76-50.01	8	–41.88	HFC2	NM	9,569	7,973	2,300	21.1	2.71	whole core	2
G-3790	50.18-50.42	8	–42.3	HFC2	NM	9,077	7,260	8	21.5	2.69	whole core	2
G-3790	52.98-53.23	8	–45.1	HFC2	NM	297	282	75	26.8	2.70	whole core	2
G-3790	56.17-56.5	8	–48.25	HFC2	NM	309	2	2	19.2	2.70	whole core	2
G-3790	57.83-57.71	8	–50.27	HFC2	NM	380	6	0.5	22.1	2.70	whole core	2
G-3791	30.63-30.88	8	–22.76	HFC2	NM	2,101	1,641	1,047	37.8	2.70	whole core	2
G-3791	32-32.29	8	–24.14	HFC2	NM	1,084	658	1,016	29.5	2.71	whole core	2
G-3791	32.83-33.25	8	–25.04	HFC2	NM	8,854	6,885	4,117	45.4	2.73	whole core	2
G-3791	33.75-34.21	8	–25.98	HFC2	NM	8,555	8,555	4,957	30.4	2.72	whole core	2
G-3791	34.38-34.8	8	–26.59	HFC2	NM	8,854	6,885	3,050	22.2	2.71	whole core	2
G-3791	38.13-38.42	8	–30.3	HFC2	NM	6,413	5,557	1,936	31.6	2.72	whole core	2
G-3791	38.63-38.96	8	–30.8	HFC2	NM	8,100	6,942	3,334	31.0	2.71	whole core	2
G-3791	41.21-41.59	8	–33.4	HFC2	NM	1,762	1,560	2,110	32.0	2.70	whole core	2
G-3791	41.96-42.38	8	–34.17	HFC2	NM	2,634	2,406	3,304	36.0	2.71	whole core	2
G-3791	42.38-42.59	8	–34.48	HFC2	NM	4,338	3,407	2,223	32.0	2.70	whole core	2
G-3791	43.42-43.65	8	–35.54	HFC2	NM	16,346	14,529	2,125	25.5	2.71	whole core	2
G-3791	51.35-51.68	8	–43.52	HFC2	NM	2,612	1,729	1,589	15.4	2.70	whole core	2
G-3791	51.68-52.06	8	–43.87	HFC2	NM	2,472	1,831	6	17.7	2.70	whole core	2
G-3792	26.06-26.39	8	–18.22	HFC2	NM	10,954	0.2	764	24.2	2.70	whole core	2
G-3792	26.39-26.72	8	–18.56	HFC2	NM	2,082	2,005	1,405	30.1	2.71	whole core	2
G-3792	27.14-27.45	8	–19.3	HFC2	NM	812	462	1,337	18.3	2.71	whole core	2
G-3792	27.83-28.25	8	–20.04	HFC2	NM	4,123	4,123	3,265	16.9	2.71	whole core	2
G-3792	28.25-28.58	8	–20.42	HFC2	NM	7,454	6,211	2,502	20.1	2.72	whole core	2
G-3792	32.82-33.24	8	–25.03	HFC2	NM	3,836	564	296	18.4	2.71	whole core	2
G-3792	34.17-34.50	8	–26.34	HFC2	NM	40	39	1	13.4	2.68	whole core	2

Table 2.4.12-207 (Sheet 13 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

PTN COL 2.4-4

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies) Steady State	Maximum Horizontal	Horizontal 90°	Vertical	Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
G-3792	34.50-34.88	8	–26.69	HFC2	NM	589	346	0.02	15.5	2.69	whole core	2
G-3792	34.88-35.09	8	–26.98	HFC2	NM	0.1	0.1	0.2	10.8	2.69	whole core	2
G-3792	38.63-38.96	8	–30.8	HFC2	NM	404	265	6	19.9	2.70	whole core	2
G-3792	43.15-43.53	8	–35.34	HFC2	NM	2	0.04	0.02	13.3	2.70	whole core	2
G-3792	45.27-45.5	8	–37.38	HFC2	NM	1,736	53	1,517	9.9	2.70	whole core	2
G-3792	45.6-45.98	8	–37.79	HFC2	NM	699	470	3,333	8.3	2.69	whole core	2
G-3792	50.05-50.3	8	–42.18	HFC2	NM	15	0.4	591	19.7	2.70	whole core	2
G-3792	51.69-51.98	8	–43.84	HFC2	NM	13,265	11,938	4,010	23.4	2.71	whole core	2
G-3792	62.71-63.04	8	–54.88	HFC2	NM	533	495	155	21.5	2.72	whole core	2
G-3792	66.81-67.06	8	–58.94	HFC2	NM	0.3	0.02	0.2	13.8	2.71	whole core	2
G-3792	67.39-67.72	8	–59.56	HFC2	NM	7,869	5,619	0.02	18.3	2.71	whole core	2
G-3792	67.72—68.05	8	–59.88	HFC2	NM	8,022	4,199	1	17.5	2.71	whole core	2
G-3792	69.47-69.89	8	–61.68	HFC2	NM	273	12	0.03	13.8	2.71	whole core	2
G-3792	76-76.25	8	–68.12	HFC2	NM	23,984	4,012	1,387	30.8	2.72	whole core	2
G-3793	13.88-14.21	10	–4.04	HFC2	NM	9,081	3,403	3,906	22.8	2.70	whole core	2
G-3793	17.21-17.63	10	–7.42	HFC2	NM	4,268	3,047	3,067	17.9	2.71	whole core	2
G-3793	27-27.21	10	–17.1	HFC2	NM	962	3	5	22.8	2.71	whole core	2
G-3793	28.68-29.01	10	–18.84	HFC2	NM	12,480	9,599	3,023	31.2	2.72	whole core	2
G-3793	29.18-29.6	10	–19.39	HFC2	NM	19,318	15,000	1,502	23.4	2.73	whole core	2
G-3793	31.75-31.94	10	–21.84	HFC2	NM	27,411	21,083	1,290	27.0	2.72	whole core	2
G-3793	32.11-32.36	10	–22.24	HFC2	NM	15,136	13,622	1,742	29.3	2.71	whole core	2
G-3793	39.52-39.9	10	–29.71	HFC2	NM	929	678	940	22.0	2.71	whole core	2
G-3793	39.9-40.28	10	–30.09	HFC2	NM	1,865	1,678	1,626	22.8	2.71	whole core	2
G-3793	40.44—40.73	10	–30.58	HFC2	NM	571	28	1,657	20.1	2.72	whole core	2
G-3793	41.15-41.42	10	–31.34	HFC2	NM	52	41	1,853	17.9	2.71	whole core	2
G-3793	52.98-53.25	10	–43.12	HFC2	NM	3,616	2,218	357	27.1	2.70	whole core	2

Table 2.4.12-207 (Sheet 14 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

PTN COL 2.4-4

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maximum Horizontal	Horizontal 90°	Vertical				
G-3793	53.79-53.98	10	–43.88	HFC2	NM	327	13	189	22.7	2.70	whole core	2
G-3794	19.4-19.73	9	–10.56	HFC2	NM	439	316	2,251	15.0	2.77	whole core	2
G-3794	24.18-24.51	9	–15.34	HFC2	NM	2,317	1,958	3,592	22.0	2.71	whole core	2
G-3794	30.72-30.97	9	–21.84	HFC2	NM	5,055	226	233	29.6	2.72	whole core	2
G-3673	51-51.5	20	–31.25	HFC1	34.3	NM	NM	NM	37.3	2.68	core plug	1
G-3674	39.25-40	10	–29.62	HFC1	77.6	NM	NM	NM	12.3	2.70	core plug	1
G-3674	49-49.75	10	–39.38	HFC1	<0.01	NM	NM	NM	21.2	2.68	core plug	1
G-3674	52.1	10	–42.1	HFC1	2.19	NM	NM	NM	18.1	2.69	core plug	1
G-3675	64.5-65	8	–56.75	HFC1	<0.01	NM	NM	NM	17.7	2.69	core plug	1
G-3678	33.3	9	–24.3	HFC1	NM	2,244	997	18,223	16.1	2.71	whole core	1
G-3679	36.7	9	–27.7	HFC1	NM	1,870	0.54	13,498	20.7	2.71	whole core	1
G-3731	39.08	10	–29.08	HFC1	NM	3,530	1,463	13,050	20.4	2.71	whole core	1
G-3732	39.5	6	–33.5	HFC1	194.3	NM	NM	NM	10.8	2.71	core plug	1
G-3732	42.4-42.7	6	–36.55	HFC1	NM	NM	NM	13,362	34.8	2.68	whole core	1
G-3732	44	6	–38	HFC1	165.3	NM	NM	NM	16.2	2.71	core plug	1
G-3674	83.5-84	10	–73.75	Tamiami	16584	NM	NM	NM	42.6	2.68	core plug	1
G-3770	64.59-64.8	6.7	–58	Tamiami	NM	1,956	1,831	1,236	28.2	2.74	whole core	2
G-3770	64.92-65.38	6.7	–58.45	Tamiami	NM	1,996	1,996	2,862	29.0	2.72	whole core	2
G-3770	69.88-70.17	6.7	–63.35	Tamiami	NM	1,983	63	296	19.7	2.72	whole core	2
G-3770	70.17-70.42	6.7	–63.6	Tamiami	NM	1,402	1,329	343	22.6	2.72	whole core	2
G-3770	70.42-70.67	6.7	–63.85	Tamiami	NM	2,186	1,994	1,878	26.1	2.72	whole core	2
G-3771	54.21-54.46	6	–48.35	Tamiami	NM	13	13	32	23.3	2.74	whole core	2
G-3771	55.47-55.7	6	–49.58	Tamiami	NM	36	12	116	19.0	2.74	whole core	2
G-3771	55.89-56.08	6	–49.98	Tamiami	NM	39	2	37	18.4	2.74	whole core	2
G-3771	58.93-59.18	6	–53.06	Tamiami	NM	2,650	2,467	2,490	26.3	2.77	whole core	2
G-3771	59.93-60.1	6	–54.02	Tamiami	NM	4,825	4,669	2,077	38.2	2.79	whole core	2

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Table 2.4.12-207 (Sheet 15 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[a]	Sample Type	Source
					Steady State	Maximum Horizontal	Horizontal 90°	Vertical				
G-3771	74.27-74.44	6	–68.36	Tamiami	NM	4,302	3,625	4,127	40.6	2.74	whole core	2
G-3771	74.57-74.78	6	–68.68	Tamiami	NM	7,091	7,091	5,116	40.3	2.72	whole core	2
G-3793	63.95-64.12	10	–54.04	Tamiami	NM	20,433	15,889	735	11.5	2.69	whole core	2
G-3793	64.29-64.62	10	–54.46	Tamiami	NM	12,171	10,954	2,042	14.5	2.69	whole core	2
G-3793	64.92-64.96	10	–54.94	Tamiami	NM	4,964	4,964	465	11.2	2.69	whole core	2
G-3794	59.23-59.65	9	–49.44	Tamiami	NM	4,690	3,607	2,006	15.7	2.72	whole core	2
G-3794	61.02-61.52	9	–52.27	Tamiami	NM	100	17	11	15.8	2.69	whole core	2
G-3794	61.94-62.27	9	–53.1	Tamiami	NM	2,807	2,010	638	26.4	2.74	whole core	2
G-3794	63.13-63.38	9	–54.26	Tamiami	NM	61	0.1	204	10.0	2.72	whole core	2
G-3794	64.07-64.57	9	–55.32	Tamiami	NM	1,952	837	0.03	21.0	2.76	whole core	2

(a) Reported as grams per centimeter in the references.
Sources: References 241 and 242
MSL = Mean sea level
NM = Not measured

PTN COL 2.4-4

Table 2.4.12-208 (Sheet 1 of 4)
Slug Test Hydraulic Conductivity Summary

Observation Well	Test Date	Surface Elevation (NAVD 88)	Screened Interval (feet bgs)	Geologic Unit	Saturated Thickness (feet)	Solution	Hydraulic Conductivity in feet per day		
							Falling	Rising	Arith-metic Mean
OW-606U Test #1	5/20/2008	–1.4	18–28	Miami Limestone	29.9	KGS	NC	97.98	97.98
OW-606U Test #1						Springer-Gelhar	NC	134.80	134.80
OW-606U Test #2						KGS	NC	92.02	92.02
OW-606U Test #2						Springer-Gelhar	NC	123.10	123.10
OW-606U Average							N/A	111.98	111.98
OW-606L Test #1	5/18/2008	–1.4	97–107	Lower Fort Thompson Formation	92.0	Butler	119.90	30.16	75.03
OW-606L Test #1						McElwee-Zenner	117.80	NC	117.80
OW-606L Test #1						KGS	NC	35.04	35.04
OW-606L Test #2						Butler	NC	67.40	67.40
OW-606L Test #2						McElwee-Zenner	NC	66.13	66.13
OW-606L Average							118.85	49.68	72.74
OW-621U	5/20/2008	0.2	17.4–27.4	Miami Limestone	27.6	KGS	NC	94.35	94.35
OW-621U						Springer-Gelhar	NC	68.89	68.89
OW-621U Average							N/A	81.62	81.62
OW-621L Test #1	5/17/2008	0.2	98.6–108.6	Lower Fort Thompson Formation	88.5	Butler	91.59	31.07	61.33
OW-621L Test #1						KGS	71.28	33.31	52.30
OW-621L Test #2						Butler	NC	35.72	35.72
OW-621L Test #2						KGS	NC	30.40	30.40
OW-621L Test #3						Butler	NC	16.65	16.65
OW-621L Test #3						KGS	NC	16.66	16.66
OW-621L Average							81.44	27.30	40.84
OW-636U Test #1	5/21/2008	-1.1	17–27	Miami Limestone	28.9	KGS	NC	57.27	57.27
OW-636U Test #1						Springer-Gelhar	NC	50.64	50.64
OW-636U Test #2						KGS	NC	79.27	79.27
OW-636U Test #2						Springer-Gelhar	NC	64.33	64.33
OW-636U Average							N/A	62.88	62.88

PTN COL 2.4-4

Table 2.4.12-208 (Sheet 2 of 4)
Slug Test Hydraulic Conductivity Summary

Observation Well	Test Date	Surface Elevation (NAVD 88)	Screened Interval (feet bgs)	Geologic Unit	Saturated Thickness (feet)	Solution	Hydraulic Conductivity in feet per day		
							Falling	Rising	Arith-metic Mean
OW-636L	5/21/2008	–1.1	97–107.1	Lower Fort Thompson Formation	88.0	Butler	NC	10.08	10.08
OW-636L						KGS	NC	10.58	10.58
OW-636L						Butler	NC	9.425	9.43
OW-636L						KGS	NC	10.01	10.01
OW-636L Average							N/A	10.02	10.02
OW-706U Test #1	5/16/2008	–1.2	17–27	Miami Limestone	30.7	KGS	6.423	31.19	18.81
OW-706U Test #1						Springer-Gelhar	83.78	30.27	57.03
OW-706U Test #1						Hvorslev	0.7146	NC	0.71
OW-706U Test #1						Bouwer-Rice	0.5455	NC	0.55
OW-706U Test #2						Springer-Gelhar	NC	70.18	70.18
OW-706U Test #2						KGS	NC	76.09	76.09
OW-706U Average							22.87	51.93	37.40
OW-706L	5/16/2008	–1.2	100–110	Lower Fort Thompson Fm	82.8	Butler	21.20	25.09	23.15
OW-706L						KGS	21.97	26.07	24.02
OW-706L Average							21.59	25.58	23.58
OW-721U Test #1	5/15/2008	–1.5	14–24	Miami Limestone	24.8	Springer-Gelhar	45.50	27.03	36.27
OW-721U Test #1						KGS	45.50	32.46	38.98
OW-721U Test #2						Springer-Gelhar	NC	24.39	24.39
OW-721U Test #2						KGS	NC	32.47	32.47
OW-721U Average							45.50	29.09	37.29
OW-721L Test #1	5/15/2008	–1.5	96–106	Lower Fort Thompson Formation	90.0	Butler	2.726	11.59	7.16
OW-721L Test #1						KGS	1.13	2.91	1.13
OW-721L Test #2						Butler	NC	2.839	2.84
OW-721L Test #2						KGS	NC	1.325	1.33
OW-721L Average							1.93	4.67	3.30

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Table 2.4.12-208 (Sheet 3 of 4)
Slug Test Hydraulic Conductivity Summary

Observation Well	Test Date	Surface Elevation (NAVD 88)	Screened Interval (feet bgs)	Geologic Unit	Saturated Thickness (feet)	Solution	Hydraulic Conductivity in feet per day		
							Falling	Rising	Arith-metic Mean
OW-735 U Test #1	5/15/2008	–0.8	16–26	Miami Limestone	26.5	Springer-Gelhar	319.20	58.21	188.70
OW-735 U Test #1						KGS	109.50	84.68	97.09
OW-735 U Test #2						Springer-Gelhar	NC	80.18	80.18
OW-735 U Test #2						KGS	NC	70.70	70.70
OW-735U Average							214.35	73.44	143.90
OW-735L Test #1	5/13/2008	–0.8	96.9–106.9	Lower Fort Thompson Fm	87.0	Butler	49.09	42.01	45.55
OW-735L Test #1						KGS	20.57	32.05	26.31
OW-735L Average							34.83	37.03	35.93
OW-802U	5/20/2008	–1.5	15–27	Miami Limestone	25.8	KGS	NC	41.06	41.06
OW-802U						Springer-Gelhar	NC	31.90	31.90
OW-802U Average							N/A	36.48	36.48
OW-802L	5/20/2008	–1.5	98–08	Lower Fort Thompson Fm	88.0	Butler	NC	23.28	23.28
OW-802L						KGS	NC	30.99	30.99
OW-802L Average							N/A	27.14	27.14
OW-805U	6/6/2008	–1.6	18–28	Miami Limestone	32.3	KGS	NC	101.7	101.70
OW-805U						Butler	NC	136.4	136.40
OW-805U						Springer-Gelhar	NC	107.1	107.10
OW-805U Average							N/A	115.07	115.07
OW-805L	6/6/2008	–1.6	85–95	Lower Fort Thompson Fm	67.5	Butler	NC	5.269	5.27
OW-805L						KGS	NC	5.936	5.94
OW-805L Average							N/A	5.60	5.60
OW-809U Test #1	5/15/2008	–1.3	15–25	Miami Limestone	25.5	Spriniger-Gelhar	91.20	60.67	75.90
OW-809U Test #1						KGS	102.90	82.32	92.60
OW-809U Test #2						Springer-Gelhar	NC	26.86	26.86
OW-809U Test #2						KGS	NC	35.94	35.94

PTN COL 2.4-4

Table 2.4.12-208 (Sheet 4 of 4)
Slug Test Hydraulic Conductivity Summary

Observation Well	Test Date	Surface Elevation (NAVD 88)	Screened Interval (feet bgs)	Geologic Unit	Saturated Thickness (feet)	Solution	Hydraulic Conductivity in feet per day		
							Falling	Rising	Arith-metic Mean
OW-809U Average							97.05	51.45	74.25
OW-809L	5/15/2008	–1.3	95.5–105.5	Lower Fort Thompson Fm	88.0	KGS	108.60	36.57	72.60
OW-809L						Butler	103.70	33.43	68.57
OW-809L Average							106.15	35.00	70.58
OW-812U	5/20/2008	–1.4	15–25	Miami Limestone	25.5	KGS	NC	31.24	31.24
OW-812U						Springer-Gelhar	NC	24.49	24.49
OW-812U Average							N/A	27.87	27.87
OW-812L	5/20/2008	–1.4	97–107	Lower Fort Thompson Fm	86.0	Butler	NC	21.01	21.01
OW-812L						KGS	NC	21.20	21.20
OW-812L Average							N/A	21.11	21.11

Source: Reference 248
bgs = Below ground surface
NAVD 88 = North American Vertical Datum of 1988
N/A = Not Applicable
NC = Not Conducted
KGS = Kansas Geological Survey
For wells with multiple tests, test results were averaged and used to calculate the geometric mean.
Data from these tests are considered not valid due to rate-limiting recharge effects from the filter pack.

Geometric Mean: Upper: 61.3 feet per day
Lower: 20.1 feet per day

PTN COL 2.4-4

Table 2.4.12-209
Summary of Units 6 & 7 Aquifer Pumping Test Results

Geologic Unit	Thickness (ft)	Test Well	Aquifer Transmissivity (gpd/ft)[a]	Aquifer Storativity (dimensionless)[a]	Hydraulic Conductivity (K_h or K_v)		
					gpd/ft^2[a]	ft/d[a]	cm/s[a]
Miami Limestone (K_v)	8	PW-6U	—	—	103	14	0.005
	13	PW-7U	—	—	173	23	0.008
Key Largo Limestone (K_h)	33	PW-6U	2,331,000	0.00015	71,000	9,400	3.3
	24	PW-7U	2,200,000	0.0022	92,000	12,000	4.3
freshwater limestone (K_v)	11	PW-6U	—	—	46	6	0.002
	19	PW-7U	—	—	54	7	0.003
	11	PW-6L	—	—	2	0.2	7E-05
	19	PW-7L	—	—	3	0.4	1E-04
Fort Thompson Formation (K_h)	57	PW-6L	122,000	0.00016	2,140	286	0.1
	36	PW-7L	131,200	0.0003	3,600	490	0.2
Tamiami Formation (K_v)	18	PW-6L	—	—	7,940	1,061	0.4
	18	PW-7L	—	—	649	87	0.03

(a) All values are averages.

PTN COL 2.4-4

Table 2.4.12-210 (Sheet 1 of 2) Summary of Units 6 & 7 Groundwater Field Measurements

Well ID	Sample Date	Temperature (° Celsius)	pH (standard units)	Dissolved Oxygen (milligrams per liter)	Specific Conductance (milliSiemens per centimeter)	Turbidity (Nephelometric Turbidity Units)	Oxidation-Reduction Potential (millivolts)
OW-606L[(a)]	5/28/2008	28.29	7.08	9.92	52.8 72.4[(c)]	0.77	-370
OW-606U[(a)]	5/28/2008	28.71	6.84	1.66	66.9 62.8[(c)]	0.34	-344
OW-621L[(a)]	6/4/2008	27.80	7.06	1.66	>99.9 73.9[(c)]	0.21	-349
OW-621U[(a)]	5/29/2008	27.82	7.08	0.05	91.0 58.3[(c)]	2.91	-351
OW-706L[(a)]	5/29/2008	29.61	6.83	1.49	46.4 48.6[(c)]	0.20	-351
OW-706U[(a)]	5/29/2008	30.85	6.65	1.13	76.6 77.3[(c)]	0.83	-392
OW-721L[(a)]	5/28/2008	28.56	6.76	1.18	74.3 73.7[(c)]	7.55	-370
OW-721U[(a)]	5/28/2008	28.92	7.10	10.6	53.1 63.8[(c)]	0.36	-364
OW-735U[(a)]	5/27/2008	29.47	7.00	0.02	86.6 77.5[(c)]	0.92	-360
OW-802U[(a)]	6/5/2008	28.27	6.80	1.90	82.8 70.8[(c)]	0.48	-322
OW-805U[(a)]	6/5/2008	28.26	7.10	1.19	60.9 59.8[(c)]	0.32	-346
OW-809U[(a)]	5/27/2008	30.82	6.98	0.01	83.9 79.0[(c)]	0.97	-371
OW-606L[(d)]	11/12/2009	26.90	7.04	0.16	88.40	NM	-199.7
OW-606U[(d)]	11/12/2009	26.61	7.07	0.33	72.20	NM	-197.6

Table 2.4.12-210 (Sheet 2 of 2)
Summary of Units 6 & 7 Groundwater Field Measurements

PTN COL 2.4-4

Well ID	Sample Date	Temperature (° Celsius)	pH (standard units)	Dissolved Oxygen (milligrams per liter)	Specific Conductance (milliSiemens per centimeter)	Turbidity (Nephelometric Turbidity Units)	Oxidation-Reduction Potential (millivolts)
OW-621L[d]	11/13/2009	27.93	7.29	0.11	90.45	NM	-185.3
OW-621U[d]	11/16/2009	27.96	7.27	0.16	81.41	NM	-183.4
OW-706L[d]	11/12/2009	28.67	7.16	0.23	55.63	NM	-101.6
OW-706U[d]	11/12/2009	28.20	7.05	0.19	98.91	NM	-241.2
OW-721L[d]	11/16/2009	28.58	7.12	0.15	103.2	NM	-188.4
OW-721U[d]	11/16/2009	28.58	7.17	0.12	95.07	NM	-179.3
OW-735U[d]	11/12/2009	29.46	7.03	0.19	108.0	NM	-206.9
OW-802U[d]	11/13/2009	26.60	7.08	0.16	76.47	NM	-178.0
OW-805U[d]	11/16/2009	27.17	7.16	0.25	82.62	NM	-121.4
OW-809U[d]	11/13/2009	29.24	7.02	0.13	94.76	NM	-197.4
ENP Precipitation[b]	mean	NM	4.98	NM	0.016	NM	NM
Surficial aquifer SFWMD[b]	median	24.8	6.9	NM	0.619	NM	NM
Floridan aquifer SFWMD[b]	median	26.3	7.4	NM	1.787	NM	NM
Cooling Canal	average	30.05	8.02	8.70	NM	1.92	NM
L-31N	average	NM	NM	NM	NM	NM	NM
Biscayne Bay	average	NM	NM	NM	NM	NM	NM
Upper Floridan Production well	mean	NM	7.70	NM	NM	1.1	NM

ENP = Everglades National Park; SFWMD = South Florida Water Management District; NM = Not Measured
(a) Reference 248
(b) Reference 245
(c) Samples collected February 3-5, 2009
(d) Samples collected and analyzed during rou ine groundwater level monitoring

Table 2.4.12-211 (Sheet 1 of 4)
Units 6 & 7 Hydrogeochemical Data

Constituent		TDS	Calcium	Iron	Magnesium	Manganese	Potassium	Silica	Silicon	Sodium
Location ID	Date Collected	milligrams/Liter								
OW-606L[a]	5/28/2008	34,320[i] 47,047[i][j]	632[b]	<0.05U[c]	1880[b]	0.0391	549[b]	3	<250[b][c]	15,100[b]
OW-606U[a]	5/28/2008	43,485[i] 40,804[i][j]	535[b]	0.318[b][d]	1730[b]	0.0354	525[b]	0.729	<250[b][c]	14,400[b]
OW-621L[a]	6/4/2008	64,935[i][k] 48,045[i][j]	574[b]	<50[b][c]	1960[b]	<2[b][c]	586[b]	133[d][e]	62.1[b][d][e]	16,300[b]
OW-621U[a]	5/29/2008	59,150[i] 37,901[i][j]	492[b]	0.453[b][d]	1600[b]	0.0368	476[b]	0.637	<250[b][c]	13,100[b]
OW-706L[a]	5/29/2008	30,160[i] 31,610[i][j]	413[b]	0.531[b][d]	1170[b]	0.0083	327[b]	8	<250[b][c]	9440[b]
OW-706U[a]	5/29/2008	49,790[i] 50,229[i][j]	725[b]	0.178[b][d]	2150[b]	0.0435	658[b]	2	<250[b][c]	17,500[b]
OW-721L[a]	5/28/2008	48,295[i] 47,912[i][j]	667[b]	0.362[b][d]	2020[b]	0.0462	587[b]	3	<250[b][c]	16,300[b]
OW-721U[a]	5/28/2008	34,515[i] 41,472[i][j]	603[b]	0.329[b][d]	1890[b]	0.0581	569[b]	0.848	<250[b][c]	15,400[b]
OW-735U[a]	5/27/2008	56,290[i] 50,351[i][j]	749[b]	0.133[b][d]	2140[b]	0.0327	655[b]	<0.250[c]	<250[b][c]	17,700[b]
OW-802U[a]	6/5/2008	53,820[i] 46,022[i][j]	579[b]	<50[b][c]	1980[b]	<2[b][c]	586[b]	143[e]	66.7[b][e]	16,400[b]
OW-805U[a]	6/5/2008	39,585[i] 38,853[i][j]	447[b]	<50[b][c]	1570[b]	<2[b][c]	493[b]	107[e]	49.9[b][e]	13,200[b]
OW-809U[a]	5/27/2008	54,535[i] 51,356[i][j]	704[b]	0.158[b][d]	2040[b]	0.0281	607[b]	<0.250[c]	<250[b][c]	16,700[b]
OW-606L[l]	11/12/2009	49,500	808[b][d]	<2.5[d]	2500[b][d]	0.0379[b][e]	735[b][d]	6.68	3.12[b][e]	15,000[b][d]
OW-606U[l]	11/12/2009	38,500	820[b][d]	0.593[b][d][e	2680[b][d]	0.0504[b][e]	757[b][d]	6.03	2.82[b][e]	12,000[b][d]
OW-621L[l]	11/13/2009	46,200	910[b][d]	0.549[b][d][e	3080[b][d]	0.0334[b][e]	844[b][d]	7.79	3.64[b][e]	14,800[b][d]
OW-621U[l]	11/16/2009	34,600	602[b]	0.754[b][d][e	2030[b][d]	0.0397[b][e]	550[b][d]	4.77	2.23[b][d][e]	11,800[b][d]

Table 2.4.12-211 (Sheet 2 of 4)
Units 6 & 7 Hydrogeochemical Data

Constituent		TDS	Calcium	Iron	Magnesium	Manganese	Potassium	Silica	Silicon	Sodium
Location ID	Date Collected	milligrams/Liter								
OW-706L(l)	11/12/2009	27,600	831(b)(d)	1.340(b)(d)(e	2330(b)(d)	0.0113(b)(e)	616(b)(d)	22.90	10.70(b)(e)	8920(b)(d)
OW-706U(l)	11/12/2009	48,900	1120(b)(d)	0.829(b)(d)(e	3760(b)(d)	0.0739(b)(e)	1030(b)(d)	7.08	3.31(b)(e)	15,200(b)(d)
OW-721L(l)	11/16/2009	45,700	1200(b)	0.782(b)(d)(e	4000(b)(d)	0.0669(b)(e)	1110(b)(d)	12.30	5.77(b)(d)(e)	15,300(b)(d)
OW-721U(l)	11/16/2009	40,500	673(b)	<2.5(b)(d)	2110(b)(d)	0.0669(b)(e)	614(b)(d)	4.99	2.33(b)(d)(e)	12,600(b)(d)
OW-735U(l)	11/12/2009	54,500	1070(b)(d)	0.656(b)(d)(e	3740(b)(d)	0.0491(b)(e)	1010(b)(d)	7.36	3.44(b)(e)	14,700(b)(d)
OW-802U(l)	11/13/2009	44,200	988(b)(d)	1.030(b)(d)(e	3310(b)(d)	0.0805(b)(e)	889(b)(d)	7.58	3.54(b)(e)	14,100(b)(d)
OW-805U(l)	11/16/2009	32,300	645(b)	0.908(b)(d)(e	2140(b)(d)	0.0311(b)(e)	602(b)(d)	4.62	2.16(b)(d)(e)	11,800(b)(d)
OW-809U(l)	11/13/2009	54,200	1110(b)(d)	0.946(b)(d)(e	3810(b)(d)	0.0554(b)(e)	1050(b)(d)	6.57	3.07(b)(e)	16,100(b)(d)
ENP Precipitation(f)(g)	mean		0.36		0.2		0.2			1.32
Surficial aquifer SFWMD(g)	median	388	98	0.88	3.9		1.3			21.1
Floridan aquifer SFWMD(g)	median	1138	67.2	<0.05(c)	46.4		9.5			220.5
Cooling Canal	average	54,500	720		2050		680	0.52		
L-31N	average	370	70		5.35		6.3			
Biscayne Bay	average	33,757	446		1270		421	0.32		
Upper Floridan Production Well	average	5451	149	0.28	177	<0.07	77	12		

Constituent		Bromide	Chloride	Fluoride	Sulfate	Nitrate	Nitrite	Bicarbonate	Carbonate	Total Alkalinity	Ammonia
Location ID	Date Collected	milligrams/Liter									
OW-606L(a)	5/28/2008	62.5	29,600	<20.0(c)	3860	<0.20(c)	<200(c)	165	<5.0(c)	165	1.58
OW-606U(a)	5/28/2008	56.6	27,900	<20.0(c)	3470	<0.20(c)	<200(c)	155	<5.0(c)	155	0.844
OW-621L(a)	6/4/2008	65.9	31,300(d)	<20.0(c)	3610	<0.20(c)	<200(c)	181	<5.0(c)	181	1.30
OW-621U(a)	5/29/2008	50.6	25,500	<1.0(c)	3210	<4.0(c)	<200(c)	189	<5.0(c)	189	0.588
OW-706L(a)	5/29/2008	37.7(e)	19,100	<1.0(c)	2280	<4.0(c)	<200(c)	191	<5.0(c)	191	0.61

Table 2.4.12-211 (Sheet 3 of 4)
Units 6 & 7 Hydrogeochemical Data

Constituent		Bromide	Chloride	Fluoride	Sulfate	Nitrate	Nitrite	Bicarbonate	Carbonate	Total Alkalinity	Ammonia
Location ID	Date Collected	milligrams/Liter									
OW-706U[a]	5/29/2008	70.5	33,300	<1.0[c]	3850	<4.0[c]	<200[c]	204	<5.0[c]	204	2.09
OW-721L[a]	5/28/2008	64.9	31,100	<20.0[c]	3990	<0.20[c]	<200[c]	180	<5.0[c]	180	1.82
OW-721U[a]	5/28/2008	60.1	29,900	<20.0[c]	3860	<0.20[c]	<200[c]	164	<5.0[c]	164	1.68
OW-735U[a]	5/27/2008	262	37,500	<20.0[c]	4090	<4.0[c]	<200[c]	179	<5.0[c]	179	2.15
OW-802U[a]	6/5/2008	65.1	31,600[d]	<20.0[c]	3720	<0.20[c]	<200[c]	178	<5.0[c]	178	1.40
OW-805U[a]	6/5/2008	53.6	27,600[d]	<20.0[c]	3070	<0.20[c]	<200[c]	177	<5.0[c]	177	0.548
OW-809U[a]	5/27/2008	241[e]	35,900	<1.0[c]	4050	<4.0[c]	<200[c]	177	<5.0[c]	177	2.21
OW-606L[l]	11/12/2009	107	28,800	<2.0[c]	3870	<0.40[c]	<4.0[c]	148[d]	<5.0[c]	148[d]	1.30
OW-606U[l]	11/12/2009	85.7	22,600	<2.0[c]	3560	<0.40[c]	<4.0[c]	163[d]	<5.0[c]	163[d]	0.486
OW-621L[l]	11/13/2009	101	29,000	<2.0[c]	3880	<0.40[c]	<4.0[c]	168[d]	<5.0[c]	168[d]	1.26
OW-621U[l]	11/16/2009	83.3	24,800	<2.0[c]	3280[d]	<0.40[c]	<4.0[c]	177[d]	<5.0[c]	177[d]	0.385
OW-706L[l]	11/12/2009	62.9	16,300	<2.0[c]	2450	<0.40[c]	<4.0[c]	168[d]	<5.0[c]	168[d]	0.485
OW-706U[l]	11/12/2009	112	30,700	<2.0[c]	4110	<0.40[c]	<20[c]	162[d]	<5.0[c]	162[d]	1.43
OW-721L[l]	11/16/2009	104	31,000	<2.0[c]	4400[d]	0.14[e]	<4.0[c]	166[d]	<5.0[c]	166[d]	1.31
OW-721U[l]	11/16/2009	88.8	27,100	<2.0[c]	3720[d]	<0.40[c]	<4.0[c]	164[d]	<5.0[c]	164[d]	0.796
OW-735U[l]	11/12/2009	119	32,300	<2.0[c]	4330	<0.40[c]	<20[c]	161[d]	<5.0[c]	161[d]	1.63
OW-802U[l]	11/13/2009	97.5	27,700	<2.0[c]	3710	<0.40[c]	<4.0[c]	163[d]	<5.0[c]	163[d]	1.05
OW-805U[l]	11/16/2009	86	24,000	<2.0[c]	3510[d]	<0.40[c]	<4.0[c]	173[d]	<5.0[c]	173[d]	0.424
OW-809U[l]	11/13/2009	115	33,700	<2.0[c]	4400	<0.40[c]	<4.0[c]	170[d]	<5.0[c]	170[d]	1.64
ENP Precipitation[f][g]	mean		2		1.14	0.73					0.22
Surficial Aquifer SFWMD[g]	median		48	0.2	12	<0.01[c]		263		251	

Table 2.4.12-211 (Sheet 4 of 4)
Units 6 & 7 Hydrogeochemical Data

Constituent		Bromide	Chloride	Fluoride	Sulfate	Nitrate	Nitrite	Bicarbonate	Carbonate	Total Alkalinity	Ammonia
Location ID	Date Collected	milligrams/Liter									
Floridan Aquifer SFWMD[g]	median		420	0.81	176	<0.01[c]				130	
Cooling Canal	average		30,000		3950			165		165	0.16
L-31N	average		59		26	1.05		200		200	
Biscayne Bay	average		18,582		2447			102		102	0.1
Upper Floridan Production Well	average		2909	1.6	661	<0.01[c]		196			

(Shaded cell) Not analyzed

SFWMD = South Florida Water Management District

(a) Reference 248.

(b) Spiked analyte recovery is outside stated control limits. Method performance confirmed using Laboratory Control Spike sample results.

(c) Analyte not detected at or above the method detection limit.

(d) Method blank contamina ion. The associated method blank contains the target analyte at a reportable level. These data should be used with caution.

(e) Estimated result. Result is less than the reporting limit.

(f) ENP = Everglades National Park.

(g) Reference 245.

(h) Test conducted on Nitrogen, as Ammonia.

(i) TDS is es imated as specific conductance in milliSiemens per centimeter x 1000 x 0.65, specific conductance values are listed in Table 2.4.12-210.

(j) Based on specific conductance measurements collected February 3-5, 2009.

(k) Assumes specific conductance equals 99 milliSiemens per centimeter.

(l) Samples collected and analyzed during routine groundwater level monitoring

Table 2.4.12-212 (Sheet 1 of 2) Reclaimed Water Estimated Constituents and Concentrations Discharged to Deep Injection Wells[a]

Constituent Name	Concentration (mg/L)[b]
Ammonia as N	No Data
BOD	No Data
Boron	No Data
Bromide	No Data
Hexavalent Chromium	0.065
Fluoride	2.46
Alkalinity, total as $CaCO_3$	72
Nitrate as N	16.1
Sulfate	484.0
Total Organic Compounds	118
Total Dissolved Solids	2721
Total Suspended Solids	33.6
Phosphorous	0.73
Phosphate	2.40
Aluminum	3.02
Antimony	0.0245
Arsenic	0.0131
Barium	1.86
Beryllium	0.0933
Cadmium	0.00718
Chromium	0.0653
Copper	0.0433
Iron	1.63
Lead	0.112
Nickel	0.088
Selenium	0.0359
Silver	0.0163
Zinc	0.646
Calcium	355
Magnesium	63
Manganese	0.379
Sodium	462
Silica as SiO_2	26.4
Chloride	1247

Table 2.4.12-212 (Sheet 2 of 2)
Reclaimed Water Estimated Constituents and Concentrations Discharged to Deep Injection Wells[(a)]

Constituent Name	Concentration (mg/L)[(b)]
Nitrate as N	4.02
Conductivity (µmhos/cm)	5577
pH (standard units)	7.89
Total Residual Chlorine	2
Thallium	0.00620
Mercury	0.00653

(a) The information provided is based on the case of makeup water for the circulating water system of 100 percent reclaimed water from the Miami-Dade Water and Sewer Department.
(b) Concentration in milligrams per liter except as noted.

Table 2.4.12-213 (Sheet 1 of 2)
Saltwater Estimated Constituents and Concentrations Discharged to Deep Injection Wells[a]

Constituent Name	Concentration (mg/L)[b]
Ammonia as N	No Data
BOD	[c]
Boron	8.65
Bromide	166
Hexavalent Chromium	No Data
Fluoride	0.00162
A kalinity, total as $CaCO_3$	149
Nitrate as N	0.102
Sulfate	4,272
Total Organic Compounds	6.350
Total Dissolved Solids	57,030
Total Suspended Solids	13.3
Phosphorous	1.05
Phosphate	1.110
Aluminum	[c]
Antimony	[c]
Arsenic	[c]
Barium	0.0149
Beryllium	[c]
Cadmium	[c]
Chromium	(c)
Copper	0.0002
Iron	[c]
Lead	[c]
Nickel	[c]
Selenium	0.019
Silver	[c]
Zinc	[c]
Calcium	787
Magnesium	2,615
Manganese	[c]
Sodium	19,164
Silica as SiO_2	0.234
Chloride	30,009

Table 2.4.12-213 (Sheet 2 of 2)
Saltwater Estimated Constituents and Concentrations Discharged to Deep Injection Wells[(a)]

Constituent Name	Concentration (mg/L)[(b)]
Nitrate as N	0.0966
Conductivity (μmhos/cm)	26,154
pH (standard units)	7.89
Total Residual Chlorine	No Data
Thallium	No Data
Mercury	(c)

(a) The information provided is based on the case of makeup water for the circulating water system of 100 percent saltwater from the radial collector wells.
(b) Concentration in milligrams per liter except as noted.
(c) Makeup water constituent values were below detectable limits.

Table 2.4.12-214
Water Quality Summary from Turkey Point Pumping Test

Locations	Total Dissolved Solids	Chloride	Sulfate	Bromide	Bicarbonate Alkalinity	Boric Acid	Calcium	Magnesium	Potassium	Sodium	Strontium
PW-1	33931	19407	2724	99	167	24	427	1289	431	10284	7.9
Biscayne Bay	41600	22475	3400	98	120	29	476	1545	506	12067	9.1
Industrial Wastewater Facility	66167	37400	6200	150	184	42	780	2367	773	18800	15.7

Source: modified from Reference 255
Notes: all units are mg/L
Fluoride results are either non-detect or between MDL and PQL
All results presented are averages
Additional information regarding the sampling and analyses conducted for the Turkey Point Pumping Test can be found in Reference 255

APPENDIX 2AA

TRANSDUCER DATA

APPENDIX 2AA TABLE OF CONTENTS

APPENDIX 2AA LIST OF TABLES

1.0 TRANSDUCER DATA

In-Situ pressure transducers were installed in 20 observation wells and 2 surface water monitoring locations to collect water level data in the Units 6 & 7 plant area. Monitoring locations are shown in Figure 2.4.12-209.

In general the transducers were programmed to collect readings once an hour. However, the readings were collected every 5 minutes at some locations for parts of the second and third quarters (October 2008 to May 2009) of data collection. All transducer locations with the exception of SW-1 and SW-2 monitor groundwater levels. SW-1 and SW-2 monitor the surface water level in the cooling canals surrounding the site.

The monitoring well naming convention uses U/L notation to identify which zone the well is monitoring, the Key Largo Limestone is designated as the upper zone (U) and the Fort Thompson Formation is designated as the lower zone (L). For example, OW-606U is observation well 606 that monitors the upper zone.

Since the groundwater at the site is saline to hypersaline in composition, the density of the groundwater is a factor when evaluating hydrostatic loading or other head considerations. Specific conductance measurements were taken in February 2009, November 2009, January 2010, and June 2010 using a water quality meter and a flow-through cell. These measurements were used to make density corrections to water surface elevation calculations. These corrections employed the observed pressure and water density at each transducer to determine the water level in each well. Temperature measurements and calculated salinity values from formulae presented in Reference 1 were used to compute water density following the methodology outlined in Reference 2. A summary of the water densities calculated are presented on Tables 2AA-201, 2AA-202, 2AA-203, and 2AA-218. The average water density in the upper monitoring zone is 1.037 grams per cubic centimeter (64.7 pounds per cubic foot). The average water density in the lower monitoring zone is 1.034 grams per cubic centimeter (64.5 pounds per cubic foot).

The water densities were individually assigned based on specific conductance measurements taken at each location. Water level data collected prior to May 27, 2009 (start of the 4th Quarter data set) were assigned the water densities collected in February 2009. Fourth quarter data (late May to late August, 2009) were assigned the average of the water densities collected in February 2009 and November 2009. Fifth quarter data (late August 2009 to mid November 2009) were assigned the water densities collected in November 2009. Sixth quarter data

(mid November 2009 to early February 2010) were assigned the average of the densities collected in November 2009 and February 2010. Seventh quarter data (February 2010 to June 2010) were assigned the average of the densities collected in February 2010 and June 2010.

2.0 REFERENCE HEADS

The head observed in a well varies with pressure, elevation, and water density. Two points in an aquifer that have equal pressures and elevations but different water densities will have different heads (Reference 3 and Reference 4). As shown in Tables 2AA-201, 2AA-202, 2AA-203, and 2AA-218, the calculated densities for the monitoring locations vary. Because the observed head in each well is dependent on density which varies from well to well, reference heads were calculated for each well to provide density normalized head values. Reference heads are used to generate potentiometric surface contour maps and calculate horizontal gradients.

Reference heads are calculated from observed head and density in each well with the following equation (equation 12 from Reference 6):

$$h_r = z_r + \frac{\rho_i}{\rho_r}(h_i - z_i) - \frac{\rho_a}{\rho_r}(z_r - z_i) \qquad (1)$$

where:

h_r is the reference head (length — meters or feet as long as consistent)

h_i is the observed head in the well/aquifer (length — meters or feet as long as consistent)

z_r is the reference elevation (length — meters or feet as long as consistent)

z_i is the well screen midpoint elevation (length — meters or feet as long as consistent)

ρ_i is the density of water in the well (kilograms per cubic meter)

ρ_r is the reference density (kilograms per cubic meter)

ρ_a is the average density between the measured point and the reference level (assumed to be equal to the measured point value for potentiometric surface map generation)

The reference elevation is the median of the upper zone screen midpoints (–21.65 feet North American Vertical Datum of 1988 [NAVD 88]) for the upper zone potentiometric surface maps and the median of the lower zone screen midpoints (–102.9 feet NAVD 88) for the lower zone surface potentiometric maps. The elevation of the center of the screened interval was employed as the elevation, z_i. A typical density for Biscayne Bay water was selected as the reference density. Salinity and temperature data have been collected monthly at 25 locations in Biscayne Bay by the South Florida Water Management District (SFWMD) since September 1993 (Reference 5). The median water temperature, 26.3°C, and median salinity, 34.3 Practical Salinity Units (PSU), from this data set were used to calculate a reference density, ρ_r of 1022.4 kilograms per cubic meter (1.022 grams per cubic centimeter or 63.8 pounds per cubic foot).

Tables 2AA-204 to 2AA-215 and Tables 2AA-219 and 2AA-220 provide a summary of the calculated reference heads for each of the potentiometric surface maps generated.

Onsite vertical hydraulic gradients were calculated using the environmental head approach from Reference 6. Environmental head is calculated as:

$$h_{e,i} = z_r + \frac{\rho_i}{\rho_r}(h_i - z_i) - \frac{\rho_a}{\rho_r}(z_r - z_i) \quad (2)$$

Where:

$h_{e,i}$ is the environmental head

ρ_a is the average density between the measured point and the reference level (lower well screen).

ρ_i is the density at the measured point

ρ_r is the reference density (kg/m^3) (assumed as Biscayne Bay water)

h_i is the observed water level

z_i is the screen midpoint elevation

The reference level (z_r) for each of the gradient calculations is the lower zone well screen midpoint elevation.

The gradient is calculated as :

$$\frac{\Delta h_{e,i}}{\Delta z} \quad (3)$$

Where: $\Delta z = z_2 - z_1$, the difference in the well screen midpoint elevations

3.0 DATA EVALUATION

During the data evaluation phase it became necessary to selectively eliminate some collected data as multiple transducers failed in the field and other transducers recorded data that were inconsistent with other nearby readings, erratic or significantly (>0.2 feet) different than manually collected water level readings during the same time period. Table 2AA-216 presents the time frames data that are judged to be acceptable for use.

Data from locations OW-721U and OW-802U appear to be erratic from the start of the data collection period compared to data from other monitoring locations. It was determined that the transducer vent tube was partially blocked. Repairs were made to the instrumentation at the OW-721U and OW-802U locations in February 2010; however, the data for OW-721U appear erratic after approximately April of 2010 and are judged to be not acceptable for use.

Monitoring locations OW-636U, OW-735L, OW-735U and OW-812L did not have functioning transducers at the time the manual water level measurements were taken at the end of the second quarter (February 2009) of data collection. Data from these locations were judged as acceptable for use if the data was consistent (i.e. similar variation in time and magnitude) with data from other monitoring locations that had small (< 0.2 feet) differences between the manually collected and transducer derived water level readings.

Data for OW-606L was initially rejected due to the small difference in the observed water levels between OW-606L and OW-606U. This small difference was in direct contrast with data collected from other paired locations which showed a much larger difference in water level between the upper and lower wells, with the lower wells having consistently higher observed water level elevations. Beginning with the third quarter (February 2009) of data collection, several other locations

(OW-735U/L, OW-621U/L and OW-721U/L) showed observed water level trends similar to those seen in the OW-606U/L well pair (i.e. a small difference between the upper and lower well water levels). Given this additional information, the OW-606L data has been judged as acceptable for use.

A downward shift in the OW-621L, OW-721L and OW-735L time series hydrographs occurred beginning approximately February 2009. This shift results in a reduction in the difference between the upper and lower observed water levels as compared to the previously collected data. This shift appears to be real as multiple manual measurements prior and subsequent to February 2009 were taken and confirm the pressure transducer derived water levels. The origin of the data shift is unclear. Drilling and well development activities in support of the aquifer pumping test were conducted during the February 2009 time period. These activities may have altered the subsurface conditions or integrity of some of the well seals or may be coincidental.

Table 2AA-217 presents the observed maximum and minimum recorded elevation for each monitoring location. Maximum and minimum values for each location are for the time frames presented in Table 2AA-216.

4.0 REFERENCES

1. Wagner, R., R. Boulger, Jr., C. Oblinger, and B. Smith, *Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, Data Reporting*, U.S. Geological Survey, Techniques and Methods 1-D3, 2006.

2. McKee, D., *Aqua TROLL® 200 Measurement Methodology*, In-Situ Incorporated, Technical Note, Fort Collins, Colorado, 2007.

3. Guo, W., and C. Langevin, *User's Guide to SEAWAT: A Computer Program for Simulation of Three-Dimensional Variable-Density Ground-Water Flow*, U.S. Geological Survey, Techniques of Water-Resources Investigations, Book 6, Chap. A7, 2002.

4. Langevin, C., D. Thorne, A. Dausman, M. Sukop, and W. Guo, *SEAWAT Version 4: A Computer Program for Simulation of Multi-Species Solute and Heat Transport*, U.S. Geological Survey, Techniques and Methods, Book 6, Chap. A22, 2008.

5. South Florida Water Management District, Biscayne Bay Monitoring Data web page. Available at http://my.sfwmd.gov/dbhydroplsql/water_quality_interface.station_select_2?v_project=&v_project=BISC&v_js_flag=Y&v_access_by=project, accessed June 9, 2009.

6. Post, V., H. Kooi, and C. Simmons, *Using Hydraulic Head Measurements in Variable-Density Ground Water Flow Analyses,* Ground Water Vol. 45, No. 6, 2007.

Table 2AA-201
Density Measurements Collected in February 2009

Location	Specific Conductance (milliSiemens per centimeter)	Salinity (PSU)	Temperature (°C)	Density (grams per cubic centimeter)
OW-606L	72.4	49.8	28.28	1.033
OW-606U	62.8	42.3	28.13	1.028
OW-621L	73.9	51.0	27.62	1.035
OW-621U	58.3	38.9	27.72	1.025
OW-636L	52.5	34.6	27.04	1.022
OW-636U	68.4	46.7	26.81	1.032
OW-706L	48.6	31.7	29.28	1.020
OW-706U	77.3	53.7	29.13	1.036
OW-721L	73.7	50.8	29.07	1.034
OW-721U	63.8	43.1	28.90	1.028
OW-735L	77.9	54.2	30.09	1.036
OW-735U	77.5	53.8	30.40	1.036
OW-802L	56.2	37.3	28.09	1.024
OW-802U	70.8	48.5	28.04	1.033
OW-805L	71.0	48.7	27.44	1.033
OW-805U	59.8	40.0	27.26	1.026
OW-809L	60.8	40.8	30.90	1.026
OW-809U	79.0	55.1	30.47	1.037
OW-812L	65.1	44.1	33.58	1.027
OW-812U	77.3	53.7	33.54	1.035
SW-1	92.7	66.4	23.53	1.048
SW-2	91.6	65.4	23.53	1.047

Table 2AA-202
Density Measurements Collected in November 2009

Location	Specific Conductance (milliSiemens per centimeter)	Salinity (PSU)	Temperature (°C)	Density (grams per cubic centimeter)
OW-606L	88.4	62.8	26.90	1.044
OW-606U	72.2	49.6	26.61	1.034
OW-621L	90.5	64.5	27.93	1.045
OW-621U	81.4	57.0	27.96	1.039
OW-636L	72.4	49.8	28.07	1.034
OW-636U	89.1	63.4	27.42	1.044
OW-706L	55.6	36.9	28.67	1.024
OW-706U	98.9	71.7	28.20	1.050
OW-721L	103.2	75.4	28.58	1.053
OW-721U	95.1	68.4	28.58	1.048
OW-735L	114.6	85.6	30.16	1.060
OW-735U	108.0	79.6	29.46	1.056
OW-802L	56.6	37.6	25.78	1.025
OW-802U	76.5	53.0	26.60	1.037
OW-805L	95.0	68.4	27.42	1.048
OW-805U	82.6	58.0	27.17	1.040
OW-809L	83.4	58.7	29.71	1.040
OW-809U	94.8	68.1	29.24	1.047
OW-812L	87.9	62.4	30.53	1.042
OW-812U	108.1	79.7	31.81	1.055
SW-1	111.2	82.5	23.44	1.060
SW-2	112.3	83.5	24.57	1.061

Table 2AA-203
Density Measurements Collected in February 2010

Location	Specific Conductance (milliSiemens per centimeter)	Salinity (PSU)	Temperature (°C)	Density (grams per cubic centimeter)
OW-606L	79.6	55.6	26.92	1.038
OW-606U	68.8	47.0	27.11	1.032
OW-621L	78.8	54.9	27.56	1.038
OW-621U	64.1	43.3	27.57	1.029
OW-636L	58.6	39.1	27.97	1.025
OW-636U	69.5	47.5	27.91	1.032
OW-706L	53.5	35.3	27.14	1.023
OW-706U	80.1	56.0	25.42	1.039
OW-721L	81.0	56.7	27.39	1.039
OW-721U	71.2	48.8	27.31	1.033
OW-735L	89.7	63.9	28.97	1.044
OW-735U	91.6	65.4	30.00	1.045
OW-802L	54.5	36.0	27.86	1.023
OW-802U	73.4	50.6	28.16	1.034
OW-805L	77.6	53.9	27.44	1.037
OW-805U	69.5	47.5	27.68	1.032
OW-809L	72.0	49.5	28.51	1.033
OW-809U	85.7	60.5	26.98	1.042
OW-812L	70.9	48.6	30.55	1.032
OW-812U	96.0	69.2	32.37	1.047
SW-1	71.6	49.2	18.15	1.036
SW-2	72.0	49.5	18.54	1.036

Table 2AA-204
Reference Heads for June 29, 2008 Potentiometric Surface Map (approximately 7am, high tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	6/29/08 6:34 AM	0.11	OW-606U	6/29/08 6:46 AM	-1.19
OW-621L	6/29/08 6:57 AM	0.80	OW-621U	6/29/08 6:47 AM	-0.99
OW-636L	6/29/08 7:17 AM	0.02	OW-636U	6/29/08 6:57 AM	-0.69
OW-706L	---	R	OW-706U	6/29/08 7:12 AM	-0.98
OW-721L	6/29/08 7:17 AM	1.95	OW-721U	---	ND
OW-735L	6/29/08 7:00 AM	2.19	OW-735U	6/29/08 6:54 AM	-1.20
OW-802L	6/29/08 7:15 AM	0.43	OW-802U	---	ND
OW-805L	6/29/08 7:30 AM	0.57	OW-805U	6/29/08 6:42 AM	-0.99
OW-809L	6/29/08 6:53 AM	0.57	OW-809U	6/29/08 7:14 AM	-1.12
OW-812L	6/29/08 7:25 AM	0.70	OW-812U	6/29/08 7:21 AM	-0.87

ND = No Data; R = Rejected Data

Table 2AA-205
Reference Heads for June 29, 2008 Potentiometric Surface Map (approximately 2pm, low tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	6/29/08 1:34 PM	-0.17	OW-606U	6/29/08 1:46 PM	-1.48
OW-621L	6/29/08 1:57 PM	0.48	OW-621U	6/29/08 1:47 PM	-1.31
OW-636L	6/29/08 2:17 PM	-0.28	OW-636U	6/29/08 1:57 PM	-1.02
OW-706L	---	R	OW-706U	6/29/08 2:12 PM	-1.13
OW-721L	6/29/08 2:17 PM	1.76	OW-721U	---	ND
OW-735L	6/29/08 2:00 PM	2.07	OW-735U	6/29/08 1:54 PM	-1.32
OW-802L	6/29/08 2:15 PM	0.21	OW-802U	---	ND
OW-805L	6/29/08 2:30 PM	0.21	OW-805U	6/29/08 1:42 PM	-1.34
OW-809L	6/29/08 1:53 PM	0.50	OW-809U	6/29/08 2:14 PM	-1.20
OW-812L	6/29/08 2:25 PM	0.58	OW-812U	6/29/08 2:21 PM	-0.97

ND = No Data; R = Rejected Data

Table 2AA-206
Reference Heads for August 15, 2008 Potentiometric Surface Map (approximately 10am, high tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	8/15/08 9:34 AM	0.33	OW-606U	8/15/08 9:46 AM	-0.86
OW-621L	8/15/08 9:57 AM	1.11	OW-621U	8/15/08 9:47 AM	-0.65
OW-636L	8/15/08 10:17 AM	0.35	OW-636U	8/15/08 9:57 AM	-0.35
OW-706L	---	R	OW-706U	8/15/08 10:12 AM	-0.70
OW-721L	8/15/08 10:17 AM	2.19	OW-721U	---	ND
OW-735L	8/15/08 10:00 AM	2.44	OW-735U	8/15/08 9:54 AM	-0.92
OW-802L	8/15/08 10:15 AM	0.72	OW-802U	---	ND
OW-805L	8/15/08 10:30 AM	0.83	OW-805U	8/15/08 9:42 AM	-0.65
OW-809L	8/15/08 9:53 AM	0.71	OW-809U	8/15/08 10:14 AM	-0.88
OW-812L	8/15/08 10:25 AM	0.94	OW-812U	8/15/08 10:21 AM	-0.63

ND = No Data; R = Rejected Data

Table 2AA-207
Reference Heads for August 15, 2008 Potentiometric Surface Map (approximately 5pm, low tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	8/15/08 4:34 PM	-0.10	OW-606U	8/15/08 4:46 PM	-1.28
OW-621L	8/15/08 4:57 PM	0.67	OW-621U	8/15/08 4:47 PM	-1.10
OW-636L	8/15/08 5:17 PM	-0.05	OW-636U	8/15/08 4:57 PM	-0.80
OW-706L	---	R	OW-706U	8/15/08 5:12 PM	-0.99
OW-721L	8/15/08 5:17 PM	1.88	OW-721U	---	ND
OW-735L	8/15/08 5:00 PM	2.18	OW-735U	8/15/08 4:54 PM	-1.20
OW-802L	8/15/08 5:15 PM	0.38	OW-802U	---	ND
OW-805L	8/15/08 5:30 PM	0.41	OW-805U	8/15/08 4:42 PM	-1.13
OW-809L	8/15/08 4:53 PM	0.49	OW-809U	8/15/08 5:14 PM	-1.10
OW-812L	8/15/08 5:25 PM	0.71	OW-812U	8/15/08 5:21 PM	-0.86

ND = No Data; R = Rejected Data

Table 2AA-208
Reference Heads for October 5, 2008 Potentiometric Surface Map (approximately 1am, high tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	---	ND	OW-606U	10/5/08 12:46 AM	0.39
OW-621L	10/5/08 12:57 AM	2.33	OW-621U	10/5/08 12:47 AM	0.62
OW-636L	10/5/08 1:17 AM	1.48	OW-636U	10/5/08 12:57 AM	0.83
OW-706L	---	R	OW-706U	10/5/08 1:12 AM	0.55
OW-721L	10/5/08 1:17 AM	3.28	OW-721U	---	ND
OW-735L	10/5/08 1:00 AM	3.54	OW-735U	10/5/08 12:54 AM	0.41
OW-802L	10/5/08 1:00 AM	2.07	OW-802U	---	ND
OW-805L	10/5/08 12:36 AM	2.07	OW-805U	10/5/08 12:42 AM	0.56
OW-809L	10/5/08 12:53 AM	2.07	OW-809U	10/5/08 1:14 AM	0.56
OW-812L	---	ND	OW-812U	10/5/08 1:21 AM	0.78

ND = No Data; R = Rejected Data

Table 2AA-209
Reference Heads for October 5, 2008 Potentiometric Surface Map (approximately 8am, low tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	---	ND	OW-606U	10/5/08 7:46 AM	-0.05
OW-621L	10/5/08 7:57 AM	1.85	OW-621U	10/5/08 7:47 AM	0.15
OW-636L	10/5/08 8:17 AM	1.01	OW-636U	10/5/08 7:57 AM	0.35
OW-706L	---	R	OW-706U	10/5/08 8:12 AM	0.27
OW-721L	10/5/08 8:17 AM	2.96	OW-721U	---	ND
OW-735L	10/5/08 8:00 AM	3.33	OW-735U	10/5/08 7:54 AM	0.19
OW-802L	10/5/08 8:00 AM	1.70	OW-802U	---	ND
OW-805L	10/5/08 7:36 AM	1.56	OW-805U	10/5/08 7:42 AM	0.04
OW-809L	10/5/08 7:53 AM	1.91	OW-809U	10/5/08 8:14 AM	0.40
OW-812L	---	ND	OW-812U	10/5/08 8:21 AM	0.59

ND = No Data; R = Rejected Data

Table 2AA-210
Reference Heads for January 20, 2009 Potentiometric Surface Map (approximately 7pm, high tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	1/20/09 7:05 PM	-1.28	OW-606U	1/20/09 7:16 PM	-2.38
OW-621L	1/20/09 6:48 PM	-0.31	OW-621U	1/20/09 6:43 PM	-2.19
OW-636L	1/20/09 6:32 PM	-1.19	OW-636U	---	ND
OW-706L	---	R	OW-706U	1/20/09 6:55 PM	-2.11
OW-721L	1/20/09 7:29 PM	0.58	OW-721U	---	ND
OW-735L	---	ND	OW-735U	---	ND
OW-802L	1/20/09 6:58 PM	-0.69	OW-802U	---	ND
OW-805L	1/20/09 7:05 PM	-0.67	OW-805U	1/20/09 7:17 PM	-2.16
OW-809L	1/20/09 7:28 PM	-0.89	OW-809U	1/20/09 6:34 PM	-2.37
OW-812L	---	ND	OW-812U	1/20/09 6:32 PM	-2.09

ND = No Data; R = Rejected Data

Table 2AA-211
Reference Heads for January 21, 2009 Potentiometric Surface Map (approximately 2am, low tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	1/21/09 2:05 AM	-1.89	OW-606U	1/21/09 2:16 AM	-3.00
OW-621L	1/21/09 1:48 AM	-0.94	OW-621U	1/21/09 1:43 AM	-2.83
OW-636L	1/21/09 1:32 AM	-1.72	OW-636U	---	ND
OW-706L	---	R	OW-706U	1/21/09 1:55 AM	-2.70
OW-721L	1/21/09 2:29 AM	-0.02	OW-721U	---	ND
OW-735L	---	ND	OW-735U	---	ND
OW-802L	1/21/09 1:58 AM	-1.37	OW-802U	---	ND
OW-805L	1/21/09 2:05 AM	-1.30	OW-805U	1/21/09 2:17 AM	-2.79
OW-809L	1/21/09 2:28 AM	-1.51	OW-809U	1/21/09 1:34 AM	-2.99
OW-812L	---	ND	OW-812U	1/21/09 1:32 AM	-2.73

ND = No Data; R = Rejected Data

Table 2AA-212
Reference Heads for July 15, 2009 Potentiometric Surface Map (7am, high tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	7/15/09 7:00 AM	0.31	OW-606U	7/15/09 7:00 AM	-1.21
OW-621L	7/15/09 7:00 AM	0.48	OW-621U	7/15/09 7:00 AM	-1.02
OW-636L	7/15/09 7:00 AM	0.47	OW-636U	7/15/09 7:00 AM	-0.66
OW-706L	---	R	OW-706U	7/15/09 7:00 AM	-0.94
OW-721L	7/15/09 7:00 AM	1.05	OW-721U	---	R
OW-735L	7/15/09 7:00 AM	1.22	OW-735U	7/15/09 7:00 AM	-1.01
OW-802L	7/15/09 7:00 AM	0.16	OW-802U	---	R
OW-805L	7/15/09 7:00 AM	0.65	OW-805U	7/15/09 7:00 AM	-1.04
OW-809L	7/15/09 7:00 AM	0.86	OW-809U	7/15/09 7:00 AM	-1.23
OW-812L	7/15/09 7:00 AM	0.71	OW-812U	7/15/09 7:00 AM	-0.93

ND = No Data; R = Rejected Data

Table 2AA-213
Reference Heads for July 15, 2009 Potentiometric Surface Map (2pm, low tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	7/15/09 2:00 PM	0.15	OW-606U	7/15/09 2:00 PM	-1.38
OW-621L	7/15/09 2:00 PM	0.31	OW-621U	7/15/09 2:00 PM	-1.18
OW-636L	7/15/09 2:00 PM	0.29	OW-636U	7/15/09 2:00 PM	-0.84
OW-706L	---	R	OW-706U	7/15/09 2:00 PM	-1.05
OW-721L	7/15/09 2:00 PM	0.92	OW-721U	---	R
OW-735L	7/15/09 2:00 PM	1.11	OW-735U	7/15/09 2:00 PM	-1.13
OW-802L	7/15/09 2:00 PM	0.02	OW-802U	---	R
OW-805L	7/15/09 2:00 PM	0.48	OW-805U	7/15/09 2:00 PM	-1.21
OW-809L	7/15/09 2:00 PM	0.77	OW-809U	7/15/09 2:00 PM	-1.33
OW-812L	7/15/09 2:00 PM	0.61	OW-812U	7/15/09 2:00 PM	-1.02

ND = No Data; R = Rejected Data

Table 2AA-214
Reference Heads for January 15, 2010 Potentiometric Surface Map (11am, high tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	1/15/09 11:00 AM	0.93	OW-606U	---	ND
OW-621L	1/15/09 11:00 AM	1.06	OW-621U	1/15/09 11:00 AM	-0.57
OW-636L	1/15/09 11:00 AM	1.00	OW-636U	1/15/09 11:00 AM	-0.39
OW-706L	1/15/09 11:00 AM	0.95	OW-706U	1/15/09 11:00 AM	-0.51
OW-721L	1/15/09 11:00 AM	1.49	OW-721U	---	R
OW-735L	1/15/09 11:00 AM	2.06	OW-735U	1/15/09 11:00 AM	-0.59
OW-802L	1/15/09 11:00 AM	0.46	OW-802U	---	R
OW-805L	1/15/09 11:00 AM	1.35	OW-805U	1/15/09 11:00 AM	-0.54
OW-809L	---	R	OW-809U	1/15/09 11:00 AM	-0.82
OW-812L	1/15/09 11:00 AM	1.27	OW-812U	1/15/09 11:00 AM	-0.45

ND = No Data; R = Rejected Data

Table 2AA-215
Reference Heads for January 15, 2010 Potentiometric Surface Map (6pm, low tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	1/15/09 6:00 PM	0.55	OW-606U	---	ND
OW-621L	1/15/09 6:00 PM	0.65	OW-621U	1/15/09 6:00 PM	-0.97
OW-636L	1/15/09 6:00 PM	0.66	OW-636U	1/15/09 6:00 PM	-0.76
OW-706L	1/15/09 6:00 PM	0.72	OW-706U	1/15/09 6:00 PM	-0.75
OW-721L	1/15/09 6:00 PM	1.22	OW-721U	---	R
OW-735L	1/15/09 6:00 PM	1.87	OW-735U	1/15/09 6:00 PM	-0.79
OW-802L	1/15/09 6:00 PM	0.14	OW-802U	---	R
OW-805L	1/15/09 6:00 PM	0.92	OW-805U	1/15/09 6:00 PM	-0.97
OW-809L	---	R	OW-809U	1/15/09 6:00 PM	-0.95
OW-812L	1/15/09 6:00 PM	1.10	OW-812U	1/15/09 6:00 PM	-0.60

ND = No Data; R = Rejected Data

Table 2AA-216
Data Acceptable for Use

Location	1st & 2nd Qtr	3rd Qtr	4th Qtr	5th Qtr	6th Qtr	7th Qtr
OW-606L	6-4-08 @12:34 to 8-17-08 @13:34, 10-15-08 @ 8:10 to 2-4-09 @ 8:05	2-12-09 @ 16:09 to 5-27-09@13:09 with the exception of the following dates: 3-2-09, 3-5-09, 3-16-09, 3-17-09, 3-20-09, 3-21-09 (pumping test activities)	5-27-09 @ 15:00 to 8-26-09@13:00	8-26-09 @ 15:00 to 11-10-09 @ 9:40	11-18-09 @ 11:00 to 2-8-10 @ 13:00	2-16-10 @ 18:00 to 6-22-10 @ 15:00
OW-606U	6-4-08 @ 12:46 to 8-17-08 @11:46, 9-25-08 @ 13:46 to 2-4-09 @ 8:16	2-12-09 @ 15:50 to 5-27-09 @ 12:50 with the exception of the following dates: 3-11-09, 3-13-09 3-16-09, 3-17-09 and 3-20-09 (pumping test activities)	5-27-09 @ 15:00 to 8-26-09@13:00	8-26-09 @ 14:00 to 11-10-09 @ 9:00	no data - transducer failed	2-16-10 @ 18:00 to 6-22-10 @ 15:00
OW-621L	6-9-08 @ 10:57 to 1-30-09 @ 14:48	2-12-09 @ 14:48 to 5-27-09 @ 11:48	5-27-09 @ 13:00 to 8-25-09 @ 13:00	8-25-09 @ 14:00 to 11-10-09 @ 10:00	11-18-09 @ 11:00 to 2-8-10 @ 13:00	2-16-10 @ 17:00 to 6-22-10 @ 16:00
OW-621U	6-9-08 @ 10:47 to 8-17-08 @ 13:47, 9-25-08 @ 0:47 to 1-30-09 @ 14:43	2-12-09 @ 14:59 to 5-27-09 @ 11:59	5-27-09 @ 13:00 to 8-25-09 @ 13:00	8-25-09 @ 15:00 to 11-10-09 @ 10:00	11-18-09 @ 12:00 to 2-8-10 @ 13:00	2-16-10 @ 17:00 to 6-22-10 @ 17:00
OW-636L	6-25-08 @ 16:17 to 1-29-09 @ 12:32	3-26-09 @ 1:04 pm to 5-28-09 @ 9:04 am	5-28-09 @ 10:00 to 8-26-09 @ 8:00	8-26-09 @ 9:00 to 11-10-09 @ 15:00	11-19-09 @ 15:00 to 2-8-10 @ 9:00	2-17-10 @ 9:00 to 6-24-10 @ 12:00
OW-636U	6-10-08 @ 9:57 to 12-6-09 @ 18:42	2-6-09 @ 17:21 to 5-28-09 @ 8:57	5-28-09 @ 10:00 to 8-26-09 @ 9:00	no data - transducer failed	11-19-09 @ 15:00 to 2-12-10 @ 10:00	2-17-10 @ 9:00 to 6-24-10 @ 13:00
OW-706L	reject all data, large delta with manual measurement	2-21-09 @ 00:04 to 5-27-09 @ 14:22 the following dates data were impacted by pumping test activities and are not included: 2-12-09 to 2-20-09, 2-23-09, 2-24-09, 2-28-09, 3-4-09 and 3-7-09	reject all data, could not connect to logger in field, failed post-cal at lab	8-27-09 @ 14:00 to 11-10-09 @ 13:00	11-18-09 @ 13:00 to 2-8-10 @ 14:00	2-16-10 @ 18:00 to 6-22-10 @ 15:00
OW-706U	6-5-08 @ 14:12 to 2-3-09 @ 11:55	2-6-09 @ 18:01 to 5-27-09 @ 15:17, with the exception of the following dates: 2-12-09 to 2-20-09, 2-23-09, 2-24-09, 2-28-09, 3-4-09 and 3-7-09 (pumping test activities)	5-27-09 @ 17:00 to 8-26-09 @ 14:00	8-26-09 @ 15:00 to 11-10-09 @ 14:00	11-18-09 @ 12:00 to 2-8-10 @ 14:00	2-16-10 @ 18:00 to 6-22-10 @ 15:00
OW-721L	6-6-08 @9:17 to 1-30-09 @ 15:29	2-6-09 @ 14:01 to 5-27-09 @ 12:34, with the exception of the following dates: 2-12-09 to 2-20-09, 2-23-09, 2-24-09, 2-28-09, 3-4-09 and 3-7-09 (pumping test activities)	5-27-09 @ 14:00 to 8-25-09 @ 14:00	8-25-09 @ 15:00 to 11-11-09 @ 10:00	11-18-09 @ 12:00 to 2-8-10 @ 14:00	2-16-10 @ 17:00 to 6-22-10 @ 16:00
OW-721U	reject all - kinked vent tube	reject all - kinked vent tube	reject all - kinked vent tube	reject all - kinked vent tube	reject all - kinked vent tube	2-16-10 @ 17:00 to 4-30-10 @ 23:00 data after 4-30-10 become erratic
OW-735L	6-9-08 @ 13:00 to 10-9-08 @ 12:00	2-12-09 @ 16:30 to 5-27-09 @ 15:30	5-27-09 @ 17:00 to 8-26-09 @ 15:00	no data - transducer failed	11-19-09 @ 14:00 to 2-8-10 @ 14:00	2-16-10 @ 19:00 to 6-23-10 @ 11:00
OW-735U	6-9-08 @12:54 to 12-21 @ 1:09	2-12-09 @ 16:44 to 5-27-09 @ 15:45	5-27-09 @ 17:00 to 8-26-09 @ 15:00	8-26-09 @ 16:00 to 11-10-09 @ 14:00	11-19-09 @ 14:00 to 2-8-10 @ 14:00	2-16-10 @ 19:00 to 6-23-10 @ 11:00
OW-802L	6-6-08 @ 12:15 to 2-3-09 @ 9:58	2-6-09 @ 12:46 to 5-27-09 @ 8:37	5-27-09 @10:00 to 8-25-09 @ 10:00	8-25-09 @ 11:00 to 11-10-09 @ 12:00	11-14-09 @ 11:00 to 2-8-10 @ 11:00	2-16-10 @ 14:00 to 6-23-10 @ 9:00
OW-802U	reject all - kinked vent tube	reject all - kinked vent tube	reject all - kinked vent tube	reject all - kinked vent tube	reject all - kinked vent tube	2-16-10 @ 14:00 to 6-23-10 @ 9:00
OW-805L	6-10-08 @ 8:30 to 8-17-08 @ 12:30, 9-24-08 @ 8:36 to 1-30-09 @ 14:05	3-26-09 @13:40 to 5-28-09 @ 9:40	5-28-09 @ 11:00 to 8-26-09 @ 11:00	8-26-09 @ 12:00 to 11-16-09 @ 8:00	11-16-09 @ 11:00 to 2-8-10 @ 12:00	2-16-10 @ 16:00 to 6-23-10 @ 15:00
OW-805U	6-10-08 @ 8:42 to 1-30-09 @ 14:17	2-12-09 @ 15:26 to 5-28-09 @ 9:26	5-28-09 @ 11:00 to 8-26-09 @ 11:00	8-26-09 @ 12:00 to 11-16-09 @ 10:00	11-16-09 @ 12:00 to 2-8-10 @ 12:00	2-16-10 @ 16:00 to 6-23-10 @ 16:00
OW-809L	6-5-08 @ 10:53 to 1-30-09 @ 15:28	2-12-09 @ 12:37 to 5-27-09 @ 9:37	5-27-09 @ 11:00 to 8-25-09 @ 11:00	no data - transducer failed	reject all data, large delta with manual measurement	2-16-10 @ 15:00 to 6-23-10 @ 10:00
OW-809U	6-5-08 @ 9:14 to 2-4-09 @ 12:34	2-12-09 @ 12:49 to 5-27-09 @ 9:49	5-27-09 @ 11:00 to 8-25-09 @ 11:00	8-25-09 @ 12:00 to 11-10-09 @ 13:00	11-19-09 @ 14:00 to 2-8-10 @ 11:00	2-16-10 @ 15:00 to 6-23-10 @ 10:00
OW-812L	6-6-08 @ 13:25 to 9-22-08 @ 7:25	2/6/2009 @ 13:22 to 5-27-09 @ 9:22	5-27-09 @ 11:00 to 8-25-09 @ 10:00	8-25-09 @ 12:00 to 11-9-09 @ 14:00	11-14-09 @ 14:00 to 2-9-10 @ 11:00	2-16-10 @ 14:00 to 6-23-10 @ 10:00
OW-812U	6-6-08 @ 13:21 to 1-30-09 @15:32	2-12-09 @ 13:32 to 5-27-09 @ 8:32	5-27-09 @ 10:00 to 8-25-09 @ 10:00	8-25-09 @ 11:00 to 11-10-09 @ 12:00	11-14-09 @ 14:00 to 2-8-10 @ 11:00	2-16-10 @ 14:00 to 6-23-10 @ 9:00
SW-1	reject all data, large delta with manual measurement	2-6-09 @ 16:38 to 5-28-09 @ 10:07	5-28-09 @ 12:00 to 8-26-09 @ 10:00	8-26-09 @ 11:00 to 11-17-09 @ 11:00	11-17-09 @ 12:00 to 2-8-10 @ 9:00	2-17-10 @ 11:00 to 6-24-10 @ 8:00
SW-2	6-9-08 @ 7:30 to 1-30-09 @ 16:09	2-6-09 @ 16:06 to 5-28-09 @ 9:06	5-28-09 @ 10:00 to 8-26-09 @ 9:00	8-26-09 @ 10:00 to 11-17-09 @ 12:00	11-17-09 @ 13:00 to 2-8-10 @ 9:00	2-17-10 @ 11:00 to 6-24-10 @ 10:00

Table 2AA-217
Maximum and Minimum Recorded Water Level Elevations

Well	Maximum Elevation[(a)] (feet NAVD 88)	Minimum Elevation[(a)] (feet NAVD 88)	Well	Maximum Elevation[(a)] (feet NAVD 88)	Minimum Elevation[(a)] (feet NAVD 88)
OW-606L	0.20	-3.06	OW-606U	0.27	-3.24
OW-621L	1.05	-2.81	OW-621U	0.56	-3.00
OW-636L	1.52	-1.75	OW-636U	0.62	-2.60
OW-706L	2.04	-1.01	OW-706U	0.25	-3.09
OW-721L	2.09	-2.56	OW-721U	-0.92	-2.21
OW-735L	2.15	-2.85	OW-735U	0.12	-2.96
OW-802L	1.91	-1.73	OW-802U	-0.93	-2.29
OW-805L	0.99	-2.59	OW-805U	0.48	-2.99
OW-809L	1.70	-2.01	OW-809U	0.24	-3.42
OW-812L	1.17	-2.12	OW-812U	0.51	-3.12
SW-1	-0.22	-3.76	SW-2	-0.26	-3.90

(a) Recorded water level elevations are observed levels in each well. These elevations have not been adjusted to reference heads.

Table 2AA-218
Density Measurements Collected in June 2010

Location	Specific Conductance (milliSiemens per centimeter)	Salinity (PSU)	Temperature (°C)	Density (grams per cubic centimeter)
OW-606L	77.2	53.6	28.83	1.036
OW-606U	72.1	49.6	29.22	1.033
OW-621L	74.5	51.5	29.17	1.034
OW-621U	61.6	41.4	28.94	1.027
OW-636L	59.6	39.9	29.11	1.026
OW-636U	66.8	45.4	28.13	1.030
OW-706L	52.3	34.4	29.73	1.021
OW-706U	80.7	56.4	30.53	1.038
OW-721L	76.8	53.3	29.90	1.036
OW-721U	68.7	46.9	29.33	1.031
OW-735L	82.4	57.8	31.10	1.039
OW-735U	82.4	57.8	31.74	1.038
OW-802L	56.7	37.7	28.69	1.024
OW-802U	74.0	51.1	28.76	1.034
OW-805L	73.6	50.8	28.50	1.034
OW-805U	71.9	49.4	28.32	1.033
OW-809L	67.0	45.6	31.04	1.029
OW-809U	81.0	56.7	31.05	1.038
OW-812L	65.3	44.3	31.90	1.028
OW-812U	78.7	54.8	33.77	1.035
SW-1	97.8	70.7	32.47	1.048
SW-2	93.9	67.4	30.37	1.046

Table 2AA-219
Reference Heads for June 15, 2010 Potentiometric Surface Map (2am, high tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	6/15/10 2:00 AM	0.39	OW-606U	6/15/10 2:00 AM	-0.89
OW-621L	6/15/10 2:00 AM	0.42	OW-621U	6/15/10 2:00 AM	-0.85
OW-636L	6/15/10 2:00 AM	0.63	OW-636U	6/15/10 2:00 AM	-0.61
OW-706L	6/15/10 2:00 AM	0.67	OW-706U	6/15/10 2:00 AM	-0.86
OW-721L	6/15/10 2:00 AM	0.55	OW-721U	—	R
OW-735L	6/15/10 2:00 AM	0.79	OW-735U	6/15/10 2:00 AM	-0.93
OW-802L	6/15/10 2:00 AM	0.30	OW-802U	6/15/10 2:00 AM	-0.96
OW-805L	6/15/10 2:00 AM	0.65	OW-805U	6/15/10 2:00 AM	-0.75
OW-809L	6/15/10 2:00 AM	0.71	OW-809U	6/15/10 2:00 AM	-1.14
OW-812L	6/15/10 2:00 AM	0.26	OW-812U	6/15/10 2:00 AM	-0.95

R = Rejected Data

Table 2AA-220
Reference Heads for June 15, 2010 Potentiometric Surface Map
(9am, low tide)

Well	Date/Time	Reference Head (feet NAVD 88)	Well	Date/Time	Reference Head (feet NAVD 88)
OW-606L	6/15/10 9:00 AM	0.07	OW-606U	6/15/10 9:00 AM	-1.20
OW-621L	6/15/10 9:00 AM	0.08	OW-621U	6/15/10 9:00 AM	-1.17
OW-636L	6/15/10 9:00 AM	0.29	OW-636U	6/15/10 9:00 AM	-0.97
OW-706L	6/15/10 9:00 AM	0.50	OW-706U	6/15/10 9:00 AM	-1.03
OW-721L	6/15/10 9:00 AM	0.34	OW-721U	—	R
OW-735L	6/15/10 9:00 AM	0.65	OW-735U	6/15/10 9:00 AM	-1.09
OW-802L	6/15/10 9:00 AM	0.07	OW-802U	6/15/10 9:00 AM	-1.19
OW-805L	6/15/10 9:00 AM	0.28	OW-805U	6/15/10 9:00 AM	-1.11
OW-809L	6/15/10 9:00 AM	0.64	OW-809U	6/15/10 9:00 AM	-1.20
OW-812L	6/15/10 9:00 AM	0.16	OW-812U	6/15/10 9:00 AM	-1.02

R = Rejected Data

APPENDIX 2BB

AQUIFER PUMPING TEST RESULTS

APPENDIX 2BB TABLE OF CONTENTS

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APPENDIX 2BB LIST OF ATTACHMENTS

1.0 PURPOSE

This appendix provides the interpretation of aquifer pumping tests performed adjacent to the locations of the Units 6 & 7 reactor buildings (Figure 2BB-201). The aquifer pumping tests were performed to provide hydrogeologic properties of the subsurface materials for construction dewatering system design, groundwater flow model support, the analysis of postulated accidental releases of radioactive liquid effluents, and to support simulation of radial collector well operation.

2.0 BACKGROUND HYDROGEOLOGY

The Units 6 & 7 subsurface investigation (Reference 1) identified five subsurface units at the plant area:

- Muck — organic calcareous silt
- Miami Formation — oolitic limestone
- Fort Thompson Formation — coralline to sandy limestone
- Tamiami Formation — poorly graded silty sand with interlayered clayey sand, silt, and clay
- Hawthorn Group — poorly graded silty sand grading to dolostone and limestone

Subsequent data interpretation divided the Fort Thompson Formation into two units, with the coralline portion being assigned as the Key Largo Limestone and the sandy limestone being assigned as the Fort Thompson Formation. This interpretation also identified a thin layer of freshwater limestone at the top of the Fort Thompson Formation. This freshwater limestone appears to have much lower porosity and permeability than the overlying Key Largo Limestone and the underlying marine limestone of the Fort Thompson Formation.

The primary aquifer in the vicinity of the Turkey Point plant property is the Biscayne aquifer, which is the main water supply source for Miami-Dade County. The Biscayne aquifer in the area of Units 6 & 7 contains saline to saltwater and is not usable as a potable water supply.

The Biscayne aquifer comprises all or parts of the Pliocene through Holocene-aged upper Tamiami Formation, Fort Thompson Formation, Key Largo Limestone, Miami Limestone (oolite), and surficial deposits. Regional

transmissivities from aquifer testing of this aquifer range from 2700 square feet per day (20,196 gallons per day per foot) to greater than 1,000,000 square feet per day (7,480,000 gallons per day per foot) (Reference 2).

Dames & Moore (Reference 3) conducted a hydrogeologic investigation adjacent to the plant area, which included three aquifer pumping tests, and determined the following properties:

Formation	Transmissivity		Storage Coefficient*
	gpd/ft	ft^2/d	
Muck and Miami Oolite	20,000	2,700	0.35
Fort Thompson Formation (void zone)	3,000,000	400,000	0.35
Fort Thompson Formation (lower zone)	1,000,000	134,000	0.20

*Reported as storage coefficient but most probably represents specific yield

3.0 CONCEPTUAL MODEL

The conceptual model for the Biscayne aquifer beneath the Units 6 & 7 plant area is shown on Figure 2BB-202. This conceptual model was created using geologic and hydrogeologic information obtained from the geotechnical investigation of the site (Reference 1) and then refined with additional information from the aquifer pumping tests program. Two test zones were identified for the testing program: the upper zone, which is located in the Key Largo Limestone, and the lower zone, which is located in the Fort Thompson Formation.

The muck and Miami Limestone units are interpreted to have a lower hydraulic conductivity than the underlying Key Largo Limestone. The freshwater limestone layer is interpreted to have a lower hydraulic conductivity than either the overlying Key Largo Limestone or the underlying Fort Thompson Formation. The Tamiami Formation is also interpreted to have a lower hydraulic conductivity than the overlying Fort Thompson Formation. Thus, the Miami Limestone, freshwater limestone, and Tamiami Formation are treated as aquitards in the subsurface.

4.0 METHODOLOGY

4.1 Test Configuration

The aquifer testing program consisted of performing two aquifer pumping tests adjacent to the location of each reactor containment. The pumping wells at Unit 6 were designated PW-6U and PW-6L and at Unit 7 were designated PW-7U and PW-7L. The U/L suffix was used to indicate pumping in either the upper or lower test zone as described in Section 3.0. For each test group, a total of 25

observation wells were installed in five groups of five wells. Each observation well is numbered using the convention CX-#$ where:

X = reactor unit (6 or 7)

= number indicating well position

1 = approximately 10 feet east of upper zone pumping well

2 = approximately 10 feet north of upper zone pumping well

3 = approximately 25 feet north of upper zone pumping well

4 = approximately 40 feet north of upper zone pumping well

5 = approximately 10 feet east of lower zone pumping well

$ = alphabetic character designating the well monitoring zone

A = Miami Limestone

B = Freshwater limestone

C = Tamiami Formation

D = Upper test zone (Key Largo Limestone)

E = Lower test zone (Fort Thompson Formation)

Figures 2BB-203 and 2BB-204 present location plans for the two test groups and Figure 2.4.12-239 shows the general location of the tests. Table 2BB-201 presents the well construction information for the pumping and observation wells.

4.2 Data Collection and Pre-Processing

Groundwater level data were collected using In-Situ, Inc. Level TROLL® or Aqua TROLL® recording pressure transducers. Three data sets were collected during each test:

- Background groundwater levels — to allow assessment of tidal influences
- Pumping levels — to measure drawdown in response to pumping the test well

- Recovery levels — to measure water level recovery after the pumping test stopped

The background levels were recorded on a linear logging interval of every five minutes. The pumping and recovery levels were either recorded on a logarithmic interval starting at 0.251 seconds and increasing as the test progressed, on a linear interval starting at 0.25 seconds for the first five minutes and then increasing to 30 seconds for the remainder of the test, or on a linear interval starting at 1 minute.

The raw water level data were pre-processed to remove tidal effects by using data from background observation wells. The corrections included the following assumptions:

- The first five minutes of the pumping or recovery periods in each observation well were not corrected due to the rapid response to pumping or recovery and relatively slow tidal response.
- One background well cluster (A, B, C, D, and E) was used to correct the observation well data for each test, due to the limited spatial extent of the well array.

The tidal correction was made using the following procedure:

1. Plot the water level change between successive readings in the observation well (ΔW) versus the changes in the background well (ΔR) during the background data collection period prior to the test and determine the tidal efficiency by linear regression. The tidal efficiency is the slope of the fitted line.
2. Determine the water level changes between successive readings in the background well during the pumping and recovery periods of the test.
3. Compute the correction factor at time t by multiplying tidal efficiency (step 1) by the water level change (step 2) and adding the previous correction factor (at start of test, correction factor = 0).
4. Subtract the correction factor from the water level at time t in the observation well to obtain the corrected water level.

5. Determine the drawdown/residual drawdown from the test by subtracting the corrected water level from the static water level (at time of test start) in the observation well.

Water level recovery data was truncated at the point where the static level was encountered (zero drawdown). The raw data may have up to several thousand readings after this point, which are not germane to the test interpretation.

4.3 Data Assessment

Data assessment was conducted for each test to evaluate the pumping rate and water level measurements collected during the test.

The acceptance criteria for the pumping rate measurements were: 1) the manual and electronic flow measurements show reasonable agreement; 2) the short term discharge did not vary more than 10 percent about the mean discharge (Reference 4); and 3) the pumping rate is between 3000 and 12,000 gallons per minute (gpm), which is the calibrated range of the flowmeter.

The acceptance criteria for water level measurements were: 1) comparison of the rate of water level change to the transducer recording interval. When a major change occurs over a single recording time interval, followed by no change in the successive time interval, the recording interval is insufficient to characterize the change, 2) water level responses are consistent between wells screened in the same zone but at different distances from the pumped well and between different monitoring zones in the same well cluster.

4.4 Data Interpretation

The aquifer pumping test results were interpreted using the AQTESOLV™ (Reference 5) computer program. This program contains solution options for different hydrogeologic conditions such as unconfined, confined, and leaky conditions.

Based on the conceptual model described above and the objectives of the test to determine the properties of the aquifers and aquitards at the site, various aquifer test solution methods were evaluated to select the most appropriate method. The test methods included:

- Neuman solution for unconfined aquifer (gravity drainage)
- Theis solution for confined aquifer

- Neuman-Witherspoon solution for leaky aquifer
- Hantush solution for leaky aquifer with aquitard storage

The test results were examined using these methods and it was found that the data did not show significant gravity drainage effects over the testing period, suggesting the pumped aquifer behaves similarly to a confined aquifer. The Neuman and Theis solutions provide information only on the properties of the pumped aquifer. The Neuman-Witherspoon method includes an assumption that the pumped aquifer is bounded on one side by a leaky aquitard and on the other side by an impermeable aquiclude. This situation does not match the conceptual model for the site or the actual field conditions encountered during well installation for the tests. The Hantush solution includes an assumption that the pumped aquifer is bounded on both sides by leaky aquitards. This condition matches the conceptualization of the site and actual conditions observed during well installations. The Theis solution was also retained as a means to determine the upper bound of transmissivity in the pumped aquifer, since this method ignores leakage or gravity drainage effects.

The two interpretation methods selected and used were: the Theis method (Reference 5) and the Hantush leaky aquifer with aquitard storage method (References 5 and 6). The Hantush leaky method with aquitard storage was used to evaluate the distance-drawdown and time-drawdown relationships in the pumping zone observation wells ("D" or "E" series wells).

The physical system represented by the Theis method is shown on Figure 2BB-205.

The method includes the following assumptions:

- Aquifer has infinite areal extent
- Aquifer is homogeneous and of uniform thickness
- Pumping well is fully or partially penetrating
- Flow to pumping well is horizontal when pumping well is fully penetrating
- Aquifer is confined above and below by aquicludes
- Flow is unsteady

- Water is released instantaneously from storage with decline of hydraulic head
- Diameter of pumping well is very small so that storage in the well can be neglected

The equations for representing drawdown (s) for a confined aquifer are (Reference 5):

$$s = \frac{Q}{4\pi T}\int_u^\infty \frac{e^{-y}}{y}dy$$

The integral expression can be represented as W(u), the well function of u, which is represented by the series (Reference 7):

$$W(u) = \left[-0.5772 - \ln u + u - \frac{u^2}{2 \bullet 2!} + \frac{u^3}{3 \bullet 3!} - \frac{u^4}{4 \bullet 4!} + \ldots\right]$$

Where,

$$u = \frac{r^2 S}{4Tt}$$

r	=	radial distance from the pumping well to the observation point [L]
Q	=	pumping rate [L^3/t]
s	=	drawdown [L]
S	=	storativity [dimensionless]
t	=	time
T	=	transmissivity [L^2/t]

The Theis drawdown equation in compact notation is:

$$s = \frac{Q}{4\pi T}W(u)$$

The physical system represented by the Hantush leaky aquifer with aquitard storage method is shown on Figure 2BB-206. The method includes the following assumptions:

- Aquifer has infinite areal extent

- Aquifer is homogeneous and of uniform thickness
- Pumping well is fully or partially penetrating
- Flow to pumping well is horizontal when pumping well is fully penetrating
- Aquifer is leaky confined
- Flow is unsteady
- Water is released instantaneously from storage with decline of hydraulic head
- Diameter of pumping well is very small so that storage in the well can be neglected
- Confining bed(s) has (have) infinite areal extent, uniform vertical hydraulic conductivity and uniform thickness
- Confining bed(s) is (are) overlain or underlain by an infinite constant-head plane source
- Flow is vertical in the aquitard(s)

The inverse Laplace transform solution for unsteady flow to a fully penetrating well in a homogeneous, isotropic leaky confined aquifer with aquitard storage is (Reference 8):

$$s(r,t) = \frac{Q}{4\pi T} H(u,\beta)$$

$$u = \frac{r^2 S}{4Tt} \qquad \beta = \frac{r}{4B}\sqrt{\frac{S'}{S}} \qquad B = \sqrt{\frac{T}{K'/b'}}$$

For a two aquitard system, AQTESOLV™ (Reference 5) determines the B' and B” leakage values, where:

$$B' = \sqrt{\frac{Tb'}{K'}}$$

$$B'' = \sqrt{\frac{Tb''}{K''}}$$

Where,

H(u,β)	=	Hantush leaky well function
b’	=	thickness of first aquitard [L]
b”	=	thickness of second aquitard [L]
K’	=	vertical hydraulic conductivity of first aquitard [L/t]
K”	=	vertical hydraulic conductivity of second aquitard [L/t]
Q	=	pumping rate [L^3/t]
r	=	radial distance [L]
s	=	drawdown [L]
S	=	storativity of aquifer [dimensionless]
S’	=	storativity of aquitard [dimensionless]
t	=	time [t]
T	=	transmissivity of aquifer [L^2/t]

For the conditions at Units 6 & 7, the Hantush method was applied as follows:

Upper Zone Test

Upper aquitard — Miami Limestone

Upper aquifer — Key Largo Limestone (pumped aquifer)

Lower aquitard — freshwater limestone

Lower aquifer — Fort Thompson Formation (unpumped aquifer)

Lower Zone Test

Upper aquifer — Key Largo Limestone (unpumped aquifer)

Upper aquitard — freshwater limestone

Lower aquifer — Fort Thompson Formation (pumped aquifer)

Lower aquitard — Tamiami Formation

The aquifer test interpretation methods utilized simplified conceptual hydrogeologic models of site conditions. Localized variations in the hydrogeologic properties of the aquifers and aquitards may not conform to these simplified conceptual models. The drawdown response from each test data set was reviewed to evaluate conformance to these conceptual models.

A constant density was applied to the water levels transducer data. This assumption is considered valid over the limited area influenced by pumping. Variations due to deviations from the constant density assumption are considered to be within the uncertainty of the other assumptions underlying aquifer pumping test analysis.

The AQTESOLV™ program allows either automatic or manual curve fitting for both the Theis and Hantush methods. For this analysis, manual curve fitting was used to eliminate data in the early time period of pumping, which may be impacted by casing storage, non-steady state leakage, or other pumping effects. For calculation of average values for the tests, only the Hantush method results were used, since the Theis method results represent an upper bound value.

4.5 Generic Input Parameters

The AQTESOLV™ program includes input for well radii, well equipment radii, screened intervals, and thicknesses of the different units. This information can be used to correct for well storage, partial penetration, and to calculate parameters for the different units. For the purposes of this analysis, all wells were assumed to be fully penetrating. For unit consistency, all measurements are in feet.

The diameter of the pumping well was represented by two components: the diameter of the cased interval (30 inches) and the diameter of the open hole interval (28 inches). The radius of the cased interval was (30 inches/12)/2 = 1.25 feet and of the open hole interval was (28 inches/12)/2 =1.17 feet. The pumping equipment (column/bowls) was 12-inch diameter or a radius of (12 inches/12)/2 = 0.5 feet. The diameter of the observation wells was 2 inches with a radius of (2 inches/12)/2= 0.08 feet.

The screened intervals for the pumping and observation wells were obtained from Table 2BB-201. Based on the drilling program to install the pumping and observation wells, the hydrogeologic unit thicknesses were determined as shown in Table 2BB-202.

5.0 UNIT 6 SHALLOW TEST

5.1 Test Summary

Background water level collection in the pumping well for the test commenced at 10:00 am eastern daylight savings time (EDT) on March 12, 2009 and stopped at 10:10 am EDT on March 13, 2009. The PW-6U aquifer pumping test was started on March 13, 2009 at 10:31 am EDT and pumped at an average rate of 5103 gpm until 6:30 pm EDT when the pump was shut off and recovery occurred. Recovery measurements continued until March 14, 2009 at 2:30 am EDT. There were no precipitation events noted during background data collection or during the test. Well cluster C7-3 was used as the background well cluster for tidal correction during this test. The pumping rates are presented in Attachment 2BB-1. It should be noted that this test was conducted during the week after the time change from eastern standard time (EST) to EDT. The electronic loggers remained on EST; however, during tidal correction, the water level data times were converted to EDT.

5.2 Data Assessment

Figure 2BB-207 presents a plot of flow measurements during the test. The plot indicates that manual and electronic flow measurements are in general agreement, that measurements are within ±10 percent of the mean flow rate, and that flow measurements are within the calibration range of the flowmeter. Therefore, the flow data for this test were considered to be usable for test interpretation. A complete listing of the flow measurements is presented in Attachment 2BB-1.

Examination of the water level measurements suggests that the data collection rate was sufficiently detailed to characterize the changes. Comparison of water level data at each well cluster (Figures 1 through 4 in Attachment 2BB-1) indicates that the following wells exhibit anomalous behavior based on the conceptual hydrogeologic model for the site: C6-1A, C6-1B, C6-2B, C6-3A, C6-4A, C6-4B, and C6-3B. The water level response in wells C6-1A, C6-1B, C6-2B, C6-3A, C6-4A, and C6-4B, screened in the “A” or “B” (Miami Limestone (A) or freshwater limestone (B) aquitard) zones, was essentially identical to the response in the “D” zone (Key Largo Limestone pumping zone). The response from these wells

showed the same transmissivity and storage values as the pumped aquifer. This may indicate placement of a portion of the screened interval of these wells within the pumped aquifer or subsurface conditions where the vertical hydraulic conductivity of the aquitard is the same as in the pumped aquifer (aquitard not present). Well C6-3B, screened in the “B” (freshwater limestone aquitard) zone shows less drawdown than in the underlying unpumped aquifer indicating a possible connection between the pumped (Key Largo Limestone) and unpumped (Fort Thompson Formation) aquifers. In either case, the responses from these wells were not consistent with the assumptions used in the Hantush method and thus were not interpreted using this method. With the exception of the seven observation wells identified above, the remaining water level data were considered acceptable for test interpretation.

5.3 Summary of Results

The AQTESOLV™ plots for the observation wells are presented in Attachment 2BB-1. The results of the interpretation are summarized on Table 2BB-203. The Hantush distance-drawdown and time-drawdown methods show general agreement for all parameters. The Theis method results generally show higher transmissivity than the Hantush method. This is most probably a result of not accounting for leakage from the overlying or underlying units. The Hantush method test results indicate a mean transmissivity of 2,331,000 gallons per day per foot (312,000 square feet per day) and a mean storage coefficient of 1.5E-04 for the pumped aquifer. The average vertical hydraulic conductivity of the upper aquitard zone “A” (Miami Limestone) is 103 gallons per day per square foot (14 feet per day) and of lower aquitard zone “B” (freshwater limestone) is 46 gallons per day per square foot (6 feet per day).

6.0 UNIT 6 DEEP TEST

6.1 Test Summary

Background water level collection in the pumping well for the test commenced at 9:32 am EDT on March 19, 2009 and stopped at 9:34 am EDT on March 20, 2009. The PW-6L aquifer pumping test was started on March 20, 2009 at 10:00 am EDT and pumped at an average rate of 3342 gpm until 6:00 pm EDT when the pump was shut off and recovery occurred. Recovery measurements continued until March 21, 2009 at 2:00 am EDT. There was a precipitation event noted immediately before background data collection resulting in measurable rainfall. During the test, some light drizzle was noted but not sufficient to produce measurable precipitation. Unit 3 was in the midst of a scheduled outage, which

resulted in higher than normal cooling canal levels. Well cluster C7-3 was used as the background well cluster for tidal correction during this test. The pumping rates are presented in Attachment 2BB-2.

6.2 Data Assessment

Figure 2BB-208 presents the pumping rate measurements for the PW-6L test. The plot indicates that manual and electronic flow measurements are in general agreement, that measurements are within ±10 percent of the mean flow rate, and that flow measurements are within the calibration range of the flowmeter. Therefore, the flow data for this test is considered to be usable for test interpretation. A complete listing of the flow measurements are presented in Attachment 2BB-2.

Examination of the water level measurements suggests that the data collection rate was sufficiently detailed to characterize the changes in water levels. Comparison of water level data at each well cluster (Figures 1 through 4 in Attachment 2BB-2) indicates that the following wells exhibit anomalous behavior based on the conceptual hydrogeologic model for the site: C6-3C, C6-2B, C6-2C, and C6-2D. In wells C6-2B and C6-2D water level responses in the “B” zone (freshwater limestone) were essentially identical to the response in the “D” zone (non-pumping zone). This may indicate placement of a portion of the screened interval of these wells within the non-pumped aquifer or subsurface conditions where the vertical hydraulic conductivity of the aquitards are the same as in the non-pumped aquifer (aquitard not present). Wells C6-3C and C6-2C show water level response greater than in the pumped zone (C6-3E or C6-2E), which suggest either anomalous transducer data or some unknown external influence. In either case, the responses from these wells were not consistent with the assumptions used in the Hantush method and thus were not interpreted using this method. The wells with acceptable water level data were all wells in cluster C6-5, all wells in cluster C6-4, C6-3B, D, and E, and C6-2E.

6.3 Summary of Results

The AQTESOLV™ plots for the observation wells are presented in Attachment 2BB-2. The results of the interpretation are summarized on Table 2BB-204. The Hantush distance-drawdown and time-drawdown methods show general agreement for all parameters. The Theis method results generally show higher transmissivity than the Hantush method. This is most probably a result of not accounting for leakage from the overlying or underlying units. The Hantush method test results indicate a mean transmissivity of 122,000 gallons per

day per foot (16,000 square feet per day) and a mean storage coefficient of 1.6E-04 for the pumped aquifer. The average vertical hydraulic conductivity of the upper aquitard zone “B” (freshwater limestone) is 2 gallons per day per square foot (0.2 feet per day) and of lower aquitard zone “C” (Tamiami Formation) is 7940 gallons per day per square foot (1061 feet per day). The high vertical hydraulic conductivity measured in the Tamiami Formation is believed to be a result of screening of the observation wells at the top of the formation in comparison to the observation wells at the Unit 7 deep test, which were screened deeper in the Tamiami Formation.

7.0 UNIT 7 SHALLOW TEST

7.1 Test Summary

Background data collection in the pumping well commenced on February 20, 2009 at 8:17 pm EST. The pumping test was started at 7:00 pm EST on February 23, 2009 and the well was pumped at an average rate of 4181 gallons per minute. Recovery was started at 3:45 am EST on February 24, 2009 and measurements were continued until 1:30 pm EST on February 24, 2009. There were no precipitation events noted during background data collection or during the test. Well cluster C6-3 was used for tidal correction during this test. The pumping rate data are presented in Attachment 2BB-3.

7.2 Data Assessment

The flow measurements collected during the test are presented on Figure 2BB-209. The plot indicates that manual and electronic flow measurements are in general agreement, that measurements are within ±10 percent of the mean flow rate, and that flow measurements are within the calibration range of the flowmeter. Therefore, the flow data for this test was considered to be usable for test interpretation. A complete listing of the flow measurements are presented in Attachment 2BB-3.

Examination of the water level measurements suggests that the data collection rate was sufficiently detailed to characterize the changes except in observation wells C7-1A and D, which did not have sufficiently detailed measurements to characterize the change. Comparison of water level data at each well cluster (Figures 1 through 4 in Attachment 2BB-3) indicates that the following wells exhibit anomalous behavior based on the conceptual hydrogeologic model for the site: C7-1B and E and C7-4B and E, which show essentially an identical water level response in the aquitard (freshwater limestone) and the unpumped aquifer. This may indicate an absence of the aquitard or placement of a portion of the

screened interval of these wells within the unpumped aquifer. Therefore, only the water level data from well clusters C7-2 and C7-3 are considered to be acceptable for time-drawdown and distance-drawdown test interpretation and data from cluster C7-4 are also acceptable with the notation of anomalous behavior discussed above. Data from the C7-1 well cluster are not acceptable except for distance-drawdown comparisons.

7.3 Summary of Results

The results of the test interpretations are presented in Attachment 2BB-3 and summarized on Table 2BB-205. The Hantush distance-drawdown and time-drawdown methods show general agreement for all parameters. The Theis method results generally show higher transmissivity than the Hantush method. This is most probably a result of not accounting for leakage from the overlying or underlying units. The Hantush method test results indicate a mean transmissivity of 2,200,000 gallons per day per foot (294,000 square feet per day) and a mean storage coefficient of 0.002 for the pumped aquifer. The average vertical hydraulic conductivity of the upper aquitard zone “A” (Miami Limestone) is 173 gallons per day per square foot (23 feet per day) and of the lower aquitard zone “B” (freshwater limestone) is 54 gallons per day per square foot (7 feet per day).

8.0 UNIT 7 DEEP TEST

8.1 Test Summary

Background data collection in PW-7L began at 5:20 pm EST on March 4, 2009. The pumping portion of the test started at 12:00 pm EST on March 7, 2009 with an average pumping rate of 3403 gallons per minute. The recovery portion of the test was started at 9:00 pm EST on March 7, 2009 and measurements continued until 7:34 am EST on March 8. 2009. There were periods of light precipitation and drizzle observed during the background period, but no significant precipitation events were noted during background data collection or during the test. The test data are presented in Attachment 2BB-4.

8.2 Data Assessment

The flow measurements collected during the test are presented on Figure 2BB-210. The plot indicates that manual and electronic flow measurements are in general agreement, that measurements are within ±10 percent of the mean flow rate, and that flow measurements are within the calibration range of the flowmeter. Therefore, the flow data for this test were

considered to be usable for test interpretation. A complete listing of the flow measurements are presented in Attachment 2BB-4.

Three of the transducers (C7-3B, C7-4D, and C7-5C) experienced what was referred to as “instrument drift” where the time recorded on these transducers was not synchronized with the other transducers. The times were manually corrected during the tidal correction, however the time shift on two of the transducers (C7-4D and C7-5C) resulted in missing the early time drawdown making the data from these transducers unacceptable for interpretation. Additionally, the transducer in well C7-4B malfunctioned during the test, resulting in only the first 300 minutes of data from the pumping period being acceptable. Therefore, with the exceptions noted above, the water level data from the remaining wells in clusters C7-3, C7-4, and C7-5 were considered acceptable for test interpretation.

8.3 Summary of Results

The results of the test interpretations are presented in Attachment 2BB-4 and summarized on Table 2BB-206. The Hantush distance-drawdown and time-drawdown methods show general agreement for all parameters. The Theis method results generally show higher transmissivity than the Hantush method. This is most probably a result of not accounting for leakage from the overlying or underlying units. The test results for the Hantush method indicate a mean transmissivity of 131,000 gallons per day per foot (17,500 square feet per day) and a mean storage coefficient of 0.0003 for the pumped aquifer. The average vertical hydraulic conductivity of the upper aquitard zone “B” (freshwater Limestone) is 3 gallons per day per square foot (0.4 foot per day) and of the lower aquitard zone “C” (Tamiami Formation) is 649 gallons per day per square foot (87 feet per day).

9.0 SUMMARY

Four aquifer pumping tests were conducted at the Units 6 & 7 plant area, with two tests performed adjacent to locations of each reactor building, one in the Key Largo Limestone and the other in the Fort Thompson formation. The tests were performed to measure the hydrogeologic properties of these aquifers and overlying or underlying aquitards. Table 2BB-207 presents a summary of the averages of the aquifer testing results.

10.0 REFERENCES

1. MACTEC Engineering and Consulting, Inc., *Final Data Report—Geotechnical Exploration and Testing: Turkey Point COL Project Florida City, Florida,* Rev. 2, included in COL Application Part 11, October 6, 2008.

2. Fish, J., and M. Stewart, *Hydrogeology of the Surficial Aquifer System*, Dade County, Florida, U.S. Geological Survey, Water-Resources Investigations Report 90-4108, 1991.

3. Dames & Moore, *Geohydrologic Conditions Related to the Construction of Cooling Ponds Florida Power & Light Company Steam Generating Station*, Turkey Point, Florida, prepared for Brown & Root, Inc., July 1971.

4. ASTM International, Standard Test Method (Field Procedure) for *Withdrawal and Injection Well Tests for Determining Hydraulic Properties of Aquifer Systems* in Annual Book of ASTM Standards, Designation: D 4050, Vol. 04.08, West Conshohocken, Pennsylvania, 1996 (Reapproved 2002).

5. Duffield, G., AQTESOLV™ for Windows Vol. 4.5 *User's Guide*, HydroSOLVE, Inc., Reston, Virginia, 2007.

6. Hantush, M., *Modification of the Theory of Leaky Aquifers*, Journal of Geophysical Research, Vol. 65, No. 11, November 1960.

7. Fetter, C., *Applied Hydrogeology,* 2d ed., Macmillan Publishing Company, New York, 1988.

8. Batu, V., *Aquifer Hydraulics a Comprehensive Guide to Hydrogeologic Data Analysis*, John Wiley & Sons, New York, 1988.

Table 2BB-201 (Sheet 1 of 3)
Observation Well and Pumping Well Construction Data

Well No.	Easting (ft)	Northing (ft)	Top of Casing Elevation (ft NAVD 88)	Ground Elevation (ft NAVD 88)	Well Depth (ft bgs)	Screen or Open Interval (ft bgs)	Well Diameter ID (inches)
PW-7U	875819.3	396935.3	0.47	–0.2	45	22–45	0–22 ft 30” 22–45 ft 28”
PW-7L	875819.4	396985.1	0.67	–0.1	87	67–87	0–67 ft 30” 67–87 ft 28”
PW-6U	876668.7	396938.0	0.37	–0.3	45	23–45	0–23 ft 30” 23–45 ft 28”
PW-6L	876668.2	396987.5	0.37	–0.1	105	66–105	0–66 ft 30” 66–105 ft 28”
C7-1A	875829.5	396932.8	2.88	–0.2	15	10–15	2”
C7-1B			2.92		64	62–64	2”
C7-1C			2.94		120	115–120	2”
C7-1D	875829.6	396937.7	2.55	–0.3	40	30–40	2”
C7-1E			2.45		82	72–82	2”
C7-2A	875822.2	396944.9	2.61	–0.2	15	10–15	2”
C7-2B			2.54		52	50–52	2”
C7-2C			2.57		117	112–117	2”
C7-2D	875817.3	396944.9	2.61	–0.1	40	30–40	2”
C7-2E			2.57		82	72–82	2”
C7-3A	875822.4	396960.2	2.71	–0.3	15	10–15	2”
C7-3B			2.64		55	53–55	2”
C7-3C			2.71		97	92–97	2”
C7-3D	875817.2	396959.9	2.61	–0.2	40	30–40	2”
C7-3E			2.60		87	77–87	2”
C7-4A	875822.3	396975.2	3.09	–0.3	15	10–15	2”
C7-4B			3.10		61	59–61	2”
C7-4C			3.21		117	112–117	2”
C7-4D	875817.3	396974.3	2.64	0.0	40	30–40	2”

Table 2BB-201 (Sheet 2 of 3)
Observation Well and Pumping Well Construction Data

Well No.	Easting (ft)	Northing (ft)	Top of Casing Elevation (ft NAVD 88)	Ground Elevation (ft NAVD 88)	Well Depth (ft bgs)	Screen or Open Interval (ft bgs)	Well Diameter ID (inches)
C7-4E	875817.3	396974.3	2.60	0.0	82	72–82	2”
C7-5A	875829.5	396984.1	2.72	–0.1	15	10–15	2”
C7-5B			2.81		62	60–62	2”
C7-5C			2.91		117	112–117	2”
C7-5D	875828.1	396989.3	3.16	0.0	40	30–40	2”
C7-5E			3.05		82	72–82	2”
C6-1A	876678.1	396935.4	1.80	–0.3	15	10–15	2
C6-1B			1.66		48	46–48	2
C6-1C			1.73		117	112–117	2
C6-1D	876677.9	396940.4	2.14	–0.4	40	30–40	2
C6-1E			2.26		87	77–87	2
C6-2A	876670.8	396947.3	2.46	–0.4	15	10–15	2
C6-2B			2.48		45	43–45	2
C6-2C			2.47		121	116–121	2
C6-2D	876665.5	396947.4	2.02	–0.4	40	30–40	2
C6-2E			2.10		87	77–87	2
C6-3A	876670.5	396962.6	2.58	–0.4	15	10–15	2
C6-3B			2.57		51	49–51	2
C6-3C			2.57		117	110–117	2
C6-3D	876665.7	396962.5	2.45	–0.4	40	30–40	2
C6-3E			2.42		87	77–87	2
C6-4A	876670.9	396978.1	1.97	0.0	16	11–16	2
C6-4B	876670.9	396978.1	2.08	0.0	48	46–48	2
C6-4C			1.94		122	118–122	2

Table 2BB-201 (Sheet 3 of 3)
Observation Well and Pumping Well Construction Data

Well No.	Easting (ft)	Northing (ft)	Top of Casing Elevation (ft NAVD 88)	Ground Elevation (ft NAVD 88)	Well Depth (ft bgs)	Screen or Open Interval (ft bgs)	Well Diameter ID (inches)
C6-4D	876666.0	396977.9	2.91	–0.2	40	30–40	2
C6-4E			2.94		86	76–86	2
C6-5A	876678.3	396984.8	2.38	–0.2	15	10–15	2
C6-5B			2.35		49	47–49	2
C6-5C			2.48		122	117–122	2
C6-5D	876678.1	396990.3	2.74	–0.4	40	30–40	2
C6-5E			2.71		86	76–86	2

Table 2BB-202
Hydrogeologic Unit Thicknesses[a]

PW-6U/L Test			
Unit	**Formation**	**Depth Interval (ft bgs)**	**Approximate Thickness (ft)**
Upper aquitard	Miami Limestone	5–13	8
Upper aquifer	Key Largo Limestone	13–46	33
Middle aquitard	Freshwater limestone/lime mud	46–57	11
Lower aquifer	Fort Thompson Formation	57–114	57
Lower aquitard	Tamiami Formation	114–117+	18[b]
PW-7U/L Test			
Upper aquitard	Miami Limestone	5–18	13
Upper aquifer	Key Largo Limestone	18–42	24
Middle aquitard	Freshwater limestone/lime mud	42–61	19
Lower aquifer	Fort Thompson Formation	61–97	36
Lower aquitard	Tamiami Formation	97–115+	18

(a) Based on composite logs, depths and thicknesses are considered approximate.
(b) A thickness of 18 feet is assumed for consistency with the PW-7L test, the thickness of the Tamiami Formation is >18 feet.

Table 2BB-203
Summary of Unit 6 Shallow Test Results

Group	Distance from Pumping Well (ft)	Transmissivity (gpd/ft)	Storage	1/B’ (ft^{-1})	1/B” (ft^{-1})	Hydraulic Conductivity of upper aquitard (gpd/ft^2)	Hydraulic Conductivity of lower aquitard (gpd/ft^2)
C6-1	10	(a)	(a)	(a)	(a)	(a)	(a)
C6-2	10	2,204,000	2.4E-04	0.0024	0.0017	102	70
C6-3	25	2,867,000	7.98E-06	0.0022	0.0011	111	38
C6-4	40	(a)	(a)	(a)	(a)	(a)	(a)
Distance-Drawdown	—	1,922,000	2.1E-04	0.0025	0.0012	96	30
C6-1 Theis	10	7,330,000	1.8E-06	—	—	—	—
C6-2 Theis	10	5,816,000	1.3E-06	—	—	—	—
C6-3 Theis	25	8,837,000	1.2E-06	—	—	—	—
C6-4 Theis	40	11,130,000	1.2E-06	—	—	—	—

(a) Data not usable from these wells.

Table 2BB-204
Summary of Unit 6 Deep Test Results

Group	Distance from Pumping Well (ft)	Transmissivity (gpd/ft)	Storage	1/B' (ft^{-1})	1/B" (ft^{-1})	Hydraulic Conductivity of upper aquitard (gpd/ft^2)	Hydraulic Conductivity of lower aquitard (gpd/ft^2)
C6-2	40	(a)	(a)	(a)	(a)	(a)	(a)
C6-3	25	201,000	0.0001	0.0011	0.06	3	13,025
C6-4	10	110,900	0.0001	0.0011	0.06	2	7,186
C6-5	10	30,920	0.0001	0.0011	0.06	0.4	2,068
Distance-Drawdown	—	146,100	0.0003	0.0011	0.06	2	9,467
C6-2 Theis	40	514,000	2.3E-06	—	—	—	—
C6-3 Theis	25	427,000	2.3E-06	—	—	—	—
C6-4 Theis	10	218,900	2.3E-06	—	—	—	—
C6-5 Theis	10	323,600	2.3E-06	—	—	—	—

(a) Data not usable from these wells.

Table 2BB-205
Summary of Unit 7 Shallow Test Results

Group	Distance from Pumping Well (ft)	Transmissivity (gpd/ft)	Storage	1/B' (ft^{-1})	1/B" (ft^{-1})	Hydraulic Conductivity of upper aquitard (gpd/ft^2)	Hydraulic Conductivity of lower aquitard (gpd/ft^2)
C7-1	10	(a)	(a)	(a)		(a)	(a)
C7-2	10	2,464,000	0.002	0.002489	0.00115	198	62
C7-3	25	2,056,000	0.002	0.00241	0.0011	155	47
C7-4	40	2,035,000	0.002	0.002484	0.00114	163	50
Distance-Drawdown	—	2,246,000	0.002	0.002455	0.00115	176	56
C7-1 Theis	10	(a)	(a)	—	—	—	—
C7-2 Theis	10	5,819,000	3.0E-05	—	—	—	—
C7-3 Theis	25	5,575,000	3.7E-05	—	—	—	—
C7-4 Theis	40	5,723,000	3.6E-05	—	—	—	—

(a) Data from this well cluster are unusable.

Table 2BB-206
Summary of Unit 7 Deep Test Results

Group	Distance from Pumping Well (ft)	Transmissivity (gpd/ft)	Storage	1/B' (ft^{-1})	1/B" (ft^{-1})	Hydraulic Conductivity of upper aquitard (gpd/ft^2)	Hydraulic Conductivity of lower aquitard (gpd/ft^2)
C7-2	40	131,300	0.0003	0.001143	0.0169	3	675
C7-3	25	134,200	0.0003	0.001145	0.0195	3	919
C7-4	10	126,200	0.0003	0.001148	0.0158	3	570
C7-5	10	132,200	0.0003	0.001148	0.0129	3.3	395
Distance-Drawdown	—	132,200	0.0003	0.001148	0.0170	3	686
C7-2 Theis	40	1,297,000	2.3E-06	—	—	—	—
C7-3 Theis	25	1,180,000	2.0E-06	—	—	—	—
C7-4 Theis	10	454,600	3.5E-05	—	—	—	—
C7-5 Theis	10	432,900	3.6E-05	—	—	—	—

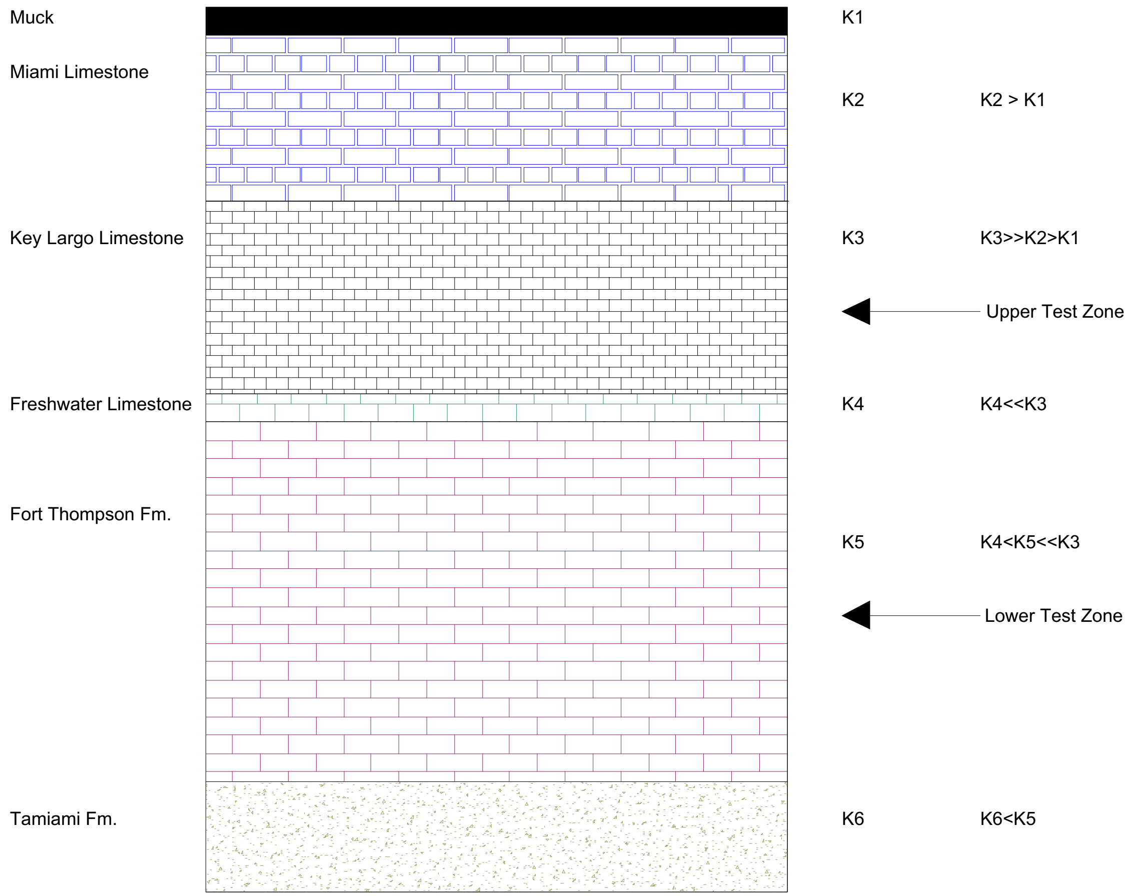
Table 2BB-207
Summary of Aquifer Testing Results

Geologic Unit	Thickness (ft)	Test Well	Aquifer Transmissivity (gpd/ft)[a]	Aquifer Storativity (dimensionless)[a]	Hydraulic Conductivity (K_h or K_v)		
					gpd/ft^2[a]	ft/d[a]	cm/s[a]
Miami Limestone (K_v)	8	PW-6U	—	—	103	14	0.005
	13	PW-7U	—	—	173	23	0.008
Key Largo Limestone (K_h)	33	PW-6U	2,331,000	0.00015	71,000	9,400	3.3
	24	PW-7U	2,200,000	0.0022	92,000	12,000	4.3
Freshwater Limestone (K_v)	11	PW-6U	—	—	46	6	0.002
	19	PW-7U	—	—	54	7	0.003
	11	PW-6L	—	—	2	0.2	7E-05
	19	PW-7L	—	—	3	0.4	1E-04
Fort Thompson Formation (K_h)	57	PW-6L	122,000	0.00016	2,140	286	0.1
	36	PW-7L	131,200	0.0003	3,600	490	0.2
Tamiami Formation (K_v)	18	PW-6L	—	—	7,940	1,061	0.4
	18	PW-7L	—	—	649	87	0.03

(a) Average values.

Figure 2BB-201 Site Location Map

Figure 2BB-202 Conceptual Model



Notes:
Not to scale
FM = Formation

Figure 2BB-203 Unit 6 Pumping Test Group

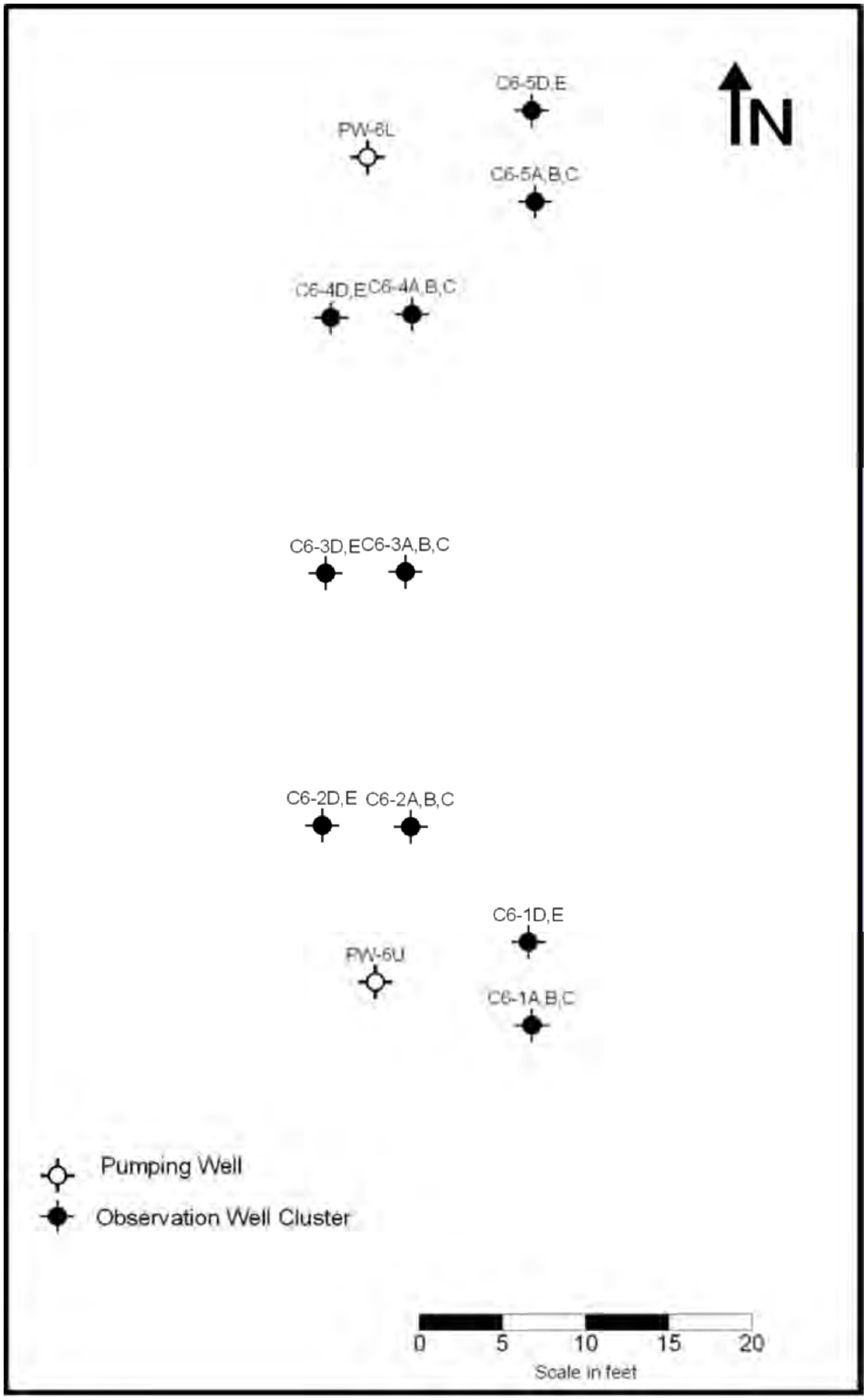


Figure 2BB-204 Unit 7 Pumping Test Group

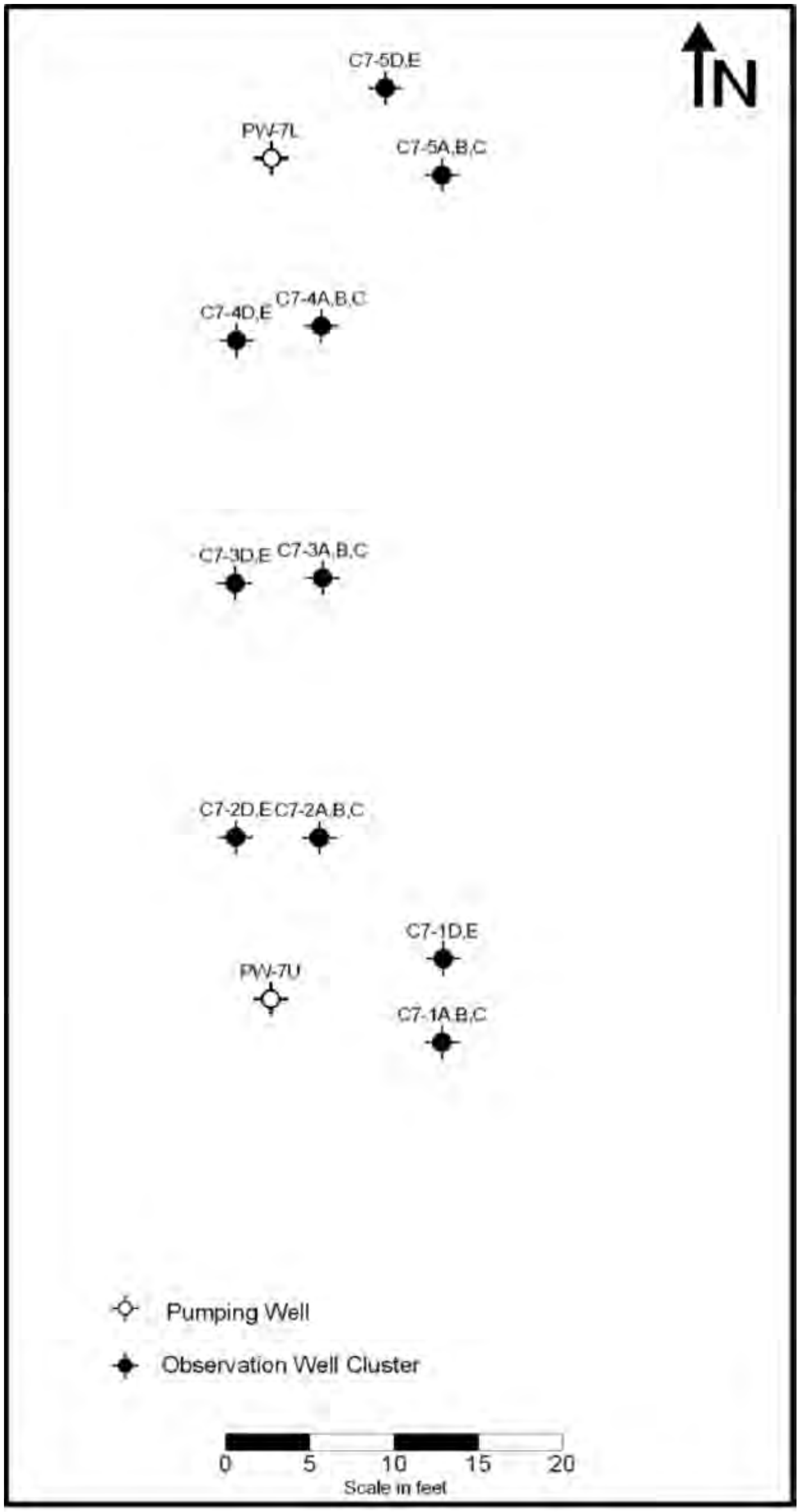
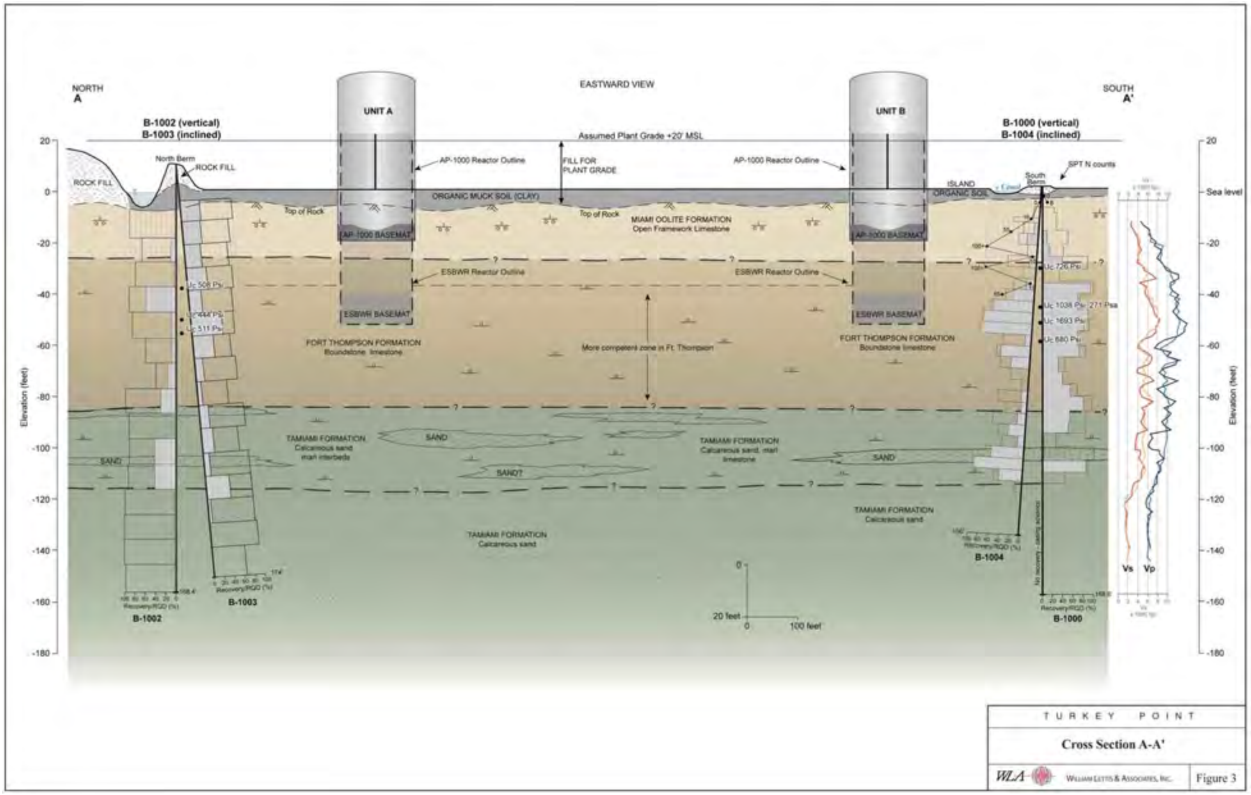
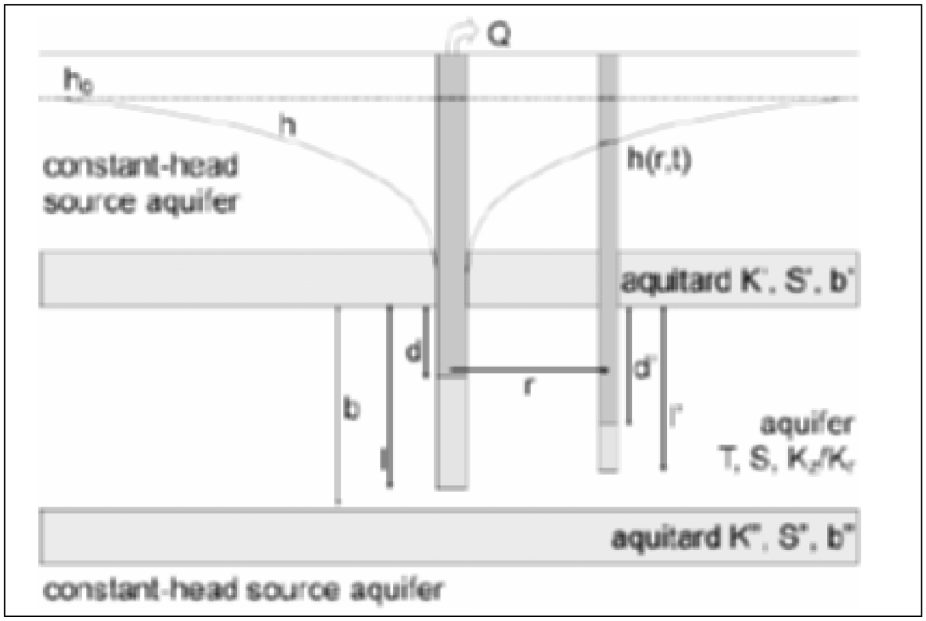


Figure 2BB-205 Physical System for Theis Method



Source: Reference 5

Figure 2BB-206 Physical System for Hantush Leaky Aquifer with Aquitard Storage Method



Source: Reference 5

Figure 2BB-207 Flow Measurements for PW-6U Test

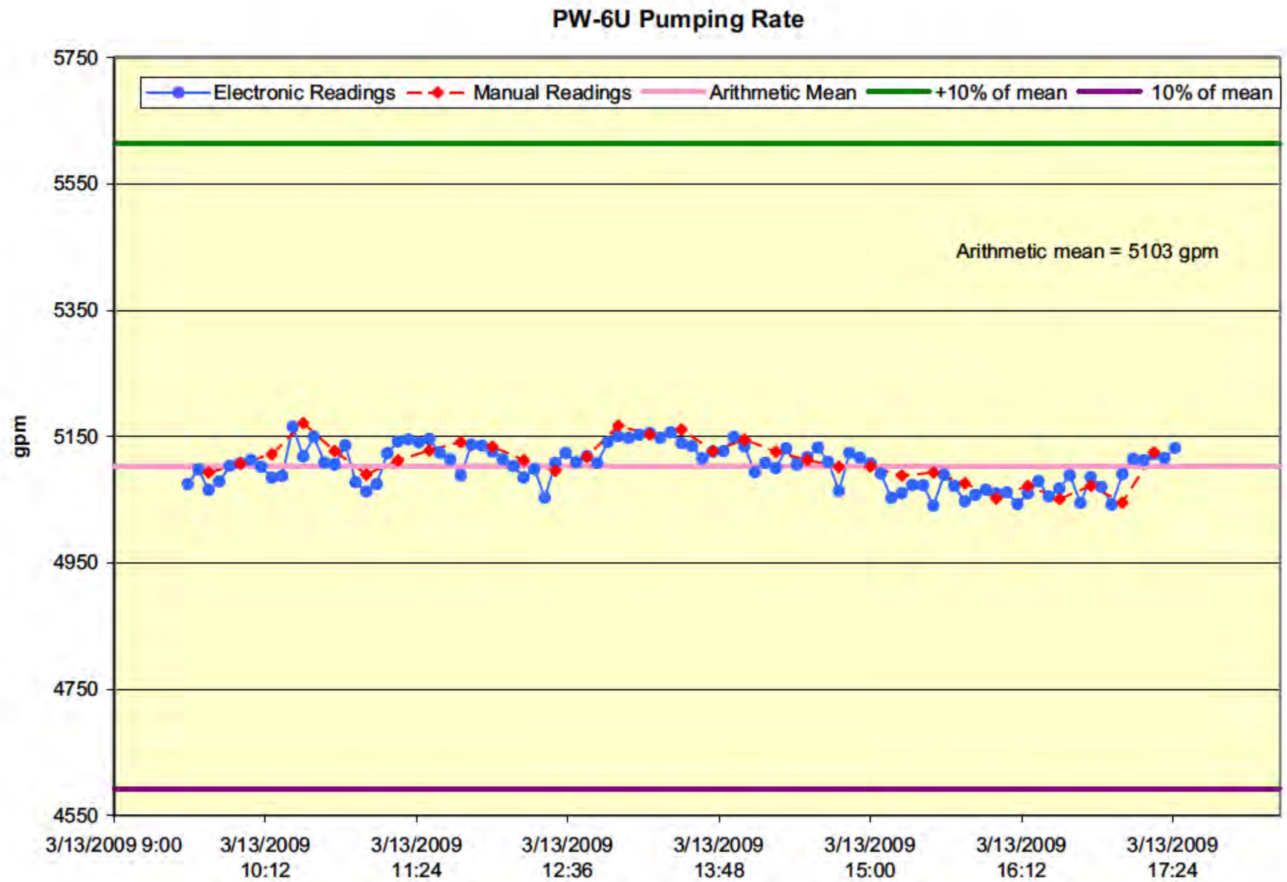


Figure 2BB-208 Flow Measurements for PW-6L Test

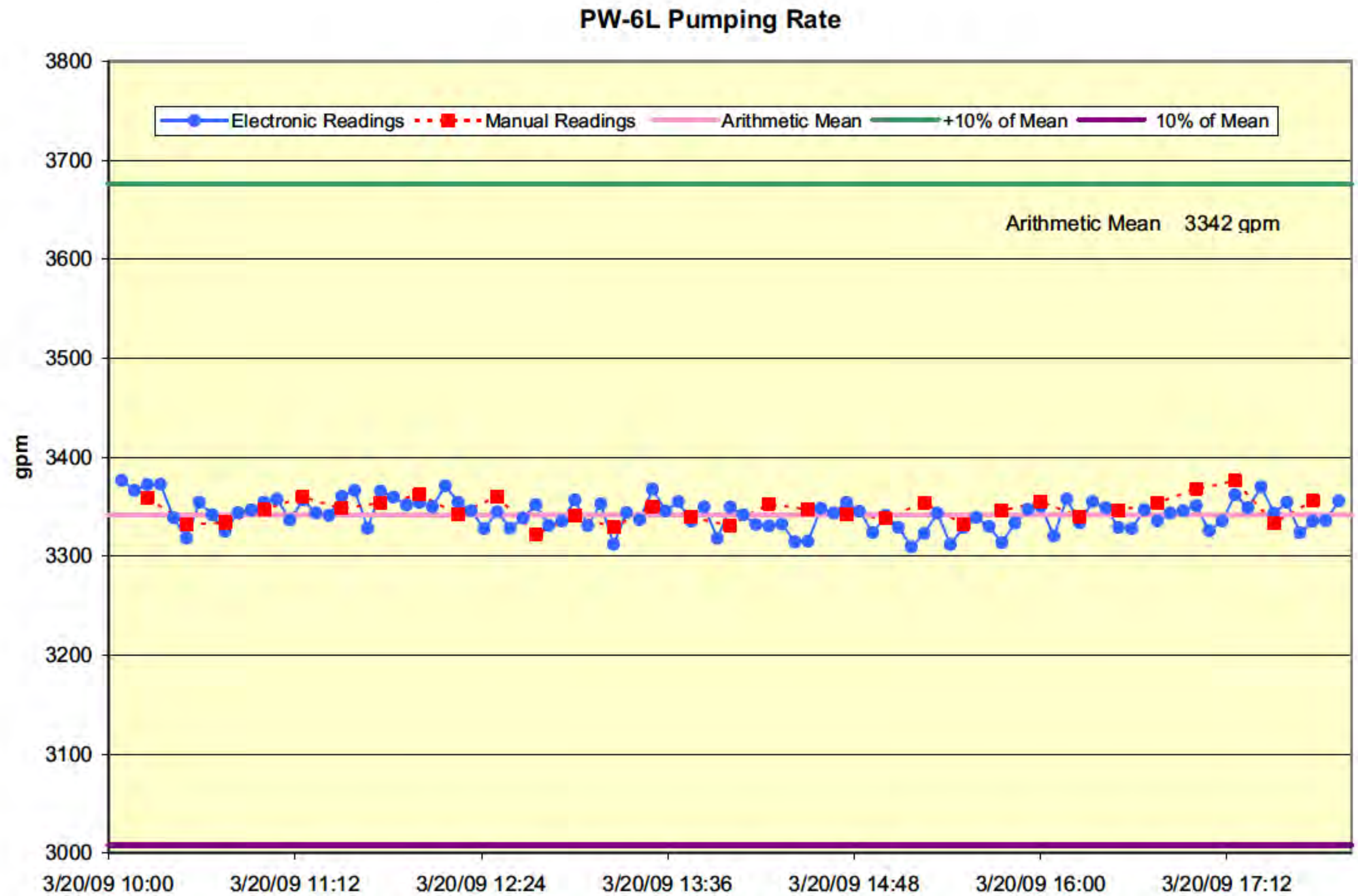


Figure 2BB-209 Flow Measurements for PW-7U Test

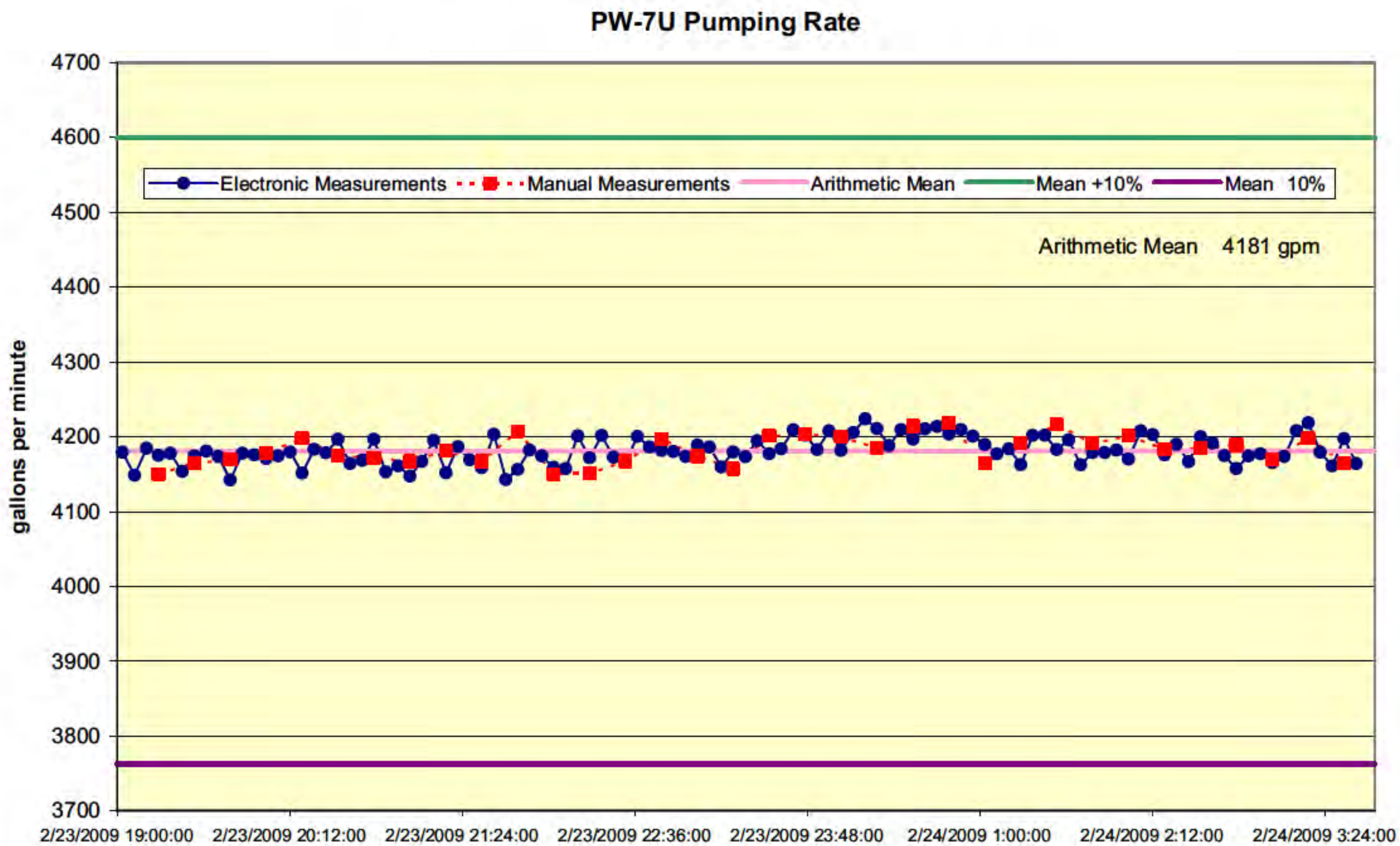
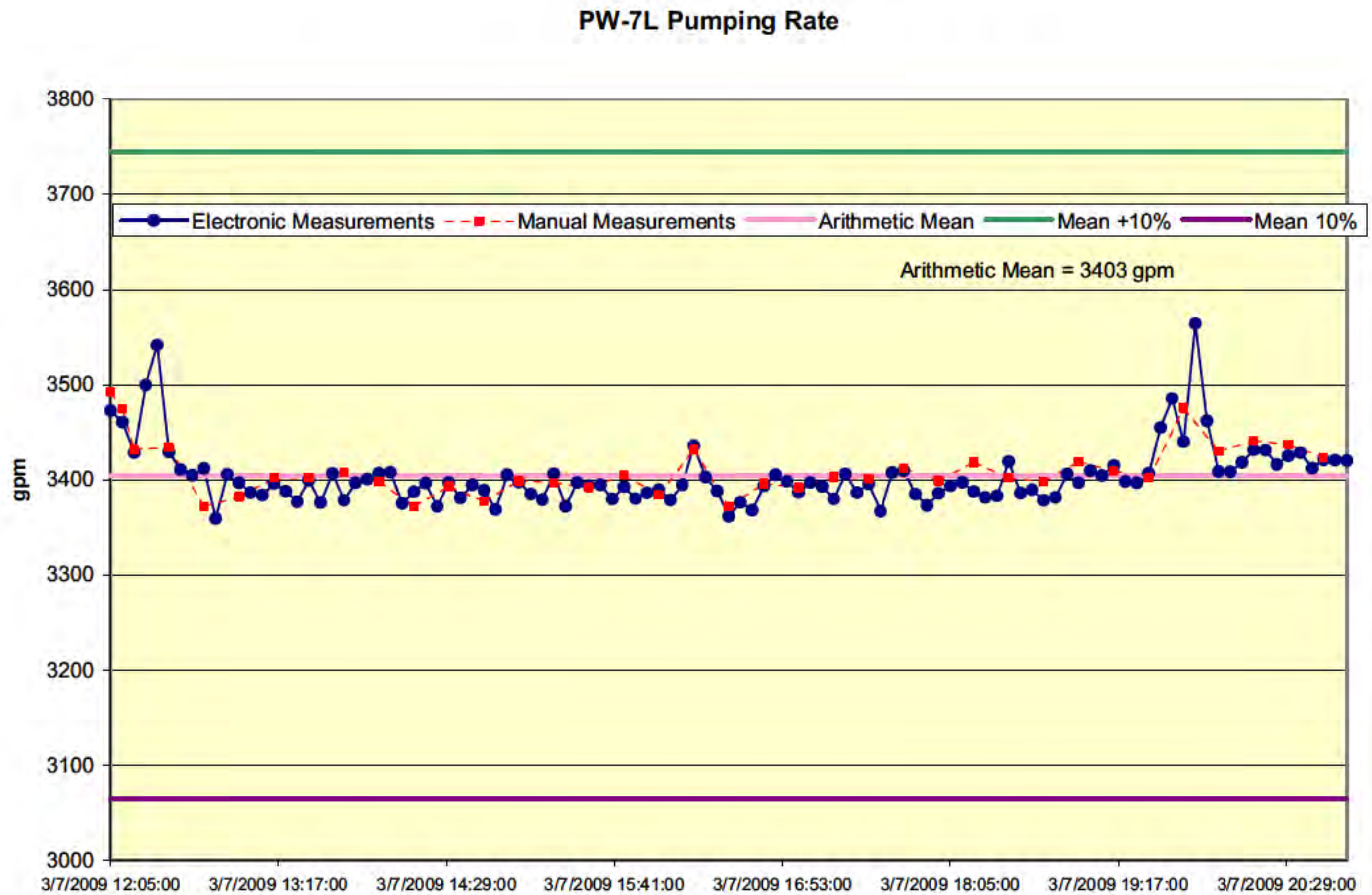


Figure 2BB-210 Flow Measurements for PW-7L Test



ATTACHMENT 2BB-1

UNIT 6 SHALLOW TEST GRAPHS AND PUMPING RATES

Table 1 of Attachment 2BB-1 (Sheet 1 of 3)
Pumping Rate Measurements for PW-6U

Date/Time (EST)	Minutes	Electronic gpm	Manual gpm[(a)]
3/13/2009 9:31	0	5075[(b)]	—
3/13/2009 9:35	4	5075	—
3/13/2009 9:40	9	5098	—
3/13/2009 9:45	14	5065	5093
3/13/2009 9:50	19	5079	—
3/13/2009 9:55	24	5103	—
3/13/2009 10:00	29	5108	5107
3/13/2009 10:05	34	5113	—
3/13/2009 10:10	39	5102	—
3/13/2009 10:15	44	5085	5122
3/13/2009 10:20	49	5088	—
3/13/2009 10:25	54	5165	—
3/13/2009 10:30	59	5119	5171
3/13/2009 10:35	64	5150	—
3/13/2009 10:40	69	5109	—
3/13/2009 10:45	74	5106	5127
3/13/2009 10:50	79	5136	—
3/13/2009 10:55	84	5078	—
3/13/2009 11:00	89	5063	5090
3/13/2009 11:05	94	5075	—
3/13/2009 11:10	99	5123	—
3/13/2009 11:15	104	5142	5112
3/13/2009 11:20	109	5145	—
3/13/2009 11:25	114	5140	—
3/13/2009 11:30	119	5146	5128
3/13/2009 11:35	124	5124	—
3/13/2009 11:40	129	5114	—
3/13/2009 11:45	134	5088	5141
3/13/2009 11:50	139	5137	—
3/13/2009 11:55	144	5136	—
3/13/2009 12:00	149	5126	5134
3/13/2009 12:05	154	5114	—
3/13/2009 12:10	159	5103	—
3/13/2009 12:15	164	5085	5112
3/13/2009 12:20	169	5099	—
3/13/2009 12:25	174	5053	—
3/13/2009 12:30	179	5108	5096

Table 1 of Attachment 2BB-1 (Sheet 2 of 3)
Pumping Rate Measurements for PW-6U

Date/Time (EST)	Minutes	Electronic gpm	Manual gpm[(a)]
3/13/2009 12:35	184	5124	—
3/13/2009 12:40	189	5109	—
3/13/2009 12:45	194	5119	5118
3/13/2009 12:50	199	5108	—
3/13/2009 12:55	204	5141	—
3/13/2009 13:00	209	5151	5167
3/13/2009 13:05	214	5148	—
3/13/2009 13:10	219	5153	—
3/13/2009 13:15	224	5155	5153
3/13/2009 13:20	229	5148	—
3/13/2009 13:25	234	5157	—
3/13/2009 13:30	239	5140	5161
3/13/2009 13:35	244	5135	—
3/13/2009 13:40	249	5115	—
3/13/2009 13:45	254	5126	5127
3/13/2009 13:50	259	5127	—
3/13/2009 13:55	264	5149	—
3/13/2009 14:00	269	5134	5145
3/13/2009 14:05	274	5094	—
3/13/2009 14:10	279	5108	—
3/13/2009 14:15	284	5100	5126
3/13/2009 14:20	289	5131	—
3/13/2009 14:25	294	5106	—
3/13/2009 14:30	299	5117	5113
3/13/2009 14:35	304	5132	—
3/13/2009 14:40	309	5110	—
3/13/2009 14:45	314	5064	5102
3/13/2009 14:50	319	5124	—
3/13/2009 14:55	324	5116	—
3/13/2009 15:00	329	5108	5103
3/13/2009 15:05	334	5091	—
3/13/2009 15:10	339	5053	—
3/13/2009 15:15	344	5060	5088
3/13/2009 15:20	349	5073	—
3/13/2009 15:25	354	5073	—
3/13/2009 15:30	359	5040	5092
3/13/2009 15:35	364	5090	—
3/13/2009 15:40	369	5072	—

**Table 1 of Attachment 2BB-1 (Sheet 3 of 3)
Pumping Rate Measurements for PW-6U**

Date/Time (EST)	Minutes	Electronic gpm	Manual gpm[(a)]
3/13/2009 15:45	374	5048	5076
3/13/2009 15:50	379	5057	—
3/13/2009 15:55	384	5066	—
3/13/2009 16:00	389	5060	5052
3/13/2009 16:05	394	5062	—
3/13/2009 16:10	399	5043	—
3/13/2009 16:15	404	5060	5072
3/13/2009 16:20	409	5079	—
3/13/2009 16:25	414	5055	—
3/13/2009 16:30	419	5068	5051
3/13/2009 16:35	424	5088	—
3/13/2009 16:40	429	5045	—
3/13/2009 16:45	434	5086	5072
3/13/2009 16:50	439	5070	—
3/13/2009 16:55	444	5042	—
3/13/2009 17:00	449	5090	5045
3/13/2009 17:05	454	5115	—
3/13/2009 17:10	459	5113	—
3/13/2009 17:15	464	5122	5125
3/13/2009 17:20	469	5116	—
3/13/2009 17:25	474	5132	—
3/13/2009 17:30	479	0	—

(a) Manual readings recorded in EDT.
(b) Value taken from next reading to provide pumping rate at t=0.

Figure 1 of Attachment 2BB-1 Time-Drawdown Graph for C6-1 Well Cluster

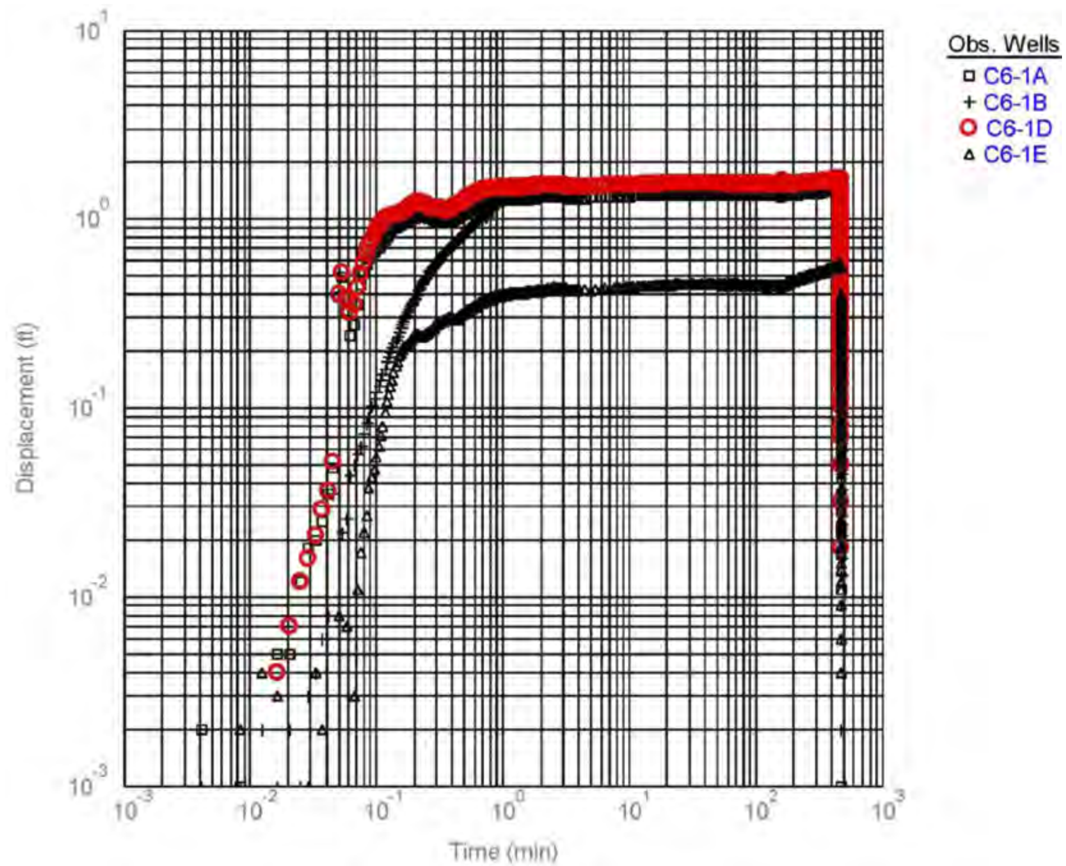


Figure 2 of Attachment 2BB-1 Time-Drawdown Graph for C6-2 Well Cluster

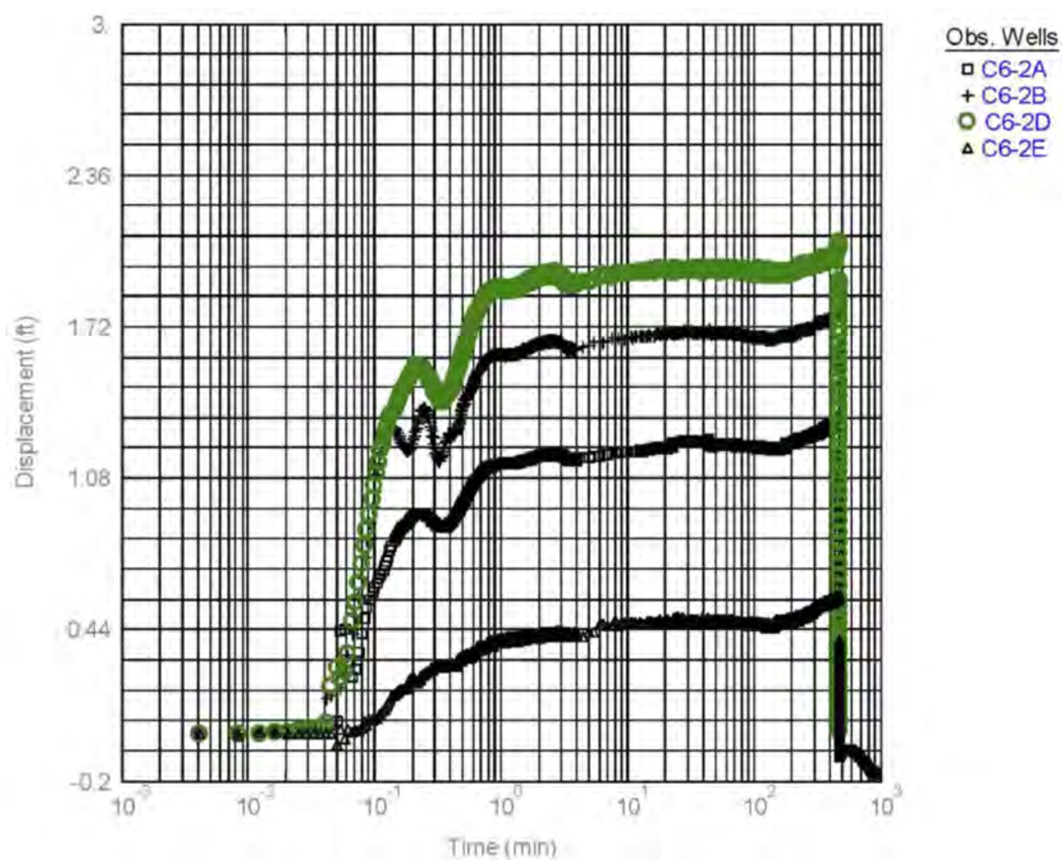


Figure 3 of Attachment 2BB-1 Time-Drawdown Graph for C6-3 Well Cluster

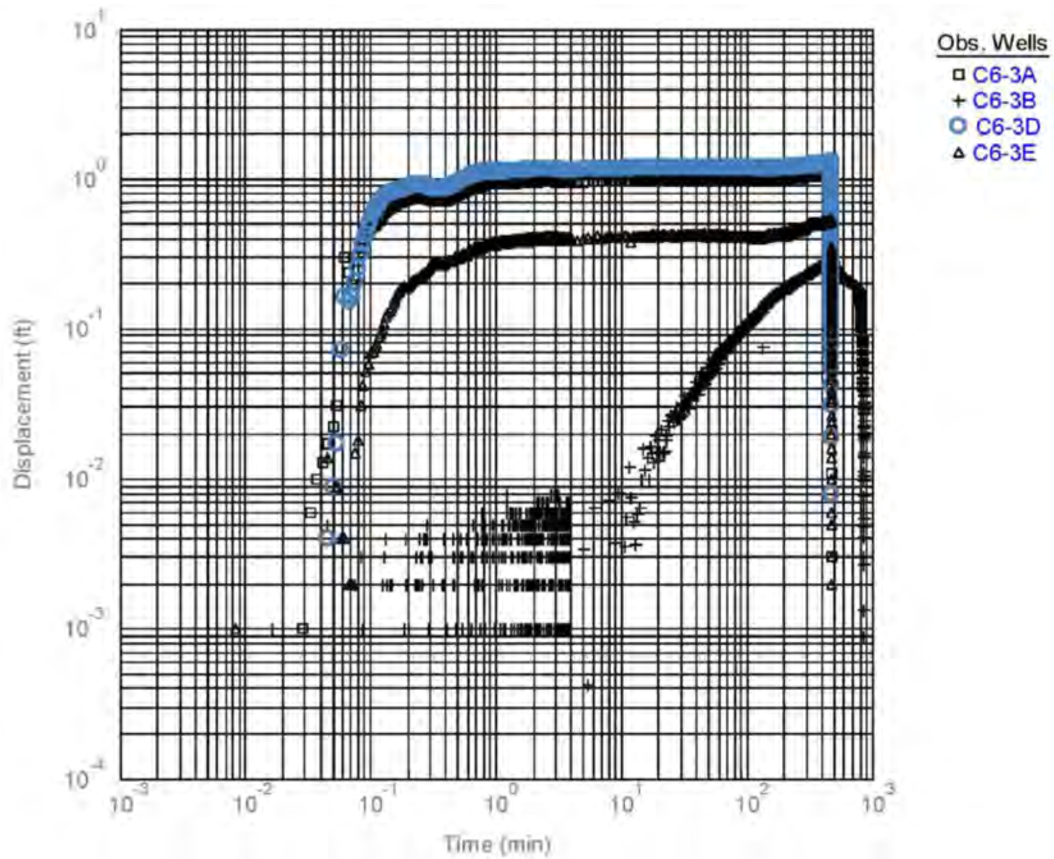


Figure 4 of Attachment 2BB-1 Time-Drawdown Graph for C6-4 Well Cluster

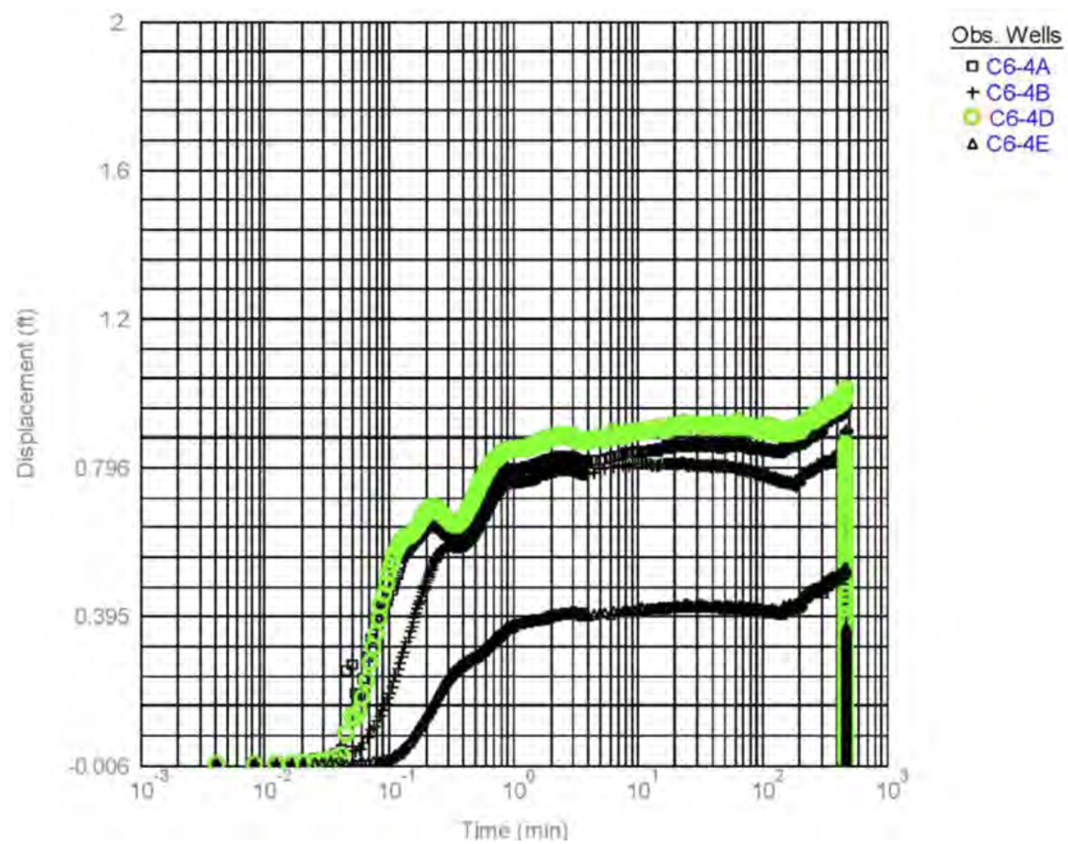


Figure 5 of Attachment 2BB-1 Distance-Drawdown Graph for PW-6U Test (t = 20 minutes)

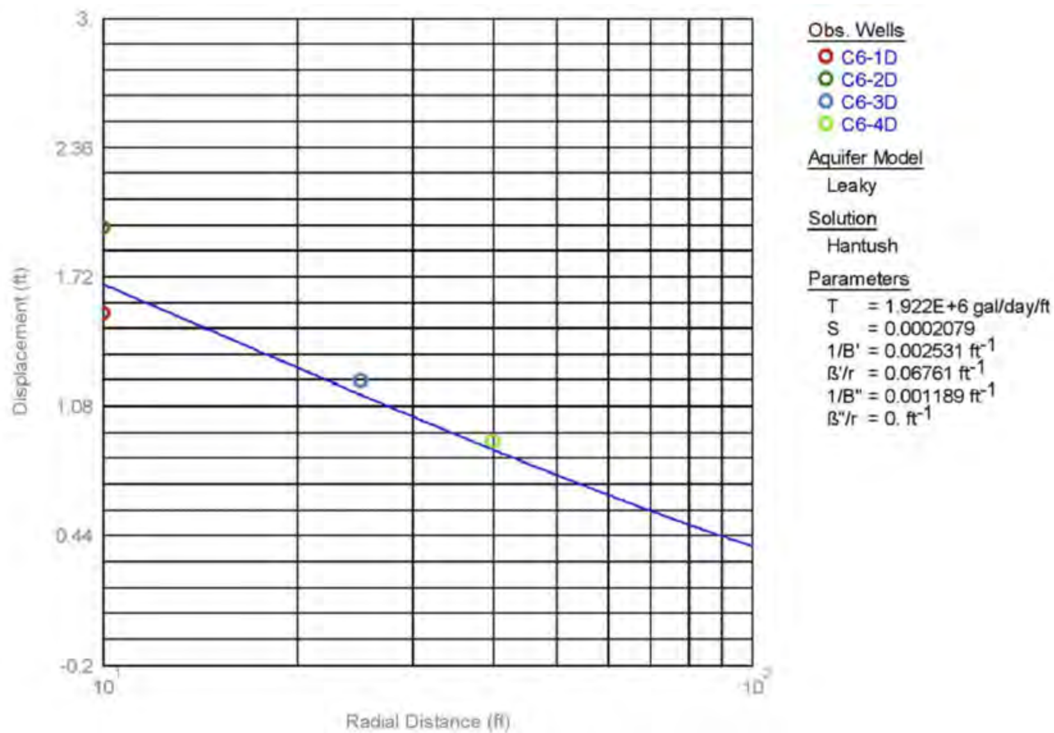


Figure 6 of Attachment 2BB-1 Time-Drawdown Graph for C6-1D Using Theis Method

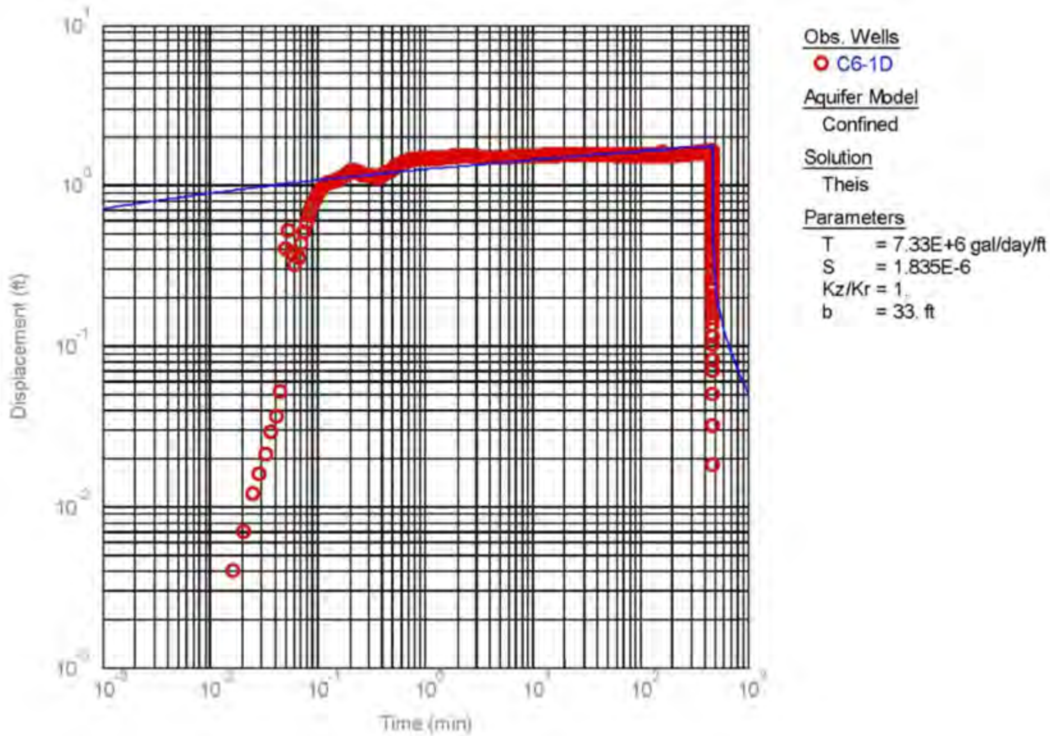


Figure 7 of Attachment 2BB-1 Time-Drawdown Graph for C6-2D Using Theis Method

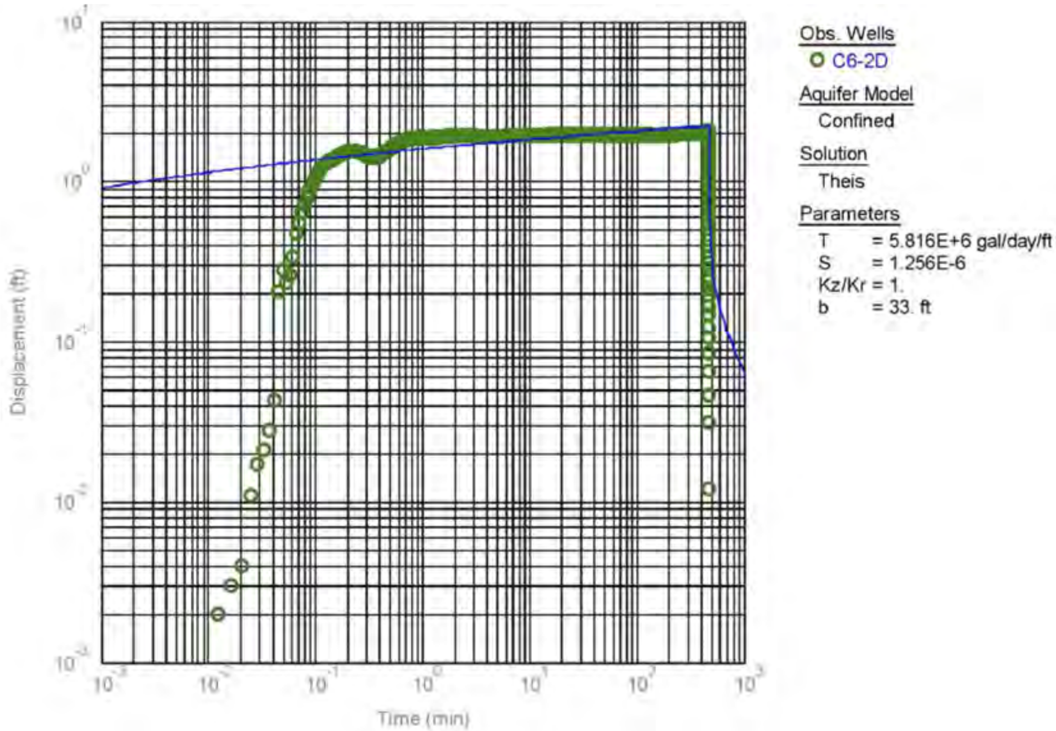


Figure 8 of Attachment 2BB-1 Time-Drawdown Graph for C6-2D Using Hantush Method

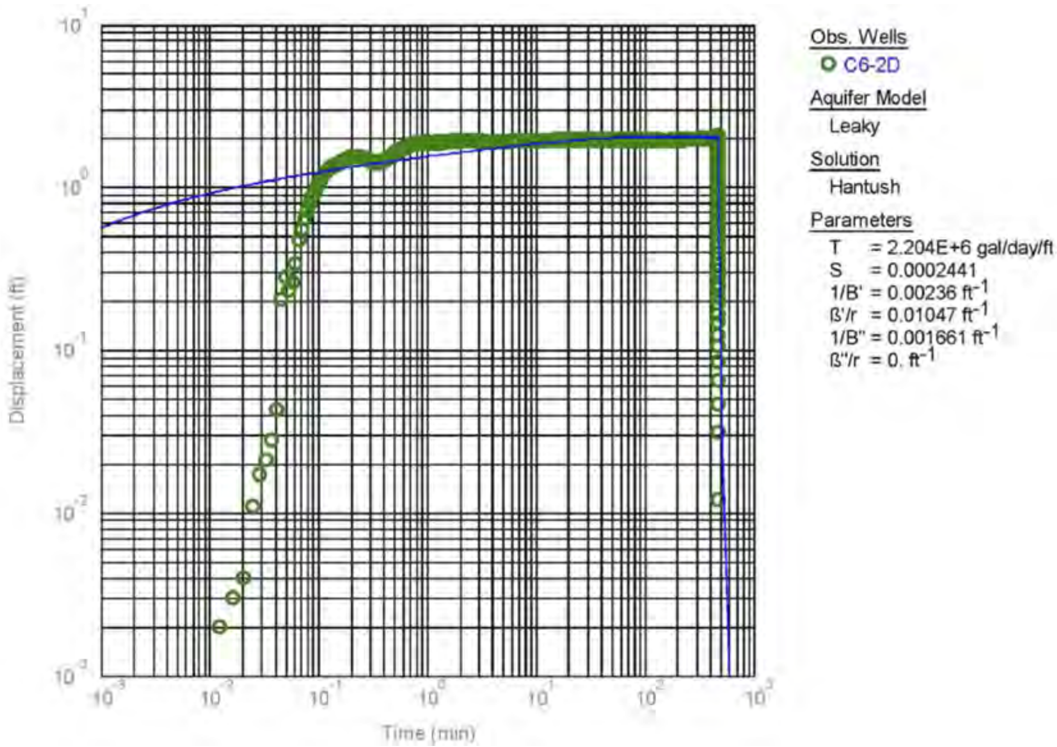


Figure 9 of Attachment 2BB-1 Time-Drawdown Graph for C6-3D Using Theis Method

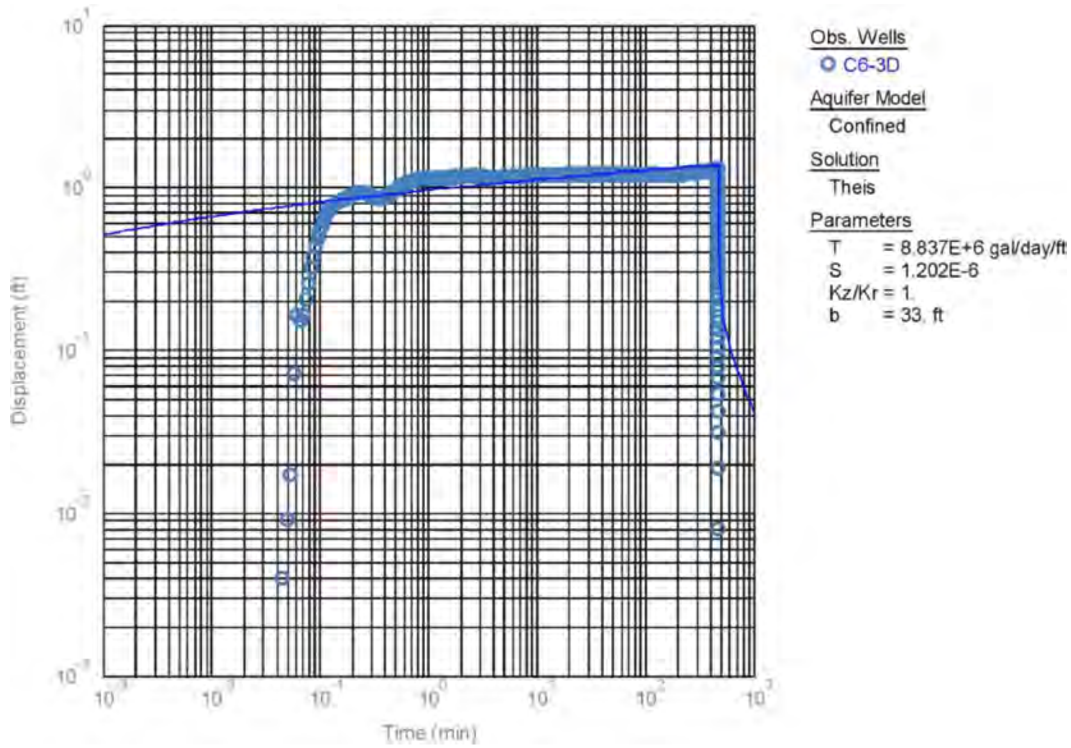


Figure 10 of Attachment 2BB-1 Time-Drawdown Graph for C6-3D Using Hantush Method

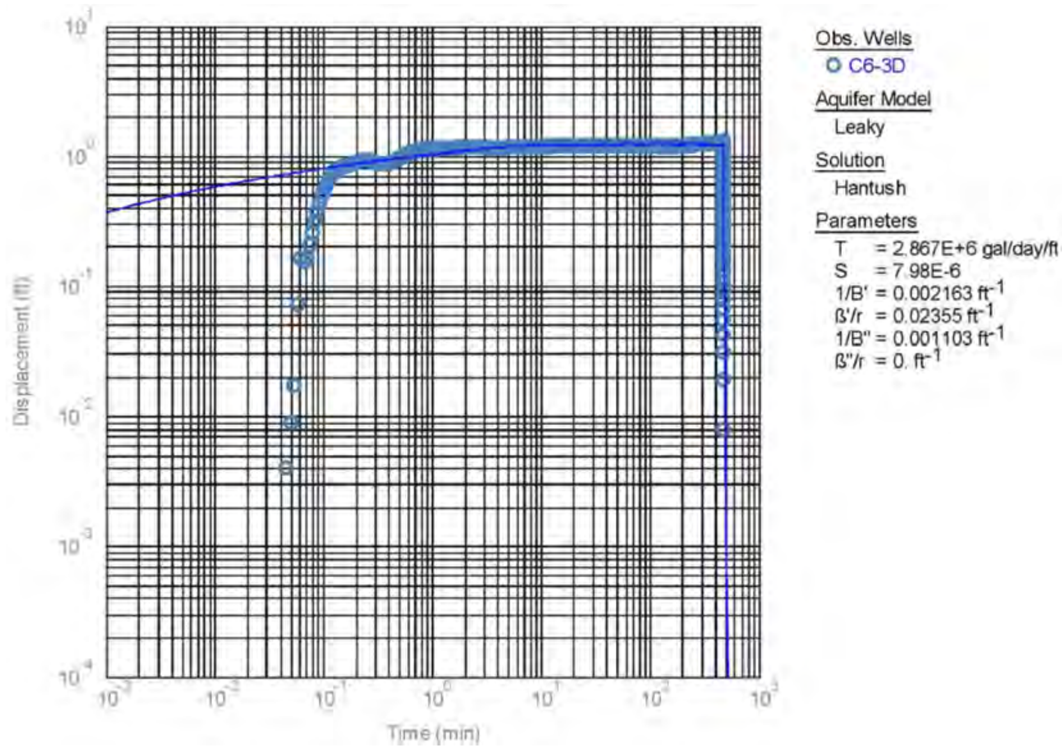
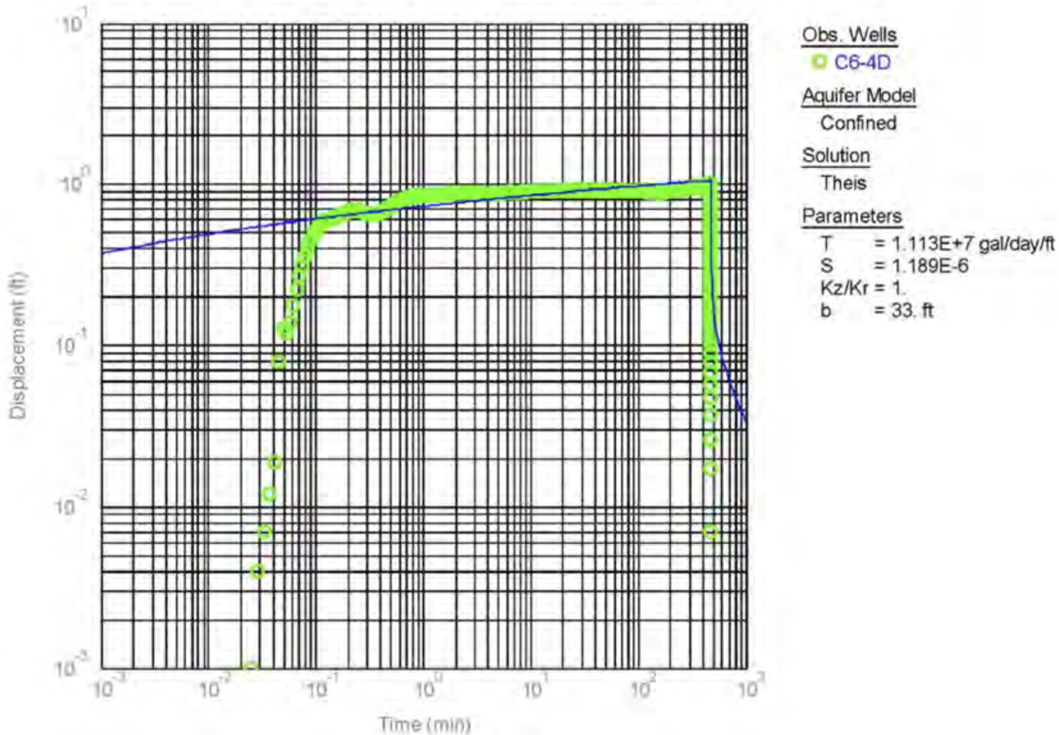


Figure 11 of Attachment 2BB-1 Time-Drawdown Graph for C6-4D Using Theis Method



ATTACHMENT 2BB-2

UNIT 6 DEEP TEST GRAPHS AND PUMPING RATES

Table 1 of Attachment 2BB-2 (Sheet 1 of 3)
Pumping Rate Measurements for PW-6L

Date/Time	Minutes	Electronic Flow (gpm)	Manual Flow (gpm)
3/20/2009 10:05:04	0	3376[(a)]	—
3/20/2009 10:05:04	5	3376	—
3/20/2009 10:10:04	10	3366	—
3/20/2009 10:15:04	15	3372	3359
3/20/2009 10:20:04	20	3373	—
3/20/2009 10:25:04	25	3339	—
3/20/2009 10:30:04	30	3318	3332
3/20/2009 10:35:04	35	3355	—
3/20/2009 10:40:05	40	3342	—
3/20/2009 10:45:04	45	3325	3334
3/20/2009 10:50:04	50	3344	—
3/20/2009 10:55:04	55	3347	—
3/20/2009 11:00:04	60	3354	3347
3/20/2009 11:05:05	65	3358	—
3/20/2009 11:10:04	70	3336	—
3/20/2009 11:15:04	75	3357	3360
3/20/2009 11:20:04	80	3344	—
3/20/2009 11:25:06	85	3341	—
3/20/2009 11:30:04	90	3360	3348
3/20/2009 11:35:04	95	3366	—
3/20/2009 11:40:04	100	3328	—
3/20/2009 11:45:04	105	3366	3354
3/20/2009 11:50:04	110	3360	—
3/20/2009 11:55:04	115	3352	—
3/20/2009 12:00:04	120	3354	3362
3/20/2009 12:05:04	125	3350	—
3/20/2009 12:10:05	130	3371	—
3/20/2009 12:15:04	135	3354	3342
3/20/2009 12:20:04	140	3346	—
3/20/2009 12:25:04	145	3328	—
3/20/2009 12:30:04	150	3345	3360
3/20/2009 12:35:04	155	3328	—
3/20/2009 12:40:04	160	3339	—
3/20/2009 12:45:04	165	3352	3322
3/20/2009 12:50:04	170	3331	—
3/20/2009 12:55:05	175	3336	—
3/20/2009 13:00:04	180	3357	3341

Table 1 of Attachment 2BB-2 (Sheet 2 of 3)
Pumping Rate Measurements for PW-6L

Date/Time	Minutes	Electronic Flow (gpm)	Manual Flow (gpm)
3/20/2009 13:05:04	185	3331	—
3/20/2009 13:10:04	190	3353	—
3/20/2009 13:15:04	195	3312	3329
3/20/2009 13:20:04	200	3344	—
3/20/2009 13:25:04	205	3337	—
3/20/2009 13:30:04	210	3368	3350
3/20/2009 13:35:04	215	3346	—
3/20/2009 13:40:05	220	3355	—
3/20/2009 13:45:04	225	3335	3339
3/20/2009 13:50:04	230	3350	—
3/20/2009 13:55:05	235	3318	—
3/20/2009 14:00:04	240	3350	3331
3/20/2009 14:05:04	245	3342	—
3/20/2009 14:10:04	250	3332	—
3/20/2009 14:15:04	255	3331	3353
3/20/2009 14:20:04	260	3332	—
3/20/2009 14:25:06	265	3314	—
3/20/2009 14:30:04	270	3315	3347
3/20/2009 14:35:05	275	3348	—
3/20/2009 14:40:04	280	3344	—
3/20/2009 14:45:04	285	3354	3342
3/20/2009 14:50:04	290	3345	—
3/20/2009 14:55:05	295	3324	—
3/20/2009 15:00:04	300	3341	3338
3/20/2009 15:05:04	305	3329	—
3/20/2009 15:10:05	310	3309	—
3/20/2009 15:15:04	315	3323	3354
3/20/2009 15:20:04	320	3344	—
3/20/2009 15:25:04	325	3312	—
3/20/2009 15:30:04	330	3329	3332
3/20/2009 15:35:05	335	3339	—
3/20/2009 15:40:04	340	3330	—
3/20/2009 15:45:05	345	3314	3346
3/20/2009 15:50:04	350	3333	—
3/20/2009 15:55:05	355	3347	—
3/20/2009 16:00:04	360	3350	3355
3/20/2009 16:05:04	365	3320	—
3/20/2009 16:10:04	370	3358	—

Table 1 of Attachment 2BB-2 (Sheet 3 of 3)
Pumping Rate Measurements for PW-6L

Date/Time	Minutes	Electronic Flow (gpm)	Manual Flow (gpm)
3/20/2009 16:15:04	375	3334	3340
3/20/2009 16:20:04	380	3355	—
3/20/2009 16:25:04	385	3349	—
3/20/2009 16:30:04	390	3329	3346
3/20/2009 16:35:04	395	3328	—
3/20/2009 16:40:05	400	3347	—
3/20/2009 16:45:04	405	3336	3354
3/20/2009 16:50:04	410	3344	—
3/20/2009 16:55:04	415	3346	—
3/20/2009 17:00:05	420	3351	3368
3/20/2009 17:05:04	425	3326	—
3/20/2009 17:10:05	430	3335	—
3/20/2009 17:15:05	435	3362	3376
3/20/2009 17:20:04	440	3349	—
3/20/2009 17:25:05	445	3370	—
3/20/2009 17:30:04	450	3343	3333
3/20/2009 17:35:04	455	3354	—
3/20/2009 17:40:04	460	3324	—
3/20/2009 17:45:04	465	3335	3356
3/20/2009 17:50:04	470	3336	—
3/20/2009 17:55:04	475	3356	—
3/20/2009 18:00	480	0	—

(a) Value taken from next reading to provide pumping rate at t=0.

Figure 1 of Attachment 2BB-2 Time-Drawdown Graph for C6-5 Well Cluster

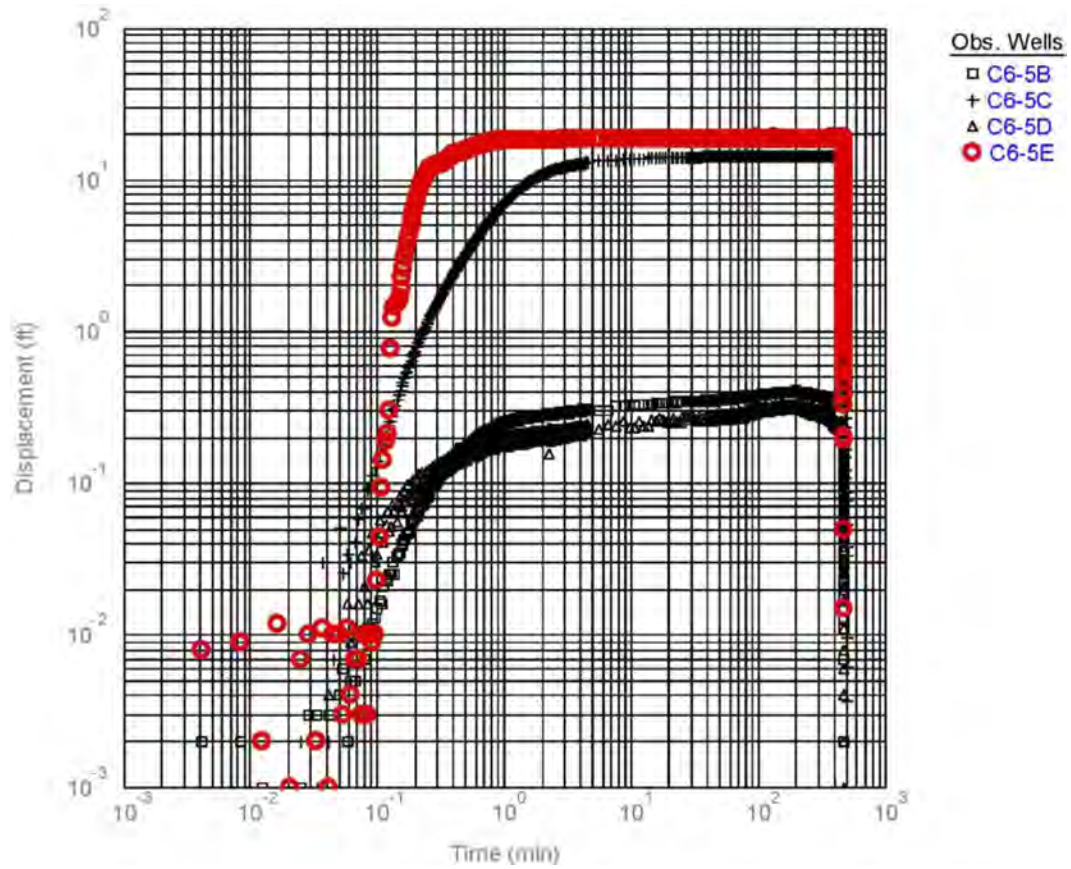


Figure 2 of Attachment 2BB-2 Time-Drawdown Graph for C6-4 Well Cluster

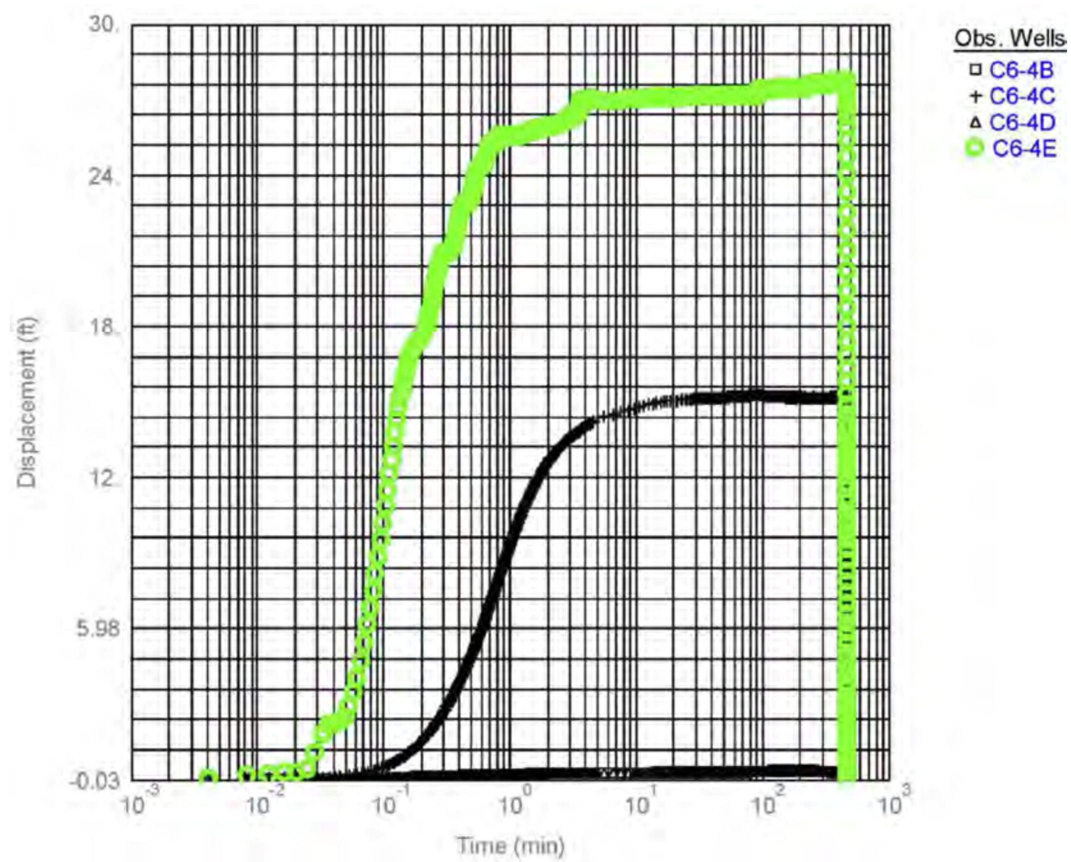


Figure 3 of Attachment 2BB-2 Time-Drawdown Graph for C6-3 Well Cluster

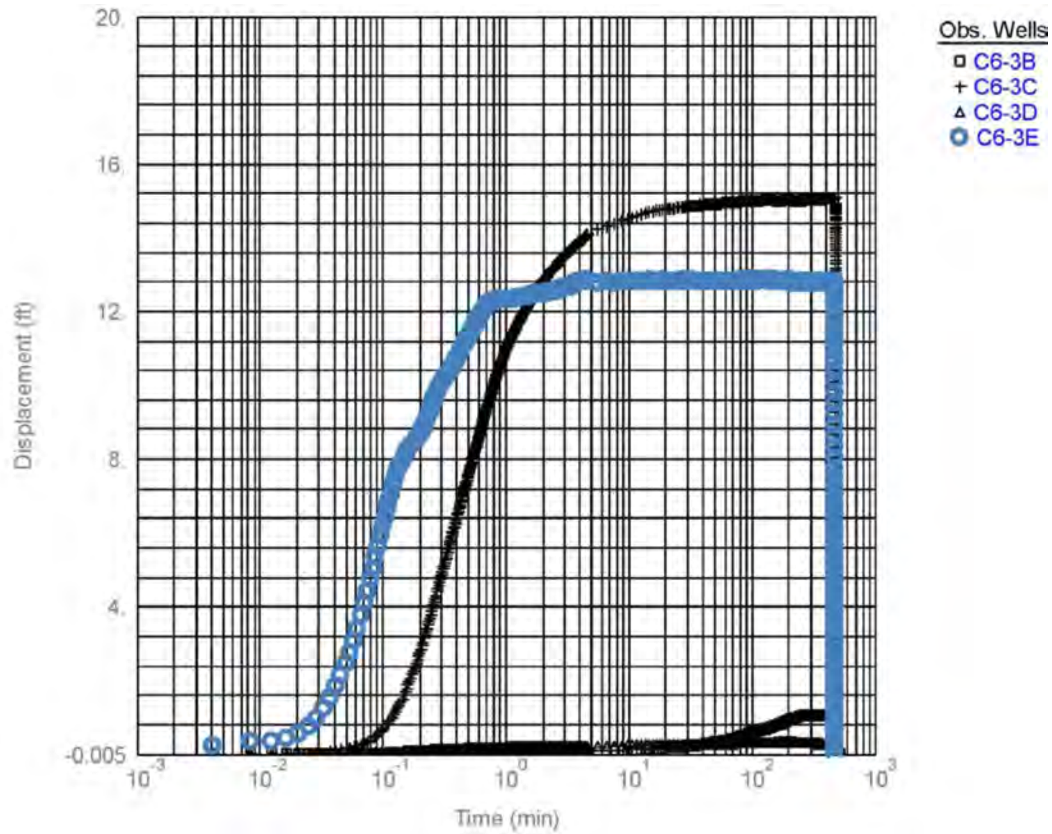


Figure 4 of Attachment 2BB-2 Time-Drawdown Graph for C6-2 Well Cluster

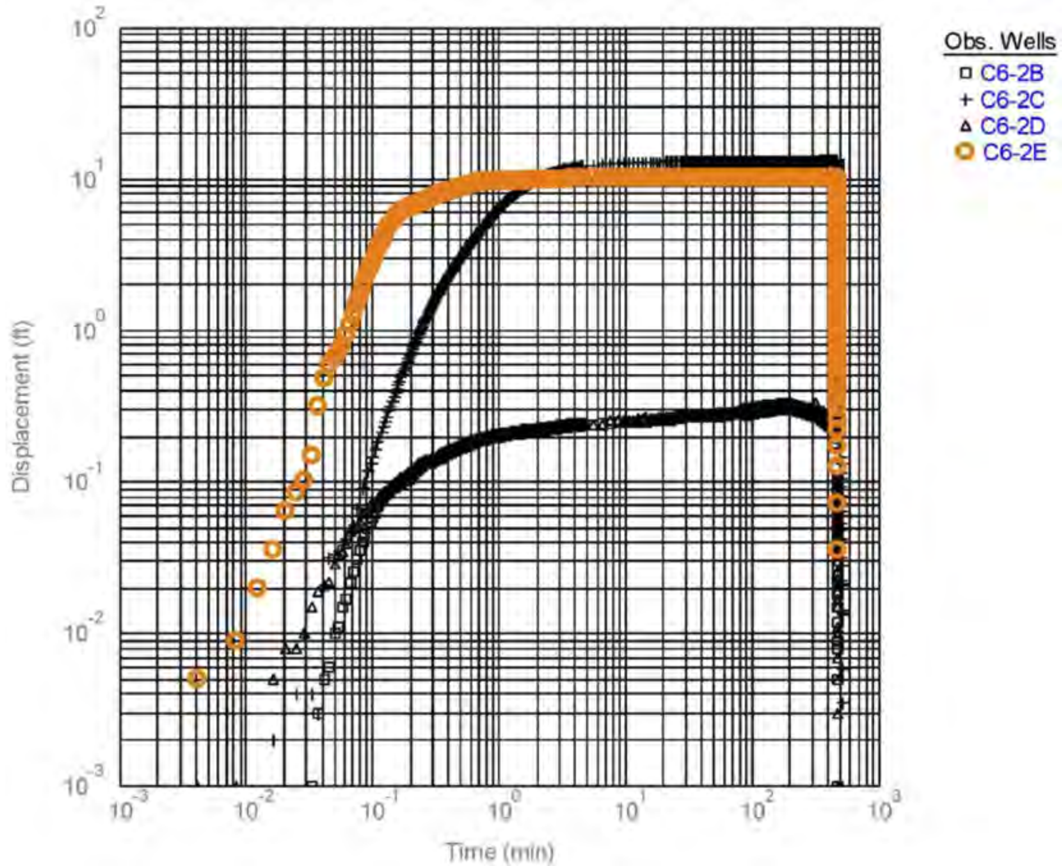


Figure 5 of Attachment 2BB-2 Distance-Drawdown Graph for PW-6L Test (t = 20 minutes)

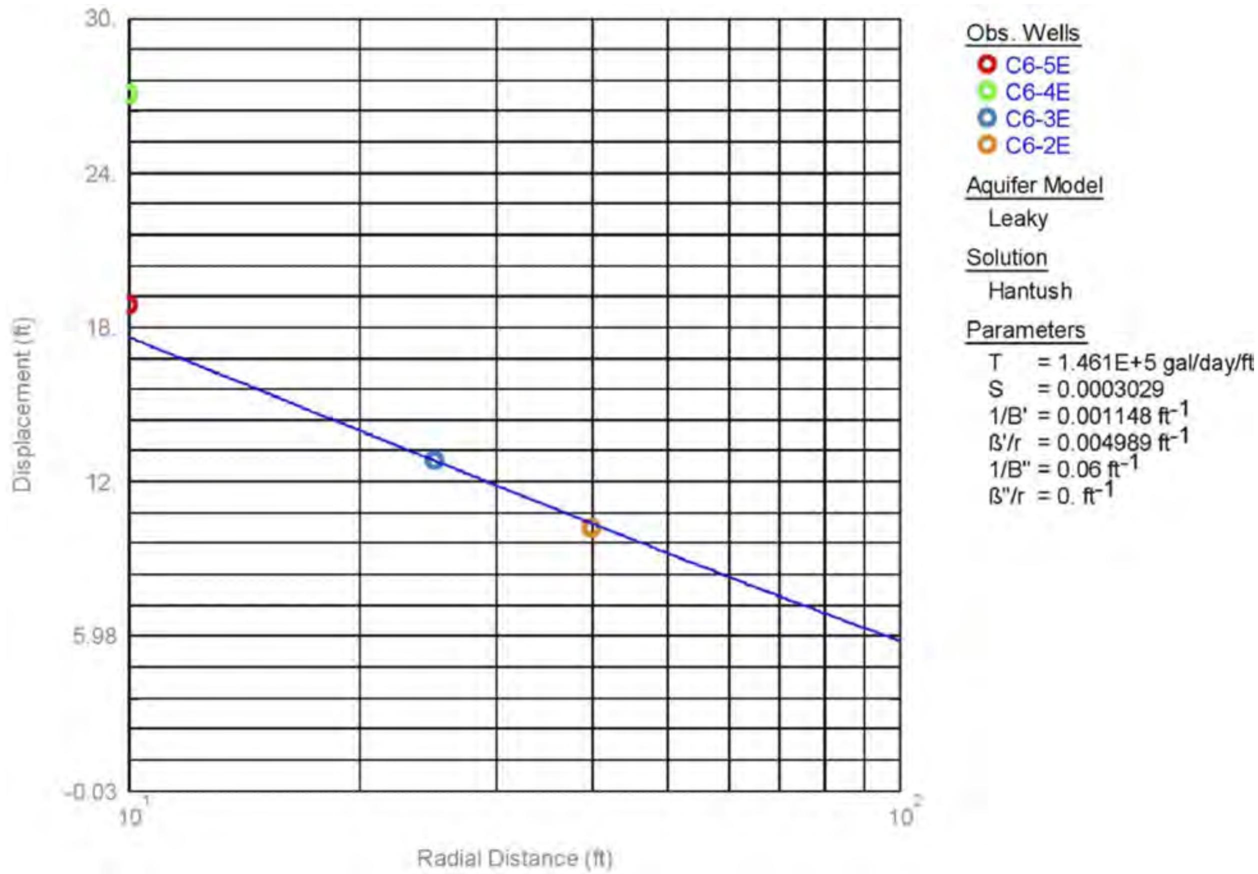


Figure 6 of Attachment 2BB-2 Time-Drawdown Graph for C6-5E Using Theis Method

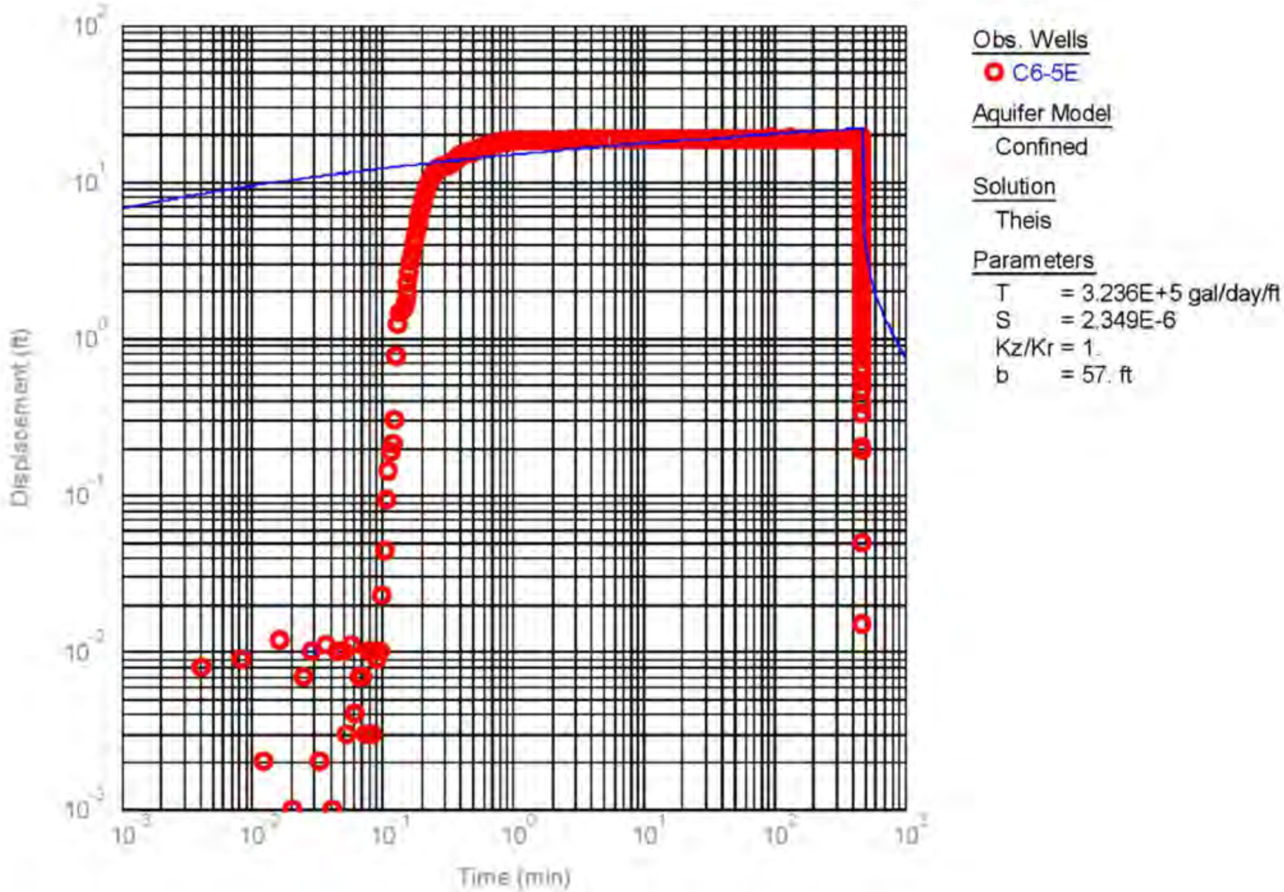


Figure 7 of Attachment 2BB-2 Time-Drawdown Graph for C6-5E Using Hantush Method

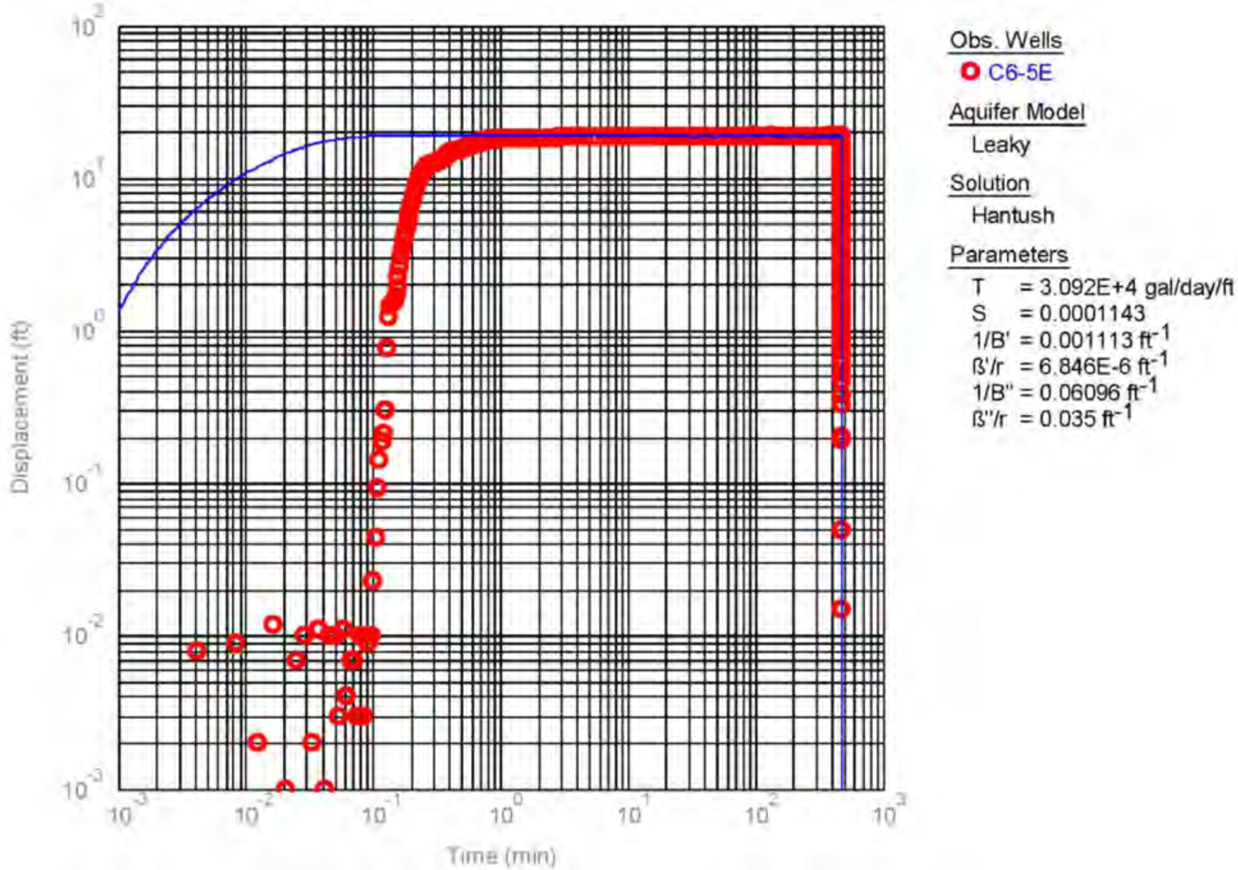


Figure 8 of Attachment 2BB-2 Time-Drawdown Graph for C6-4E Using Theis Method

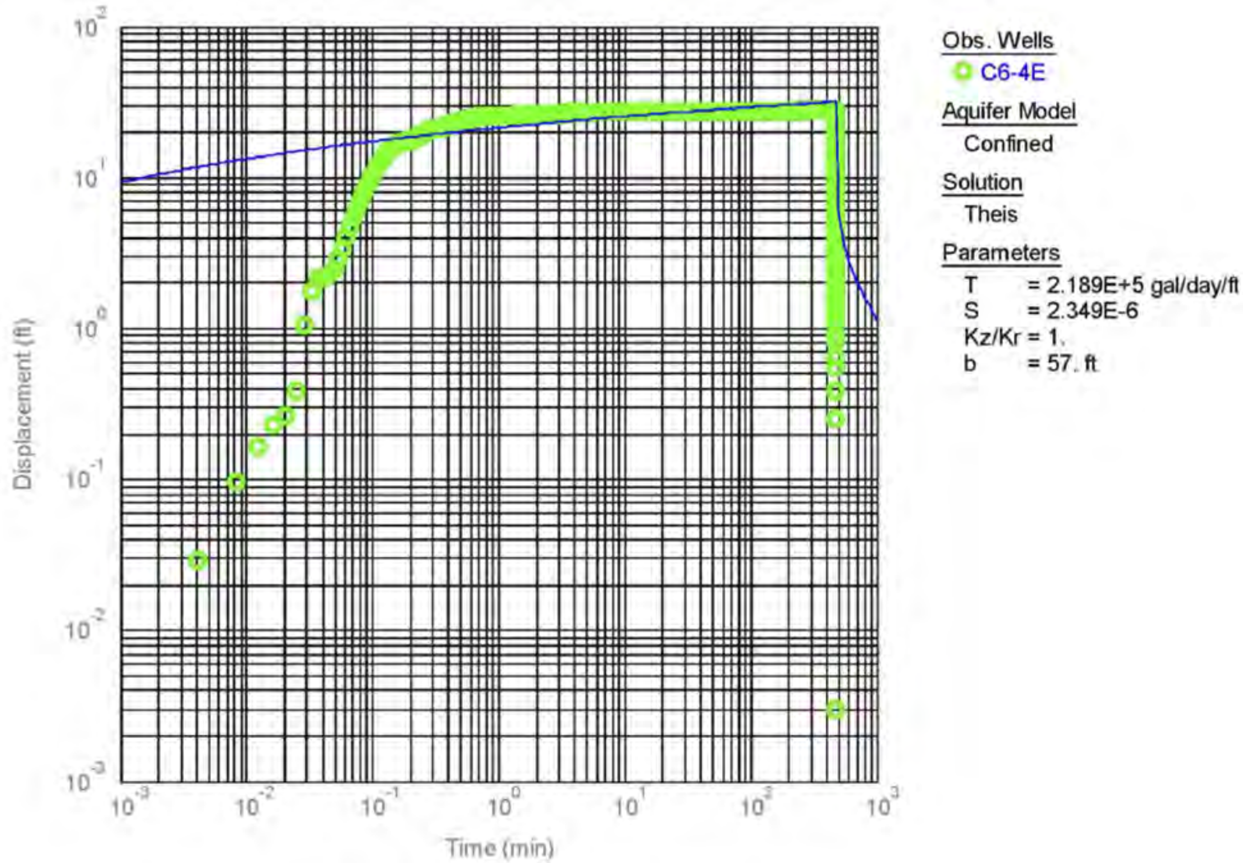


Figure 9 of Attachment 2BB-2 Time-Drawdown Graph for C6-4E Using Hantush Method

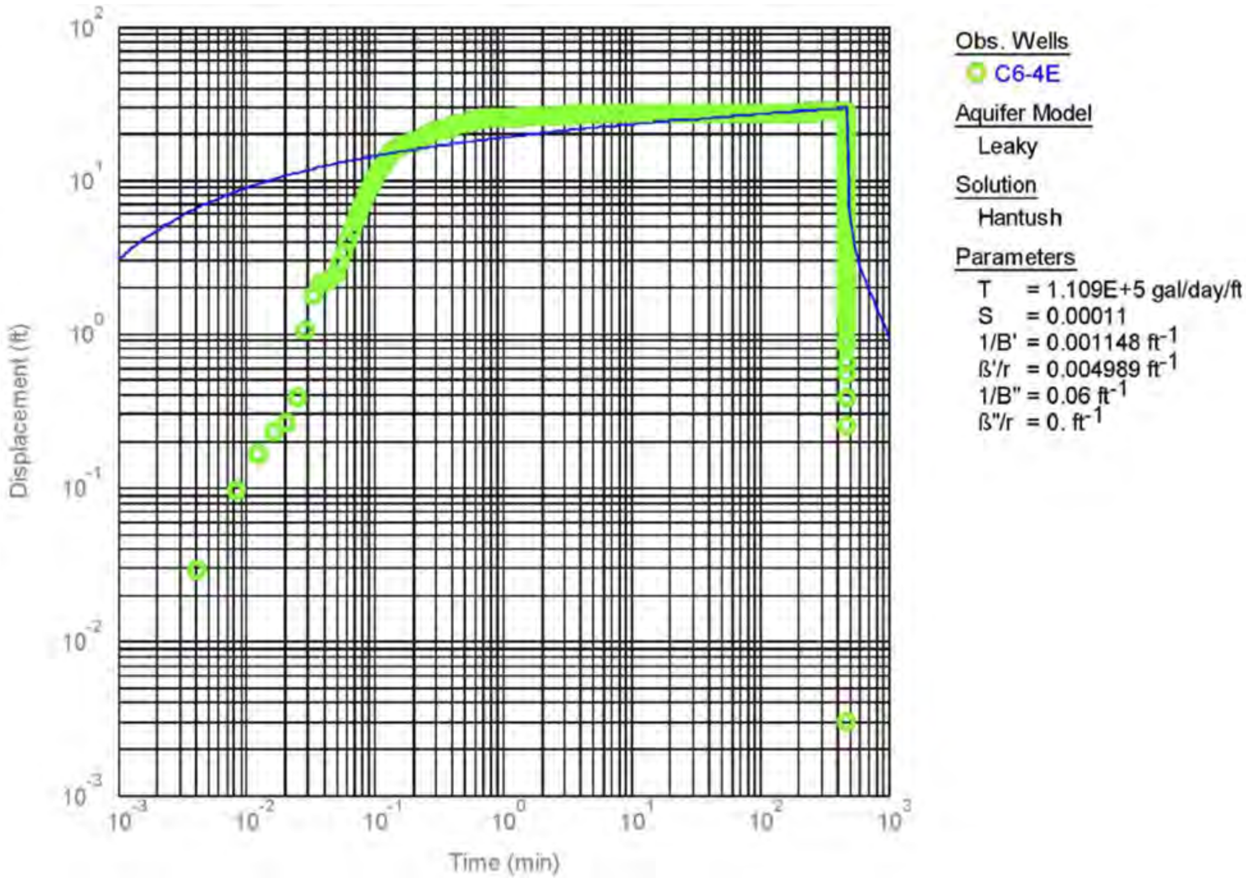


Figure 10 of Attachment 2BB-2 Time-Drawdown Graph for C6-3E Using Theis Method

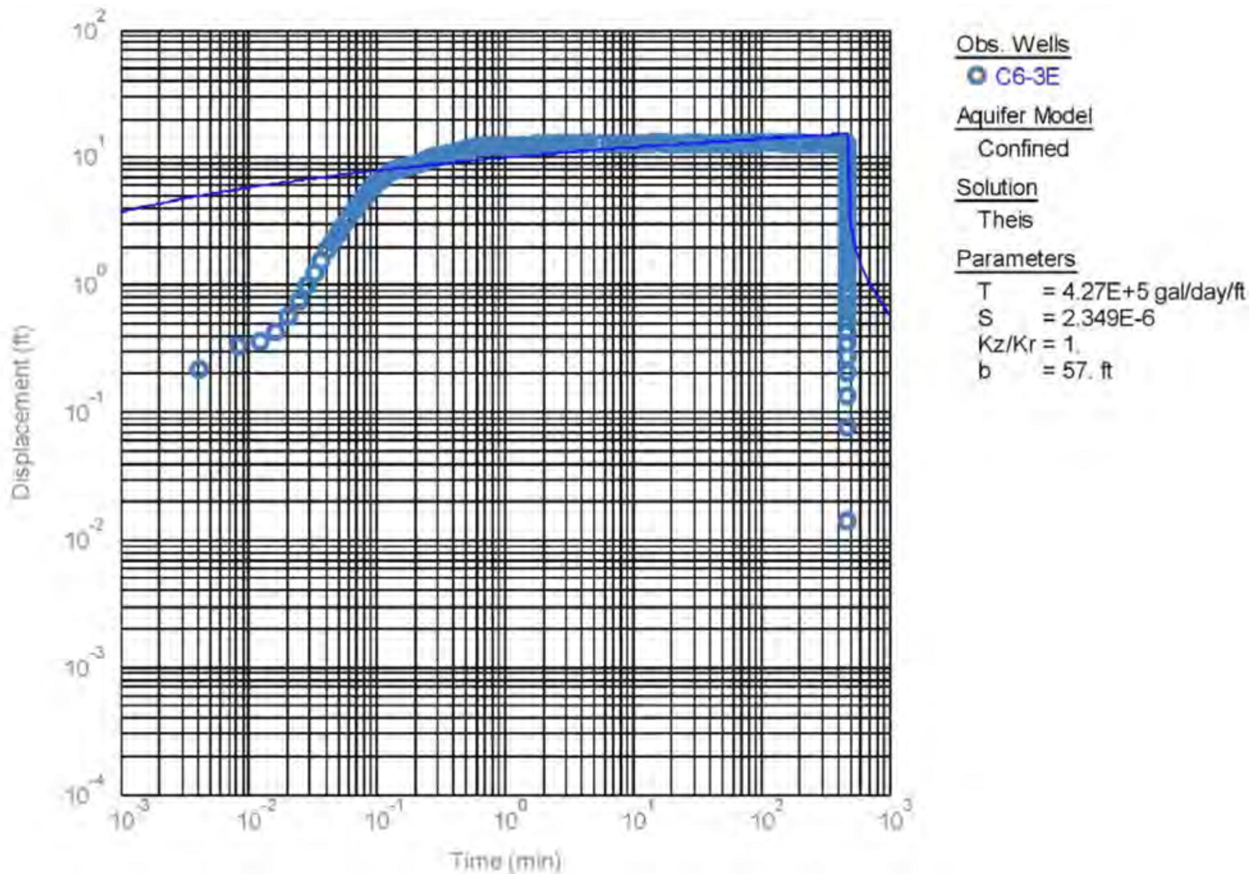


Figure 11 of Attachment 2BB-2 Time-Drawdown Graph for C6-3E Using Hantush Method

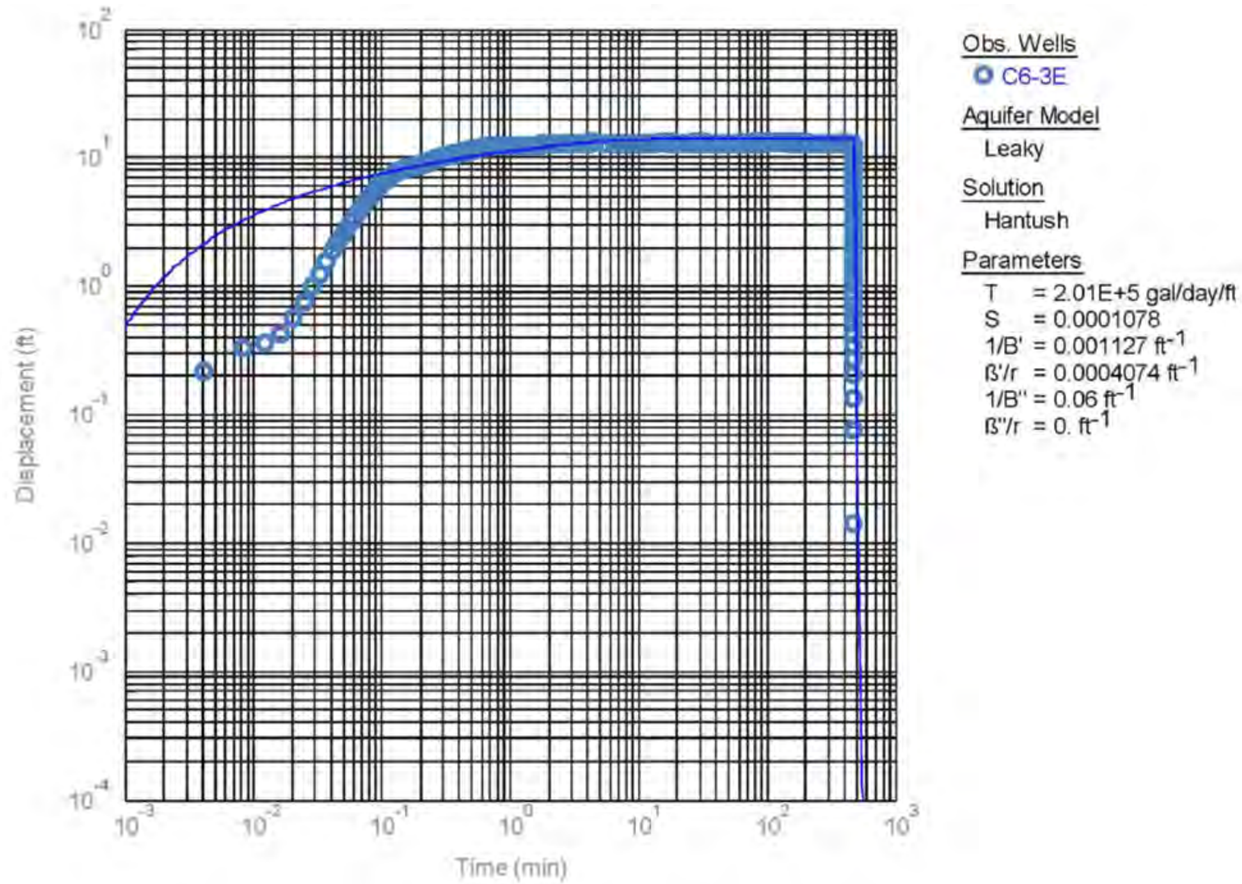
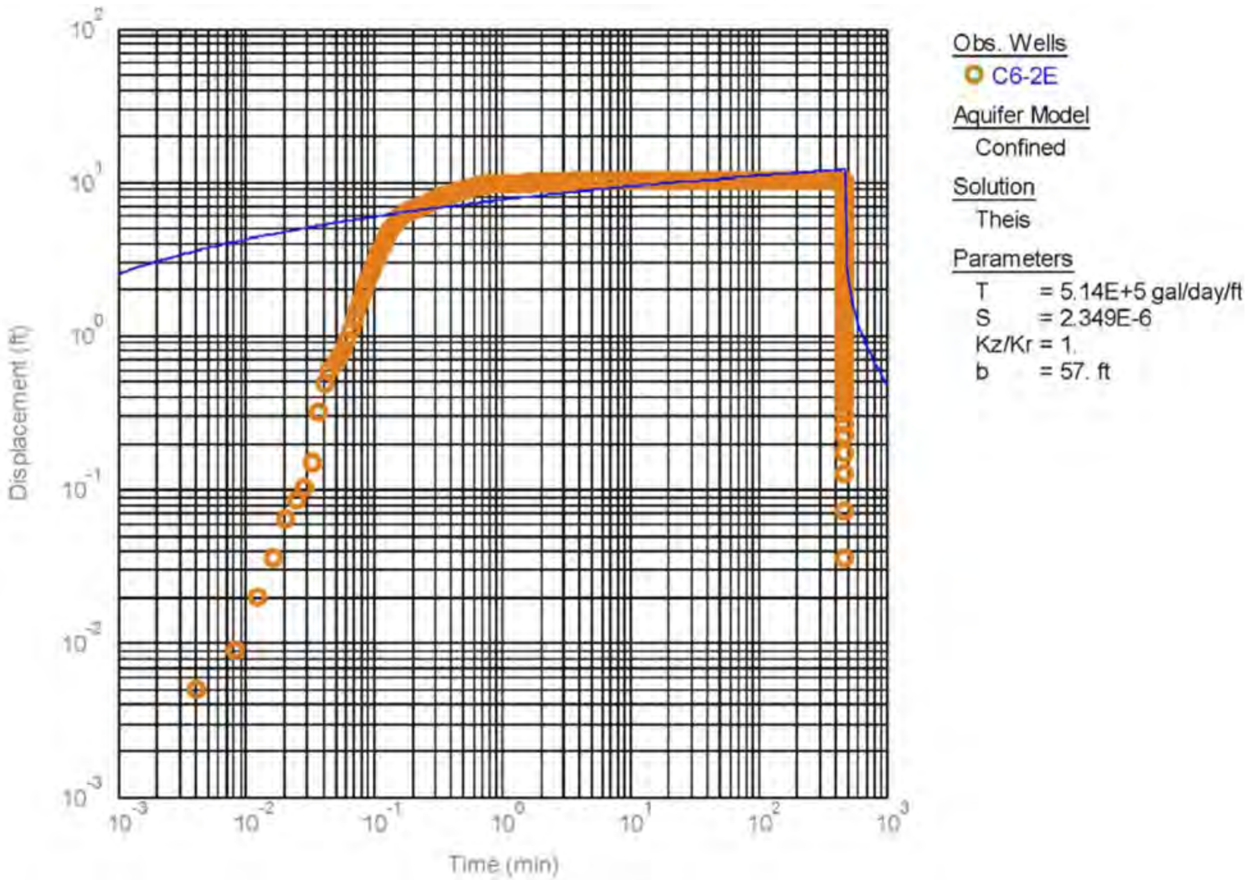


Figure 12 of Attachment 2BB-2 Time-Drawdown Graph for C6-2E Using Theis Method



ATTACHMENT 2BB-3

UNIT 7 SHALLOW TEST GRAPHS AND PUMPING RATES

Table 1 of Attachment 2BB-3 (Sheet 1 of 3)
Pumping Rate Measurements for PW-7U

Date/Time	Time (minutes)	Flow Meter Recorded (gpm)	Flow Meter Manual (gpm)[b]
2/23/2009 19:00:15	0	4179[a]	—
2/23/2009 19:02:15	2.25	4179	—
2/23/2009 19:07:15	7.25	4149	—
2/23/2009 19:12:15	12.25	4185	—
2/23/2009 19:17:15	17.25	4175	4150
2/23/2009 19:22:14	22.23	4178	—
2/23/2009 19:27:14	27.23	4154	—
2/23/2009 19:32:14	32.23	4174	4165
2/23/2009 19:37:14	37.23	4181	—
2/23/2009 19:42:14	42.23	4174	—
2/23/2009 19:47:14	47.23	4142	4169
2/23/2009 19:52:14	52.23	4178	—
2/23/2009 19:57:15	57.25	4176	—
2/23/2009 20:02:14	62.23	4171	4178
2/23/2009 20:07:15	67.25	4174	—
2/23/2009 20:12:14	72.23	4180	—
2/23/2009 20:17:14	77.23	4151	4195
2/23/2009 20:22:14	82.23	4183	—
2/23/2009 20:27:14	87.23	4178	—
2/23/2009 20:32:14	92.23	4196	4175
2/23/2009 20:37:14	97.23	4164	—
2/23/2009 20:42:15	102.25	4168	—
2/23/2009 20:47:15	107.25	4196	4172
2/23/2009 20:52:14	112.23	4153	—
2/23/2009 20:57:15	117.25	4161	—
2/23/2009 21:02:14	122.23	4147	4167
2/23/2009 21:07:14	127.23	4167	—
2/23/2009 21:12:14	132.23	4195	—
2/23/2009 21:17:14	137.23	4152	4181
2/23/2009 21:22:14	142.23	4187	—
2/23/2009 21:27:15	147.25	4169	—
2/23/2009 21:32:14	152.23	4158	4167
2/23/2009 21:37:14	157.23	4203	—
2/23/2009 21:42:14	162.23	4143	—
2/23/2009 21:47:15	167.25	4156	4207
2/23/2009 21:52:14	172.23	4182	—

Table 1 of Attachment 2BB-3 (Sheet 2 of 3)
Pumping Rate Measurements for PW-7U

Date/Time	Time (minutes)	Flow Meter Recorded (gpm)	Flow Meter Manual (gpm)[(b)]
2/23/2009 21:57:14	177.23	4174	—
2/23/2009 22:02:14	182.23	4159	4150
2/23/2009 22:07:14	187.23	4157	—
2/23/2009 22:12:16	192.27	4201	—
2/23/2009 22:17:15	197.25	4172	4151
2/23/2009 22:22:14	202.23	4202	—
2/23/2009 22:27:14	207.23	4172	—
2/23/2009 22:32:14	212.23	4167	4167
2/23/2009 22:37:14	217.23	4200	—
2/23/2009 22:42:14	222.23	4186	—
2/23/2009 22:47:14	227.23	4182	4197
2/23/2009 22:52:14	232.23	4180	—
2/23/2009 22:57:15	237.25	4174	—
2/23/2009 23:02:14	242.23	4189	4174
2/23/2009 23:07:14	247.23	4186	—
2/23/2009 23:12:14	252.23	4159	—
2/23/2009 23:17:14	257.23	4180	4157
2/23/2009 23:22:14	262.23	4173	—
2/23/2009 23:27:14	267.23	4195	—
2/23/2009 23:32:15	272.25	4177	4201
2/23/2009 23:37:14	277.23	4184	—
2/23/2009 23:42:15	282.25	4209	—
2/23/2009 23:47:15	287.25	4202	4203
2/23/2009 23:52:14	292.23	4183	—
2/23/2009 23:57:15	297.25	4208	—
2/24/2009 0:02:14	302.23	4182	4200
2/24/2009 0:07:14	307.23	4205	—
2/24/2009 0:12:14	312.23	4224	—
2/24/2009 0:17:14	317.23	4211	4185
2/24/2009 0:22:14	322.23	4188	—
2/24/2009 0:27:15	327.25	4210	—
2/24/2009 0:32:14	332.23	4196	4214
2/24/2009 0:37:14	337.23	4211	—
2/24/2009 0:42:15	342.25	4214	—
2/24/2009 0:47:14	347.23	4203	4218
2/24/2009 0:52:14	352.23	4209	—
2/24/2009 0:57:14	357.23	4201	—

Table 1 of Attachment 2BB-3 (Sheet 3 of 3)
Pumping Rate Measurements for PW-7U

Date/Time	Time (minutes)	Flow Meter Recorded (gpm)	Flow Meter Manual (gpm)[(b)]
2/24/2009 1:02:15	362.25	4189	4164
2/24/2009 1:07:14	367.23	4177	—
2/24/2009 1:12:15	372.25	4184	—
2/24/2009 1:17:14	377.23	4163	4192
2/24/2009 1:22:14	382.23	4202	—
2/24/2009 1:27:14	387.23	4202	—
2/24/2009 1:32:14	392.23	4183	4216
2/24/2009 1:37:15	397.25	4196	—
2/24/2009 1:42:14	402.23	4162	—
2/24/2009 1:47:14	407.23	4179	4191
2/24/2009 1:52:15	412.25	4179	—
2/24/2009 1:57:15	417.25	4182	—
2/24/2009 2:02:14	422.23	4170	4201
2/24/2009 2:07:15	427.25	4208	—
2/24/2009 2:12:14	432.23	4203	—
2/24/2009 2:17:14	437.23	4176	4183
2/24/2009 2:22:15	442.25	4190	—
2/24/2009 2:27:15	447.25	4167	—
2/24/2009 2:32:14	452.23	4200	4185
2/24/2009 2:37:14	457.23	4191	—
2/24/2009 2:42:15	462.25	4175	—
2/24/2009 2:47:15	467.25	4158	4189
2/24/2009 2:52:14	472.23	4174	—
2/24/2009 2:57:14	477.23	4177	—
2/24/2009 3:02:14	482.23	4165	4169
2/24/2009 3:07:14	487.23	4174	—
2/24/2009 3:12:14	492.23	4208	—
2/24/2009 3:17:14	497.23	4219	4198
2/24/2009 3:22:14	502.23	4179	—
2/24/2009 3:27:15	507.25	4161	—
2/24/2009 3:32:14	512.23	4197	4165
2/24/2009 3:37:14	517.23	4164	—
2/24/2009 3:45	525.00	0	—

(a) Value taken from next reading to provide pumping rate at t=0.
(b) Manual measurements reported at the closest electronic measurement time.

Figure 1 of Attachment 2BB-3 Time-Drawdown Graph for C7-1 Well Cluster

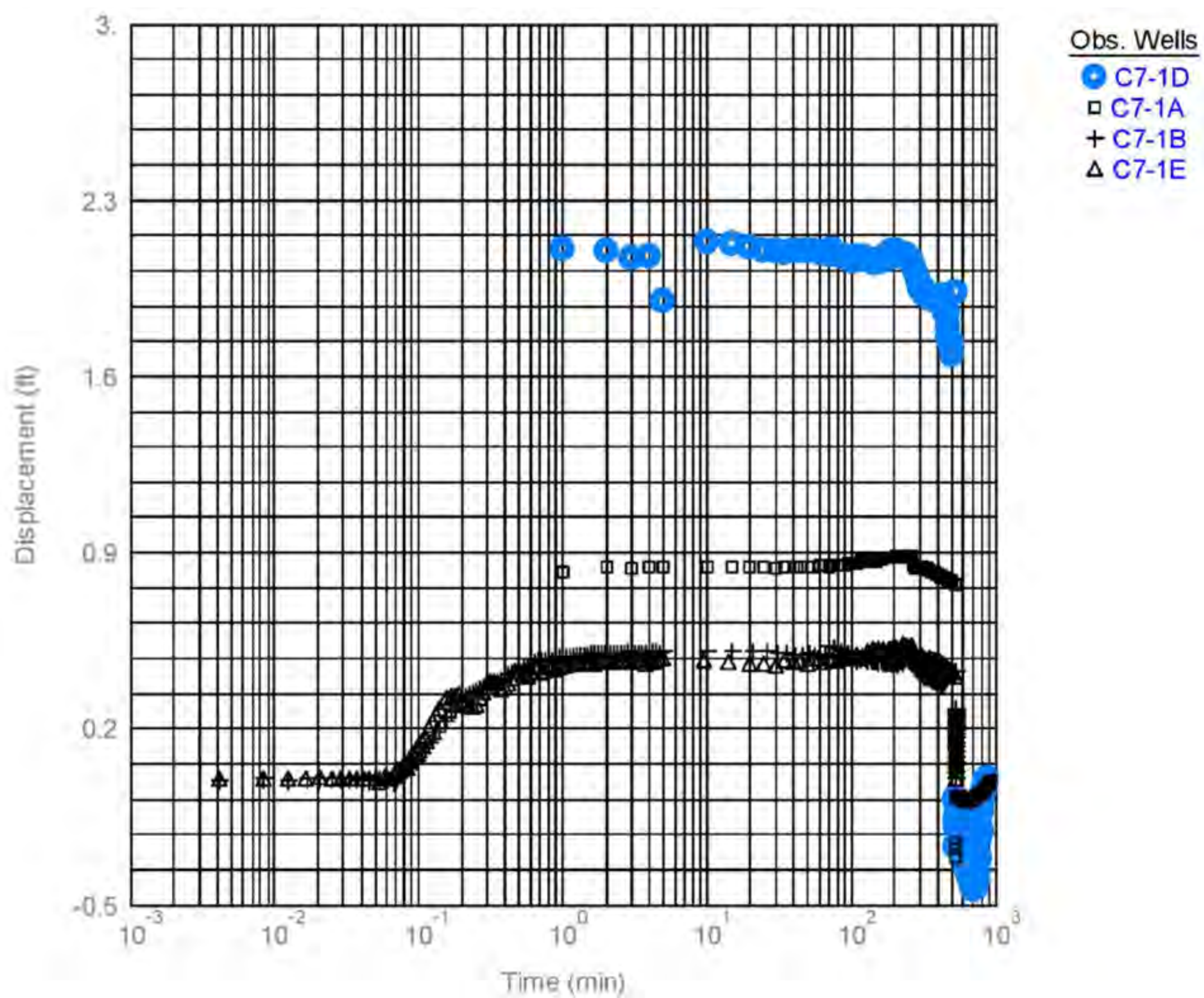


Figure 2 of Attachment 2BB-3 Time-Drawdown Graph for C7-2 Well Cluster

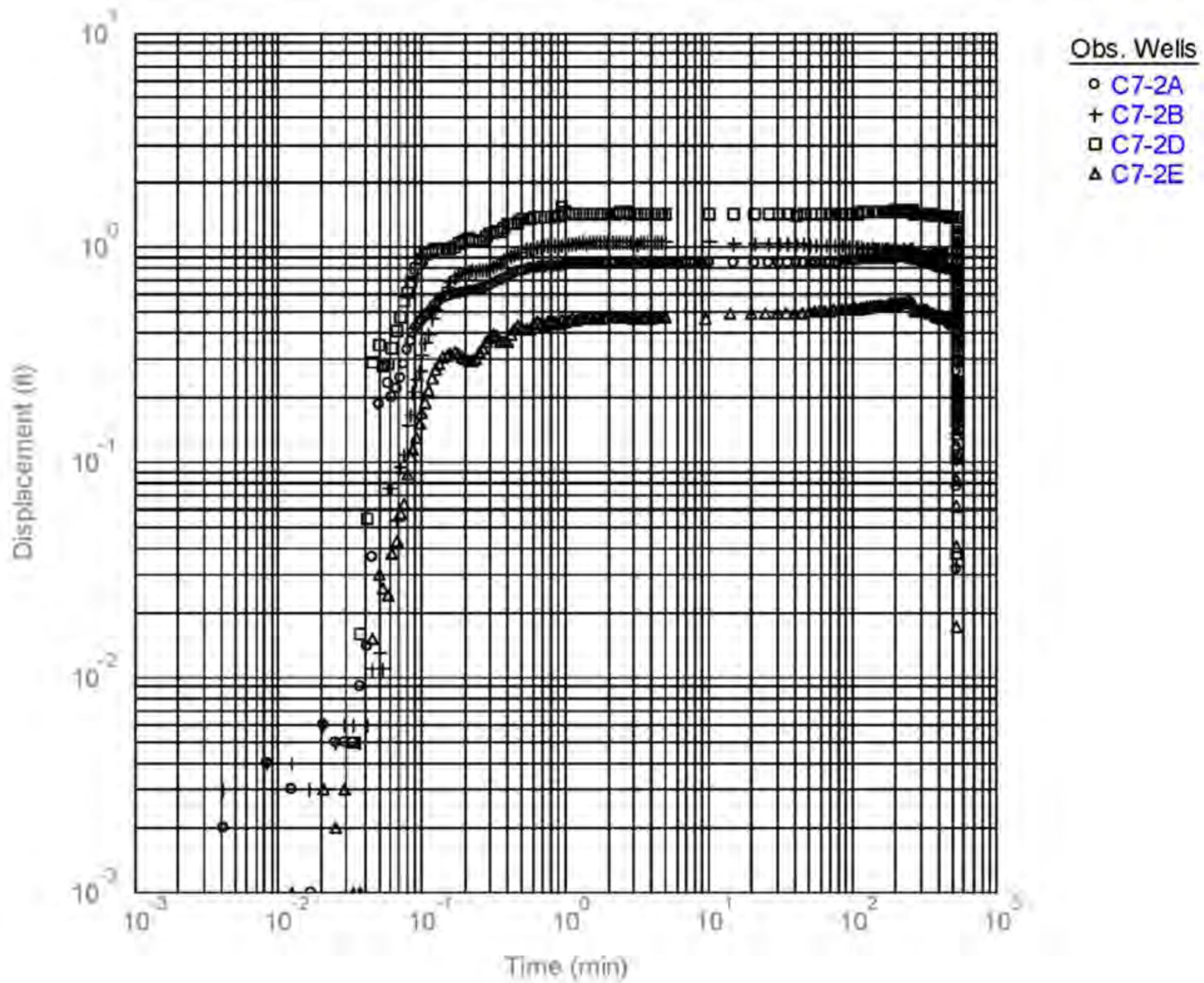


Figure 3 of Attachment 2BB-3 Time-Drawdown Graph for C7-3 Well Cluster

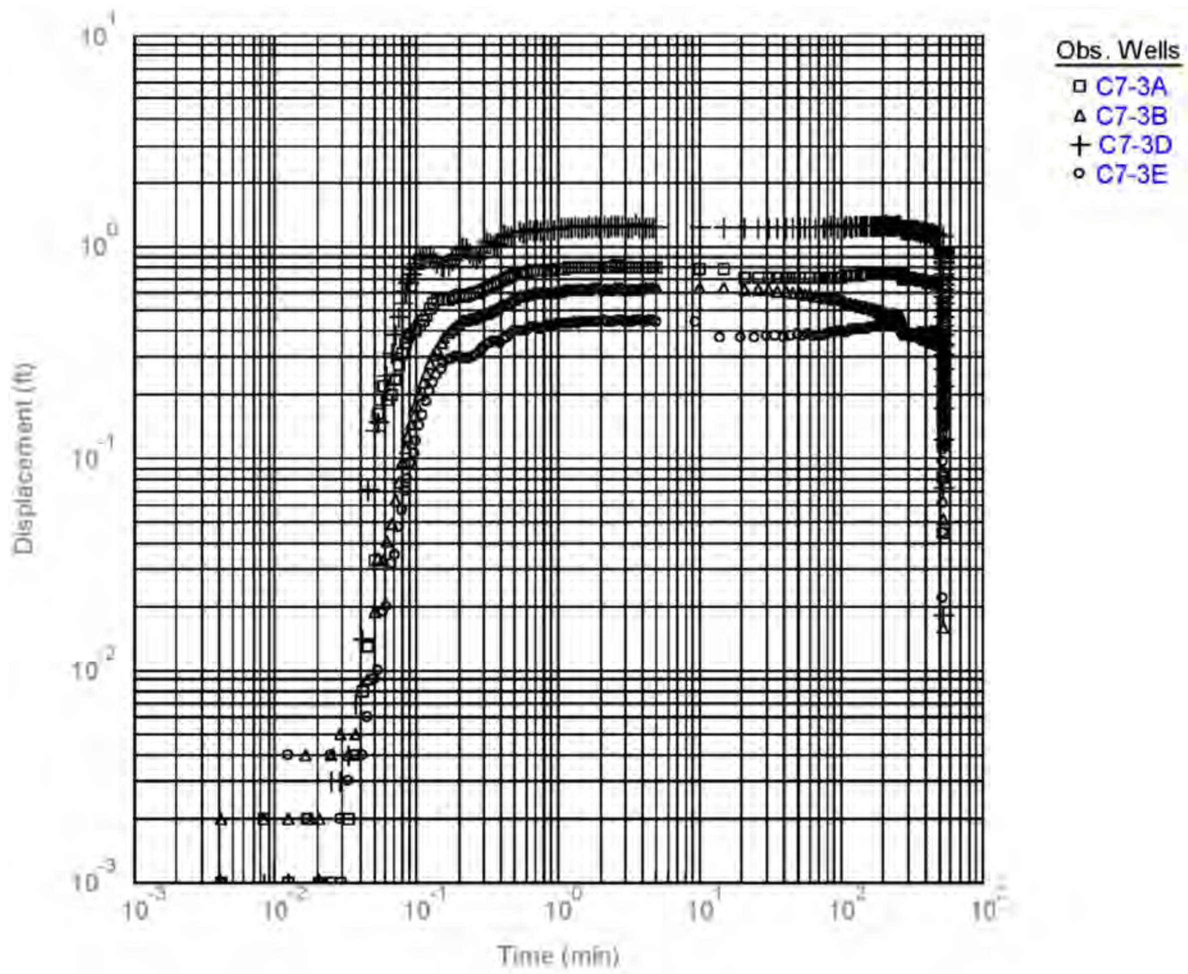


Figure 4 of Attachment 2BB-3 Time-Drawdown Graph for C7-4 Well Cluster

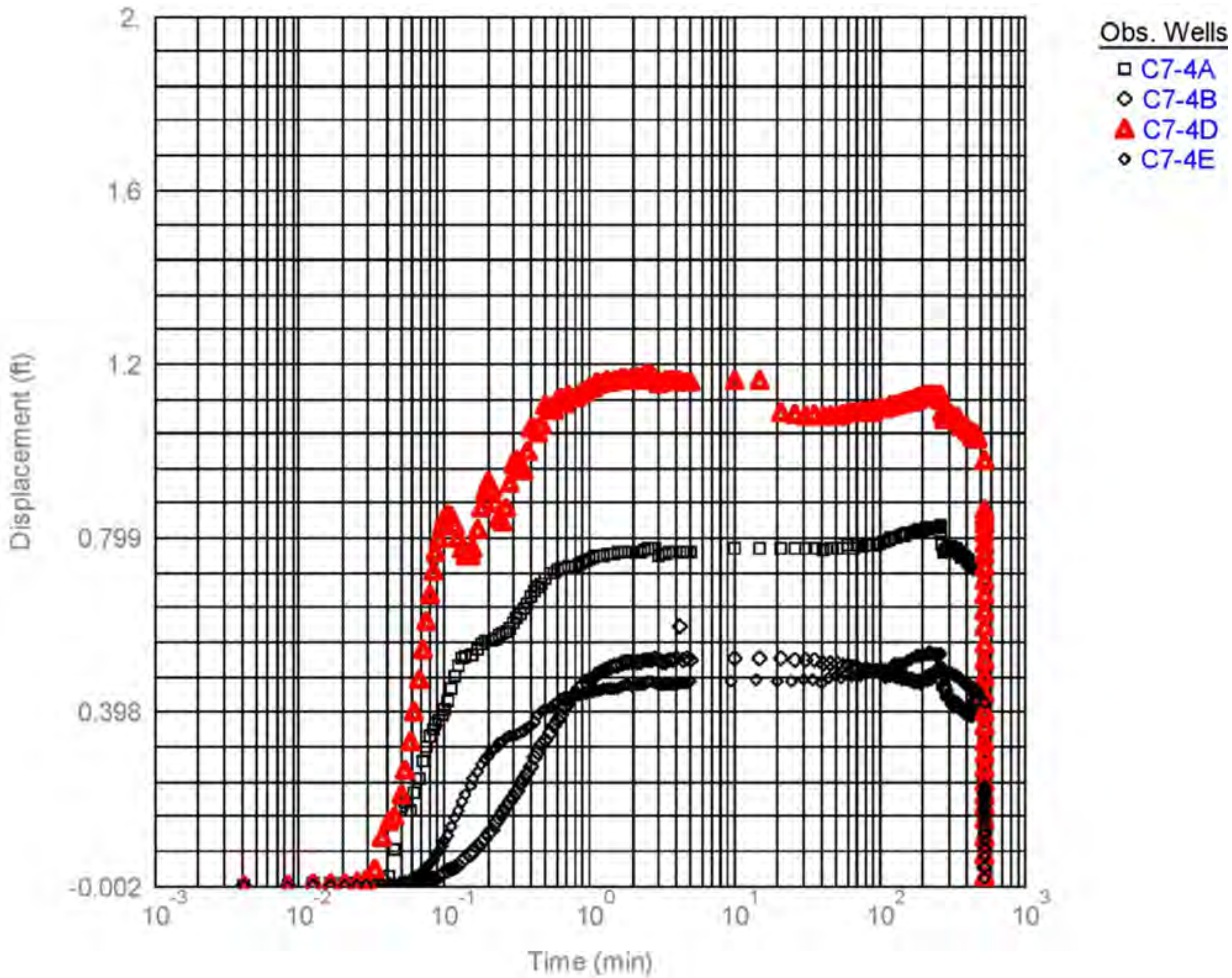


Figure 5 of Attachment 2BB-3 Distance Drawdown Graph (at t= 20 minutes)

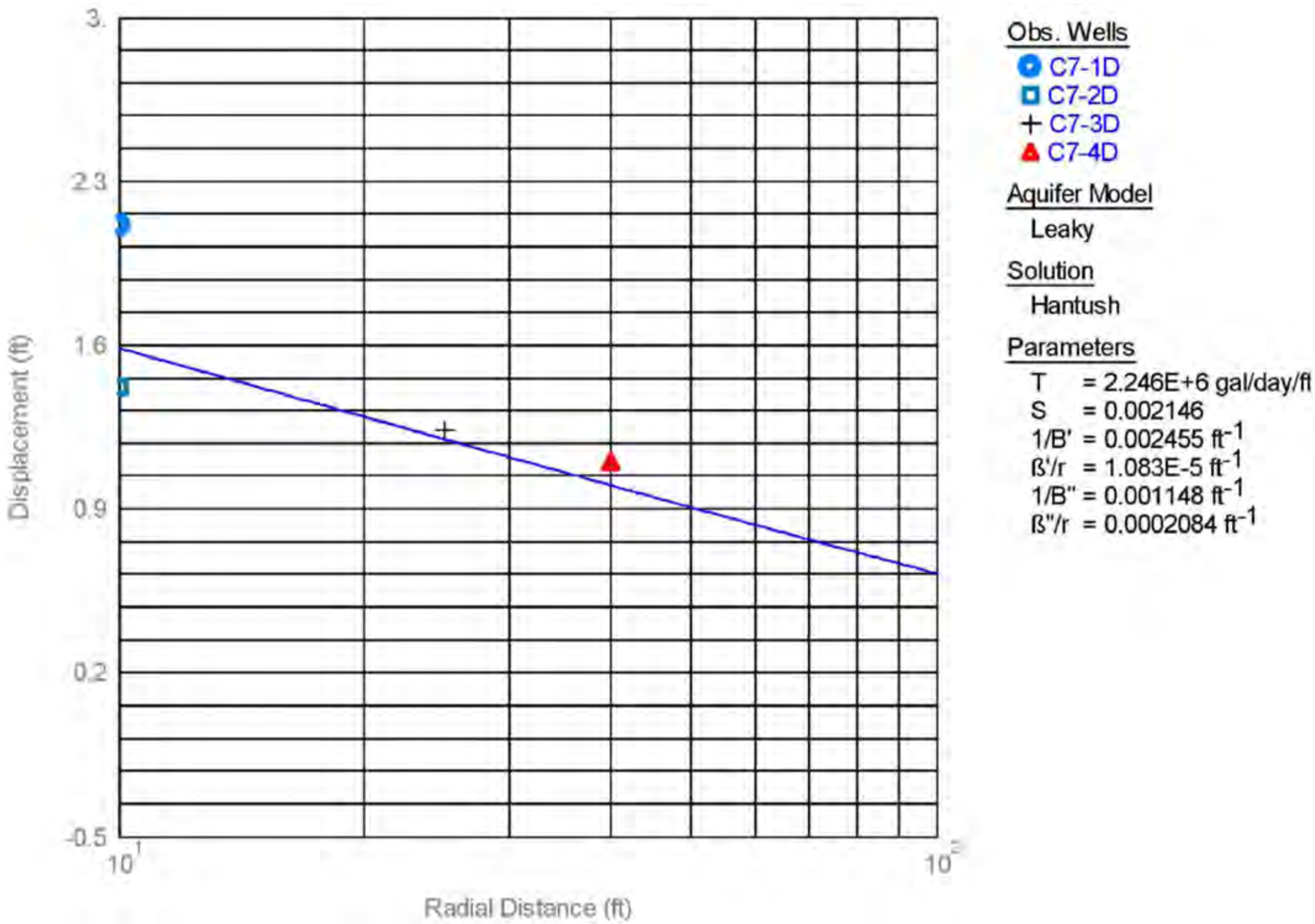


Figure 6 of Attachment 2BB-3 Time-Drawdown Graph for C7-2D Using Theis Method

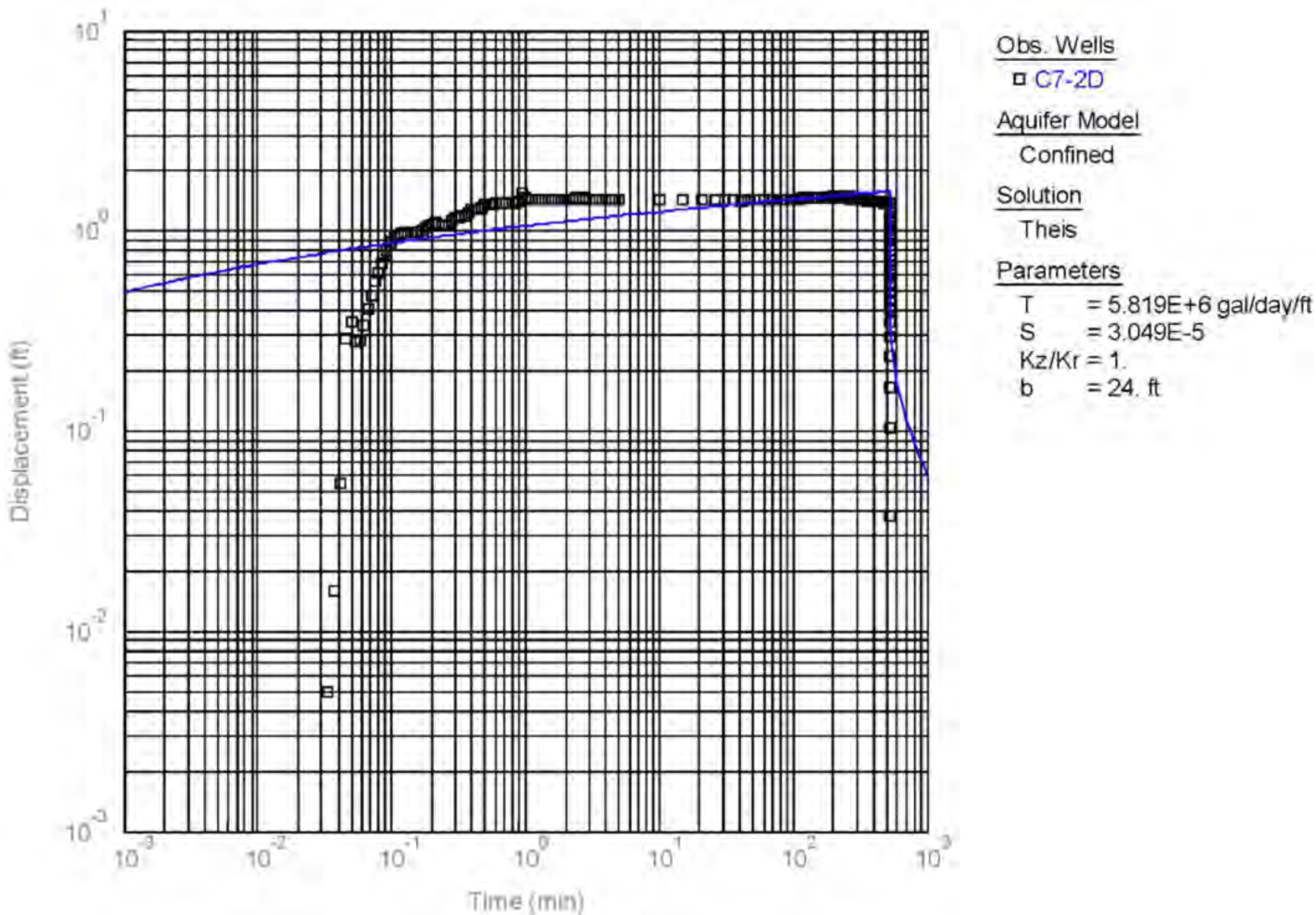


Figure 7 of Attachment 2BB-3 Time-Drawdown Graph for C7-2D Using Hantush Method

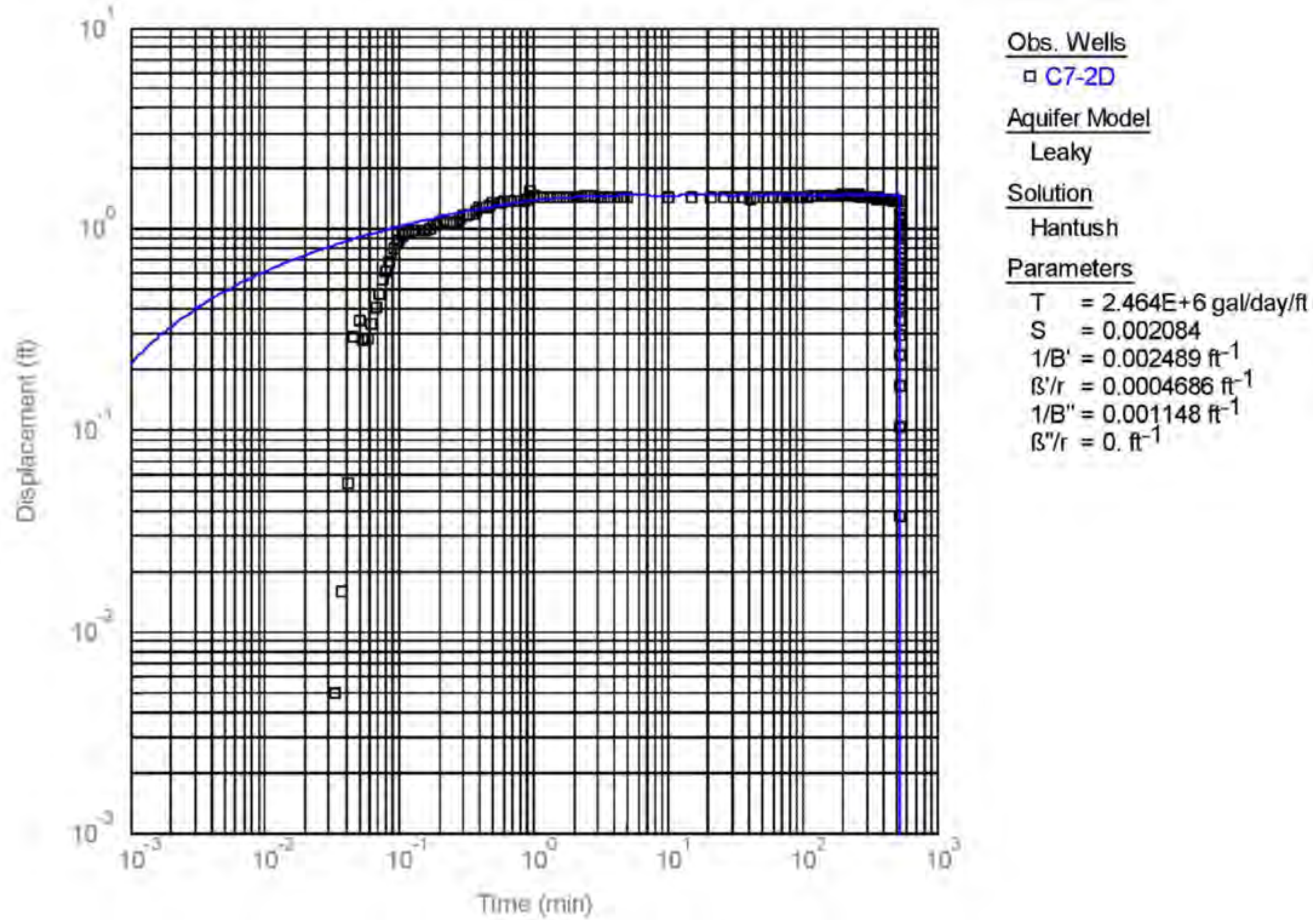


Figure 8 of Attachment 2BB-3 Time-Drawdown Graph for C7-3D Using Theis Method

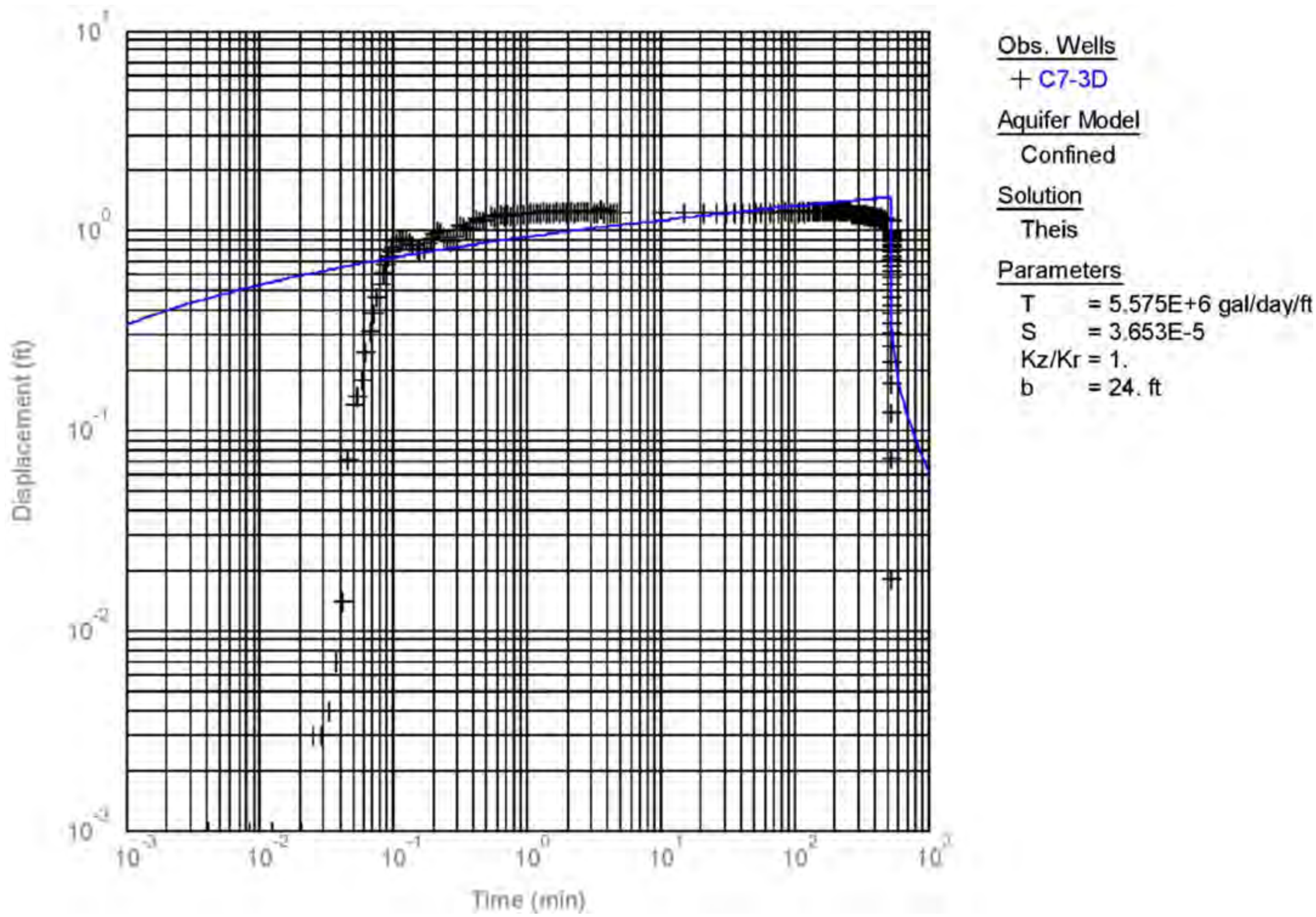


Figure 9 of Attachment 2BB-3 Time-Drawdown Graph for C7-3D Using Hantush Method

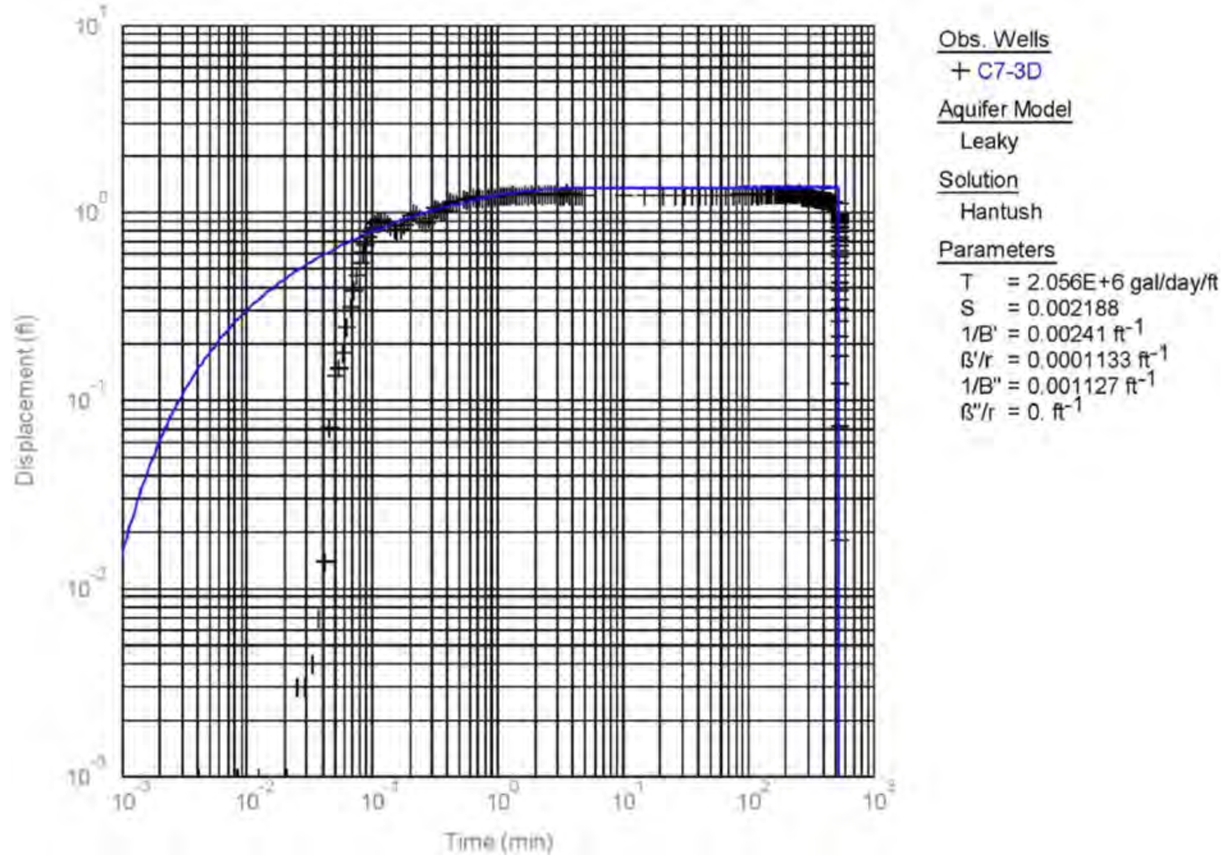


Figure 10 of Attachment 2BB-3 Time-Drawdown Graph for C7-4D Using Theis Method

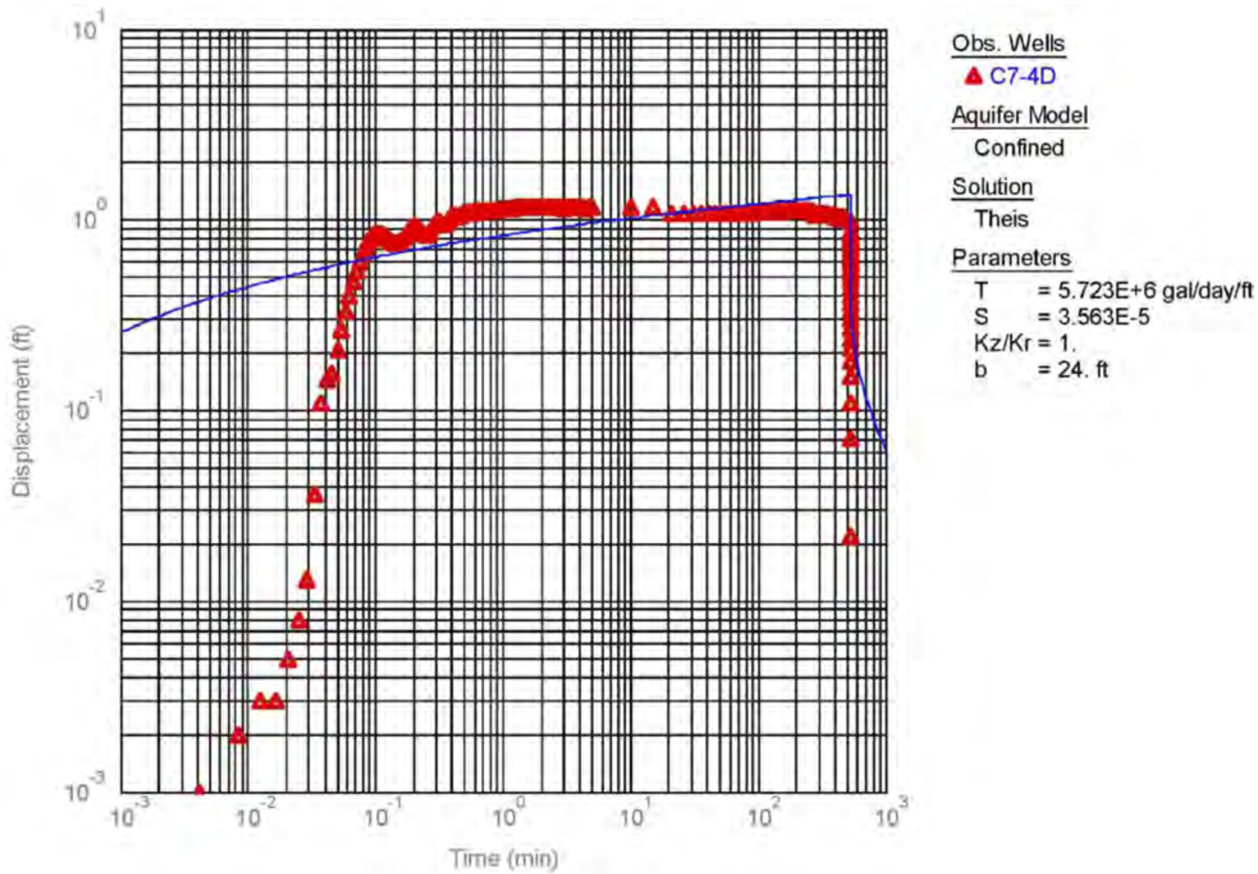
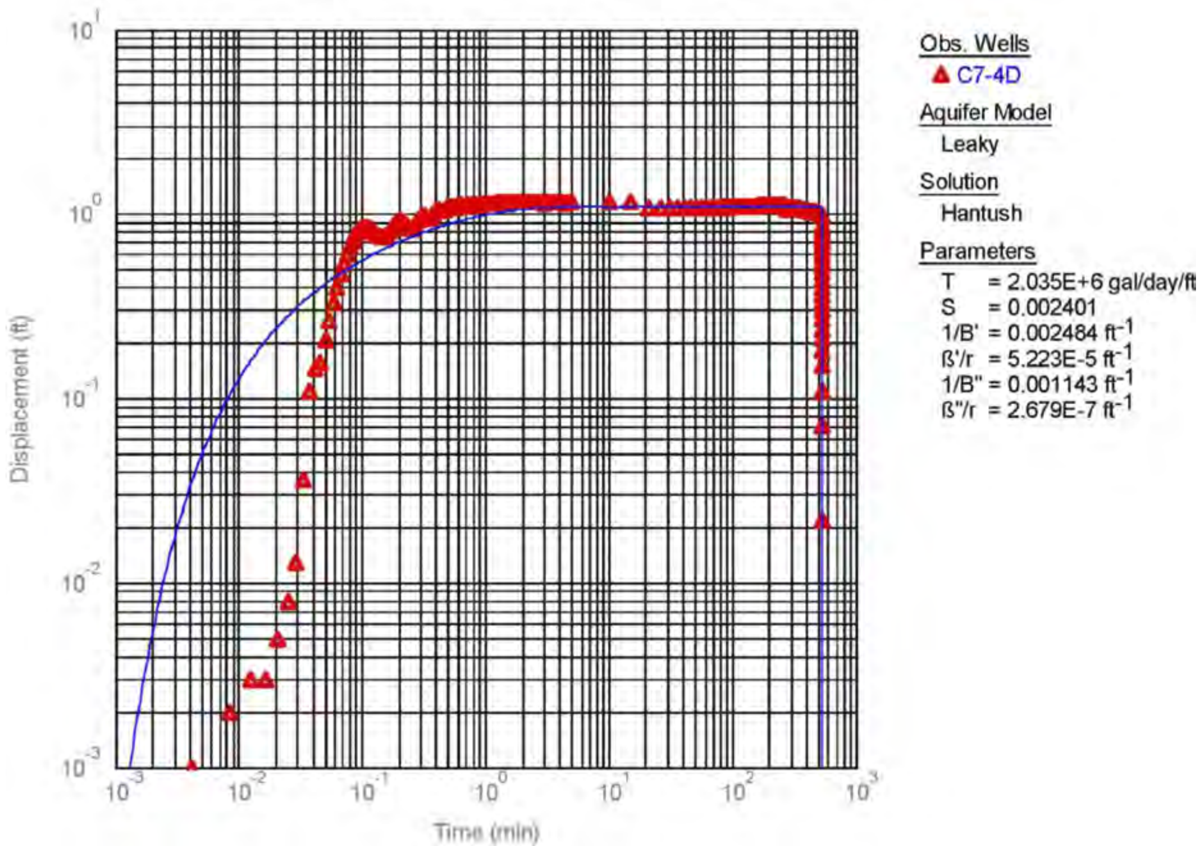


Figure 11 of Attachment 2BB-3 Time-Drawdown Graph for C7-4D Using Hantush Method



ATTACHMENT 2BB-4

UNIT 7 DEEP TEST GRAPHS AND PUMPING RATES

Table 1 of Attachment 2BB-4 (Sheet 1 of 3)
Pumping Rate Measurements for PW-7L

Date/Time (EST)	Minutes	Electronic Flow (gpm)	Manual Flow (gpm)
3/7/2009 12:00	0	3473[a]	—
3/7/2009 12:05:02	5	3473	3492
3/7/2009 12:10:03	10	3460	3474
3/7/2009 12:15:03	15	3428	3432
3/7/2009 12:20:02	20	3500	—
3/7/2009 12:25:03	25	3542	—
3/7/2009 12:30:03	30	3429	3434
3/7/2009 12:35:02	35	3410	—
3/7/2009 12:40:02	40	3405	—
3/7/2009 12:45:02	45	3412	3372
3/7/2009 12:50:02	50	3359	—
3/7/2009 12:55:02	55	3406	—
3/7/2009 13:00:02	60	3397	3382
3/7/2009 13:05:02	65	3387	—
3/7/2009 13:10:03	70	3384	—
3/7/2009 13:15:02	75	3396	3402
3/7/2009 13:20:02	80	3388	—
3/7/2009 13:25:02	85	3377	—
3/7/2009 13:30:02	90	3399	3402
3/7/2009 13:35:02	95	3376	—
3/7/2009 13:40:02	100	3407	—
3/7/2009 13:45:02	105	3379	3408
3/7/2009 13:50:02	110	3397	—
3/7/2009 13:55:03	115	3400	—
3/7/2009 14:00:02	120	3407	3398
3/7/2009 14:05:02	125	3408	—
3/7/2009 14:10:02	130	3375	—
3/7/2009 14:15:02	135	3387	3372
3/7/2009 14:20:02	140	3396	—
3/7/2009 14:25:03	145	3372	—
3/7/2009 14:30:02	150	3397	3393
3/7/2009 14:35:02	155	3381	—
3/7/2009 14:40:04	160	3395	—
3/7/2009 14:45:02	165	3389	3377
3/7/2009 14:50:03	170	3369	—
3/7/2009 14:55:02	175	3405	—
3/7/2009 15:00:02	180	3398	3399

Table 1 of Attachment 2BB-4 (Sheet 2 of 3)
Pumping Rate Measurements for PW-7L

Date/Time (EST)	Minutes	Electronic Flow (gpm)	Manual Flow (gpm)
3/7/2009 15:05:03	185	3385	—
3/7/2009 15:10:02	190	3379	—
3/7/2009 15:15:02	195	3406	3397
3/7/2009 15:20:02	200	3372	—
3/7/2009 15:25:04	205	3397	—
3/7/2009 15:30:02	210	3394	3392
3/7/2009 15:35:02	215	3395	—
3/7/2009 15:40:02	220	3380	—
3/7/2009 15:45:03	225	3393	3405
3/7/2009 15:50:02	230	3380	—
3/7/2009 15:55:02	235	3386	—
3/7/2009 16:00:02	240	3389	3384
3/7/2009 16:05:02	245	3379	—
3/7/2009 16:10:04	250	3395	—
3/7/2009 16:15:02	255	3436	3432
3/7/2009 16:20:02	260	3403	—
3/7/2009 16:25:02	265	3388	—
3/7/2009 16:30:02	270	3361	3372
3/7/2009 16:35:02	275	3376	—
3/7/2009 16:40:02	280	3368	—
3/7/2009 16:45:03	285	3393	3396
3/7/2009 16:50:03	290	3405	—
3/7/2009 16:55:03	295	3398	—
3/7/2009 17:00:02	300	3387	3392
3/7/2009 17:05:02	305	3397	—
3/7/2009 17:10:03	310	3393	—
3/7/2009 17:15:02	315	3380	3403
3/7/2009 17:20:03	320	3406	—
3/7/2009 17:25:02	325	3387	—
3/7/2009 17:30:02	330	3396	3401
3/7/2009 17:35:03	335	3367	—
3/7/2009 17:40:03	340	3408	—
3/7/2009 17:45:02	345	3409	3412
3/7/2009 17:50:02	350	3385	—
3/7/2009 17:55:02	355	3373	—
3/7/2009 18:00:02	360	3386	3399
3/7/2009 18:05:02	365	3393	—
3/7/2009 18:10:02	370	3397	—

Table 1 of Attachment 2BB-4 (Sheet 3 of 3)
Pumping Rate Measurements for PW-7L

Date/Time (EST)	Minutes	Electronic Flow (gpm)	Manual Flow (gpm)
3/7/2009 18:15:02	375	3388	3418
3/7/2009 18:20:02	380	3381	—
3/7/2009 18:25:03	385	3383	—
3/7/2009 18:30:02	390	3419	3402
3/7/2009 18:35:02	395	3386	—
3/7/2009 18:40:02	400	3389	—
3/7/2009 18:45:02	405	3378	3398
3/7/2009 18:50:03	410	3381	—
3/7/2009 18:55:02	415	3406	—
3/7/2009 19:00:02	420	3397	3419
3/7/2009 19:05:02	425	3409	—
3/7/2009 19:10:03	430	3404	—
3/7/2009 19:15:02	435	3415	3409
3/7/2009 19:20:02	440	3398	—
3/7/2009 19:25:02	445	3397	—
3/7/2009 19:30:03	450	3407	3402
3/7/2009 19:35:03	455	3455	—
3/7/2009 19:40:02	460	3485	—
3/7/2009 19:45:02	465	3440	3475
3/7/2009 19:50:02	470	3564	—
3/7/2009 19:55:03	475	3462	—
3/7/2009 20:00:02	480	3409	3430
3/7/2009 20:05:03	485	3408	—
3/7/2009 20:10:02	490	3418	—
3/7/2009 20:15:02	495	3431	3441
3/7/2009 20:20:02	500	3431	—
3/7/2009 20:25:03	505	3416	—
3/7/2009 20:30:02	510	3425	3437
3/7/2009 20:35:03	515	3428	—
3/7/2009 20:40:03	520	3412	—
3/7/2009 20:45:03	525	3421	3423
3/7/2009 20:50:02	530	3420	—
3/7/2009 20:55:02	535	3420	—
3/7/2009 21:00	540	0	—

(a) Value taken from next reading to provide pumping rate at t=0.

Figure 1 of Attachment 2BB-4 Time-Drawdown Graph for C7-2 Well Cluster

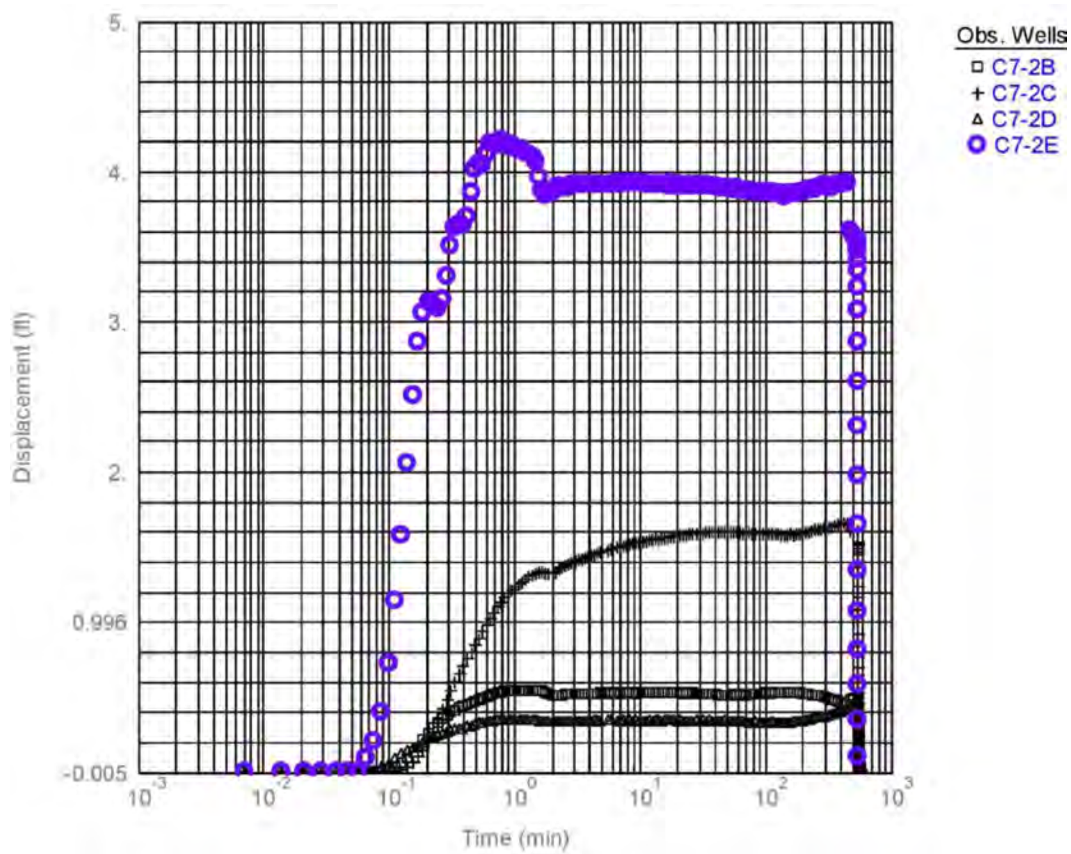


Figure 2 of Attachment 2BB-4 Time-Drawdown Graph for C7-3 Well Cluster

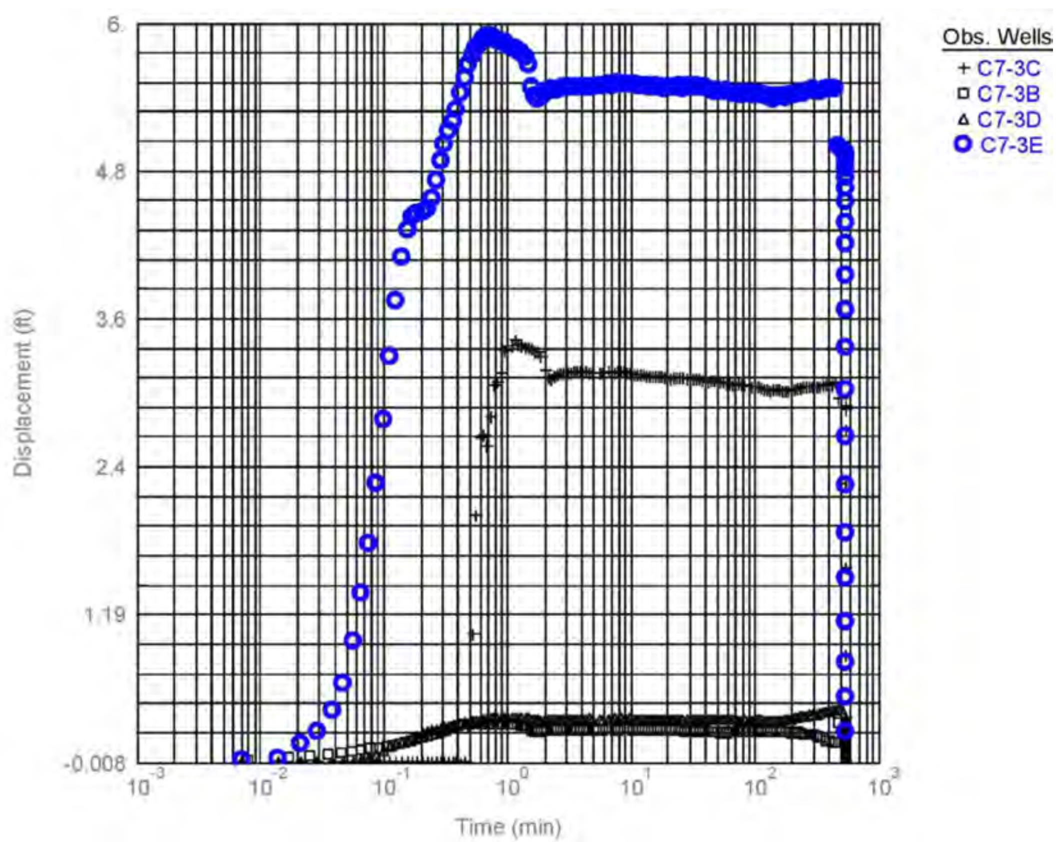


Figure 3 of Attachment 2BB-4 Time-Drawdown Graph for C7-4 Well Cluster

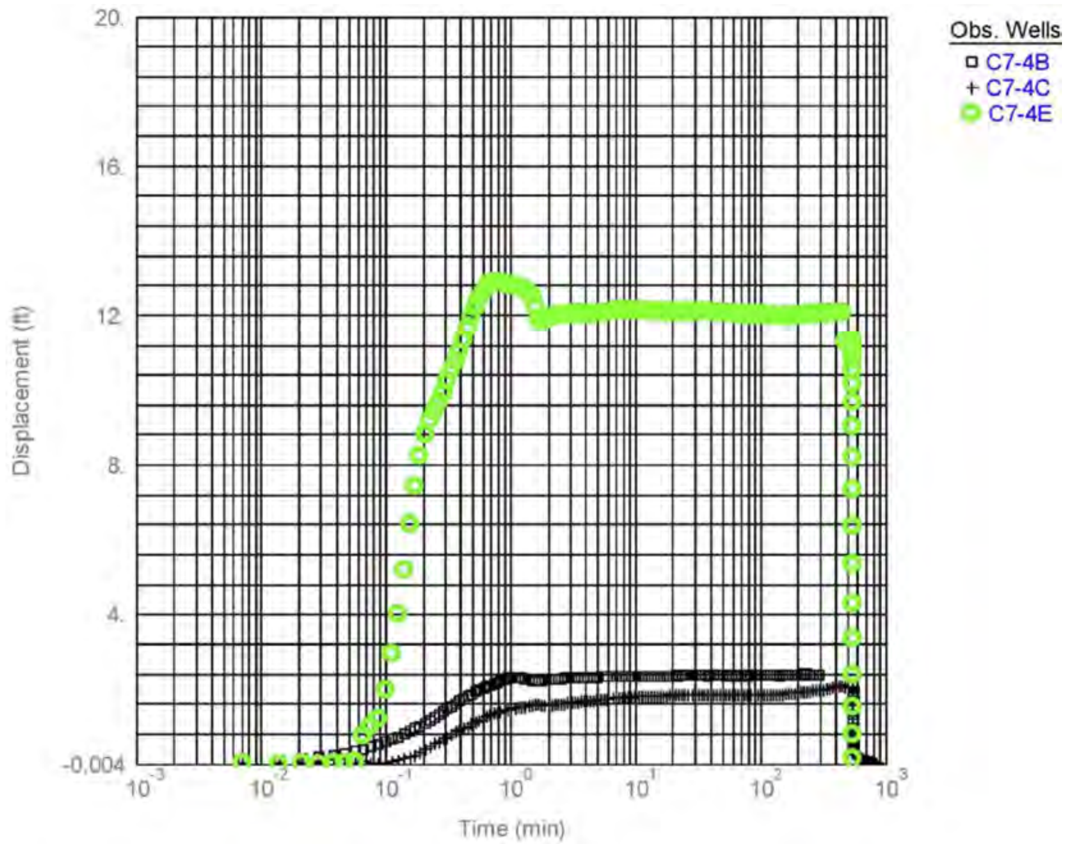


Figure 4 of Attachment 2BB-4 Time-Drawdown Graph for C7-5 Well Cluster

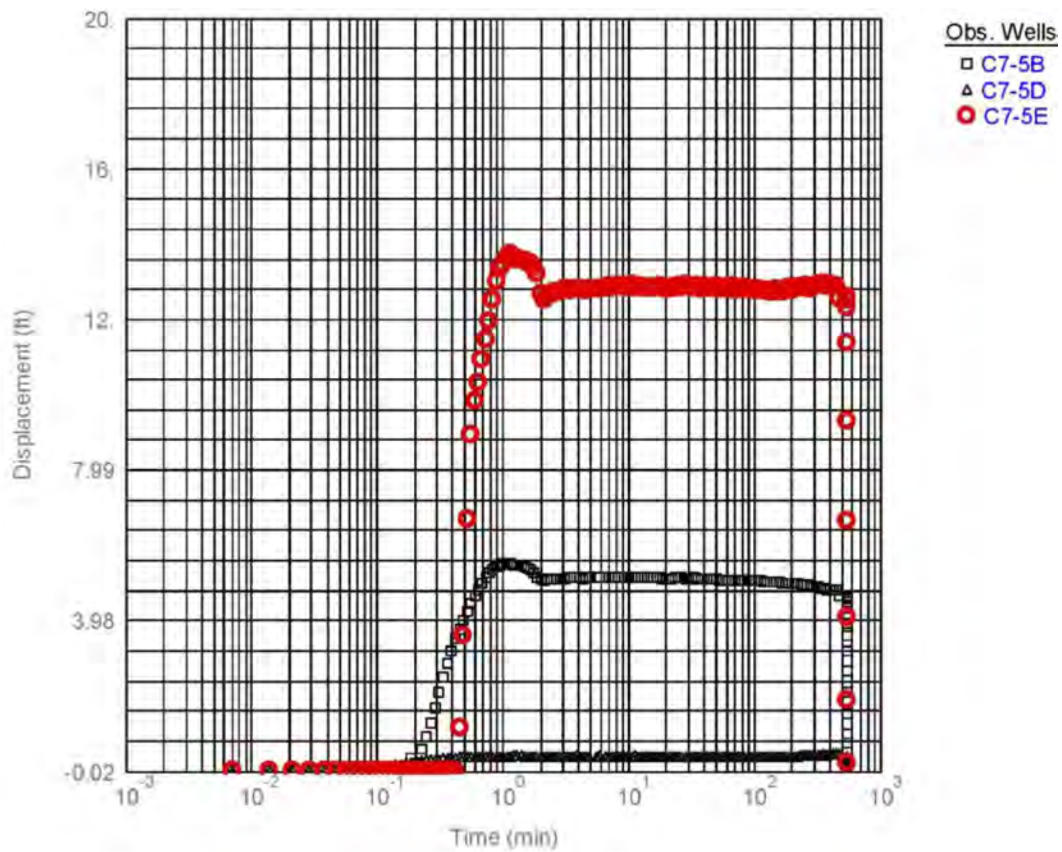


Figure 5 of Attachment 2BB-4 Distance-Drawdown Graph for PW-7L Test (t = 20 minutes)

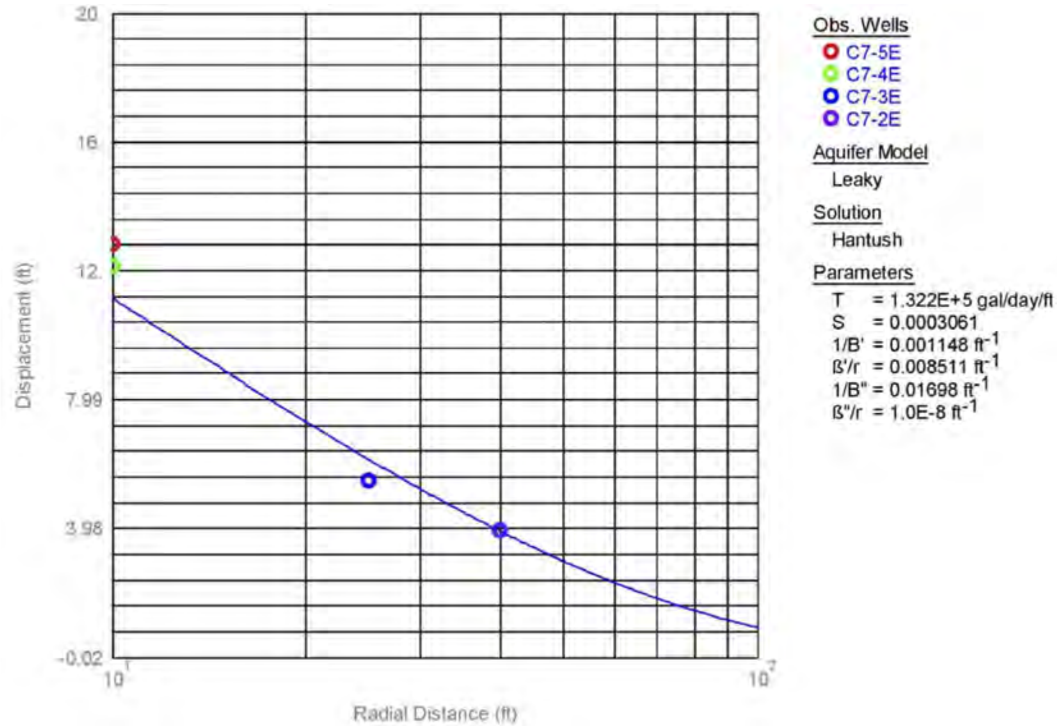


Figure 6 of Attachment 2BB-4 Time-Drawdown Graph for C7-2E Using Theis Method

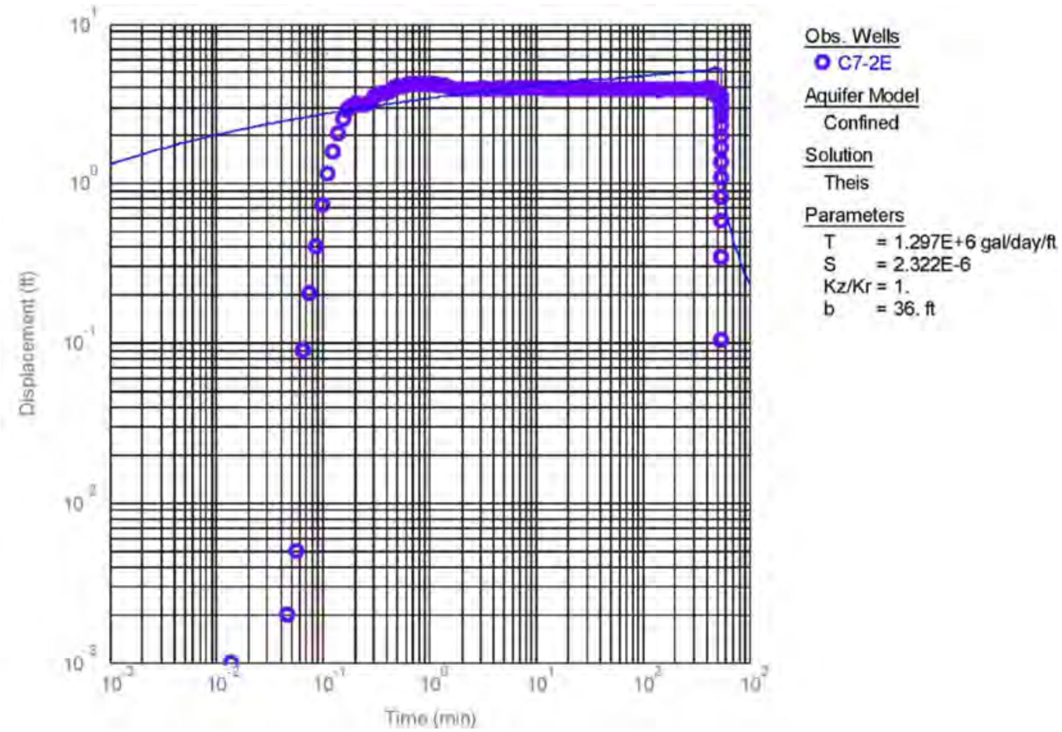


Figure 7 of Attachment 2BB-4 Time-Drawdown Graph for C7-2E Using Hantush Method

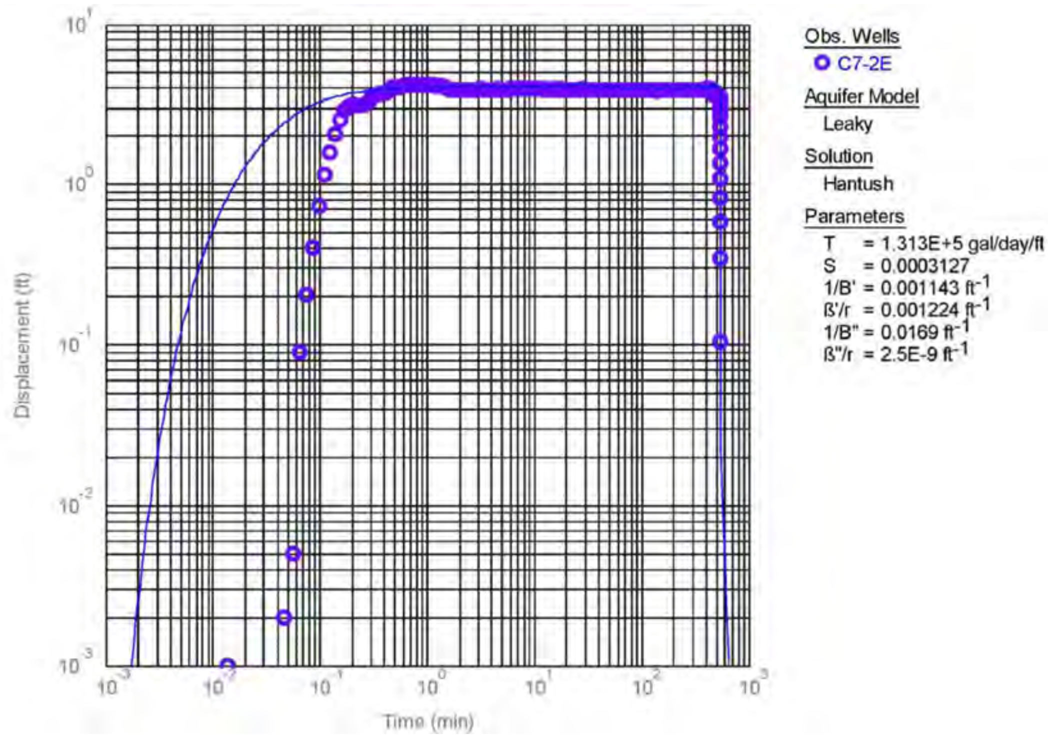


Figure 8 of Attachment 2BB-4 Time-Drawdown Graph for C7-3E Using Theis Method

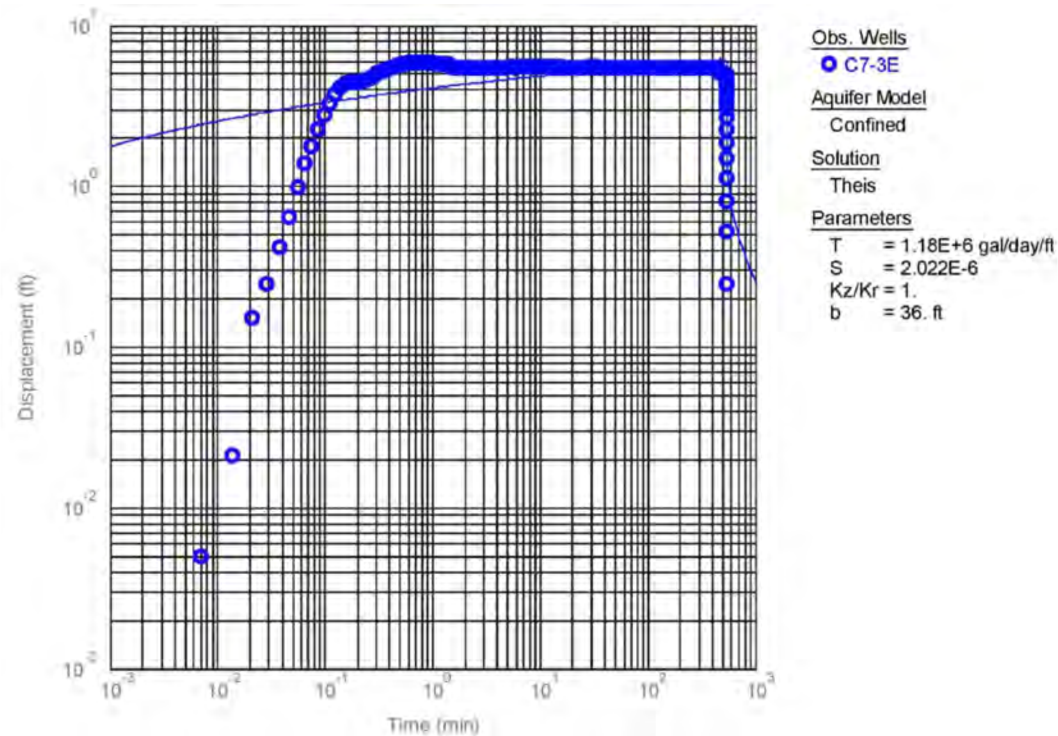


Figure 9 of Attachment 2BB-4 Time-Drawdown Graph for C7-3E Using Hantush Method

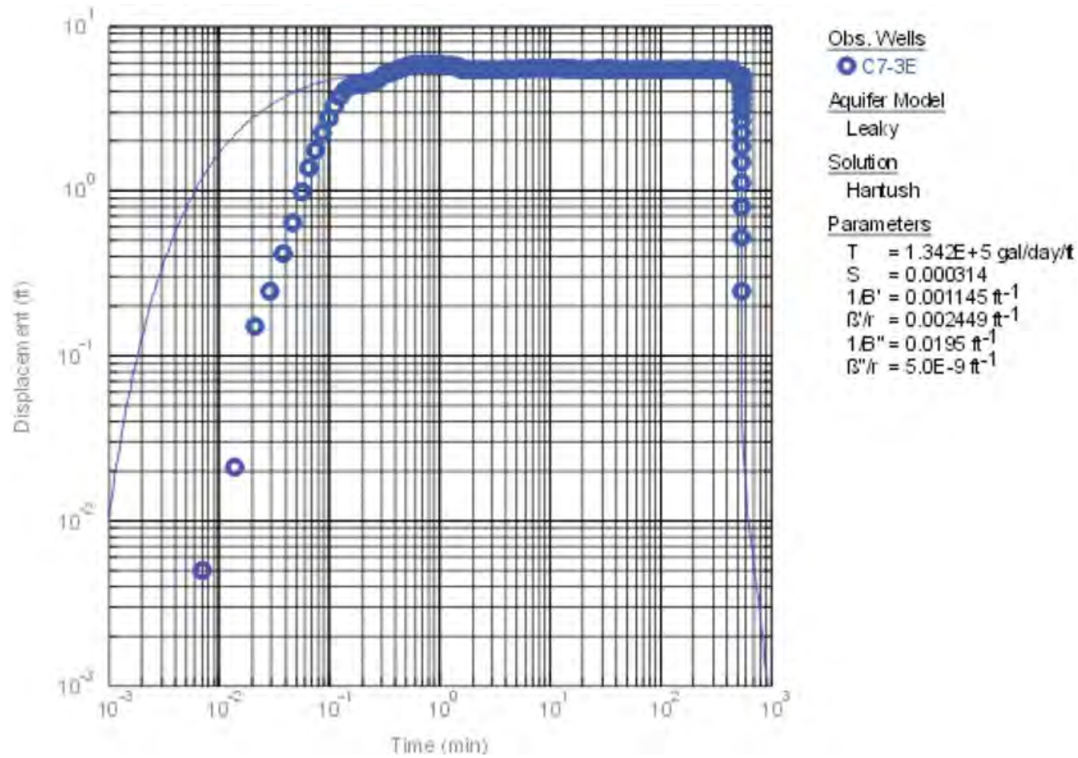


Figure 10 of Attachment 2BB-4 Time-Drawdown Graph for C7-4E Using Theis Method

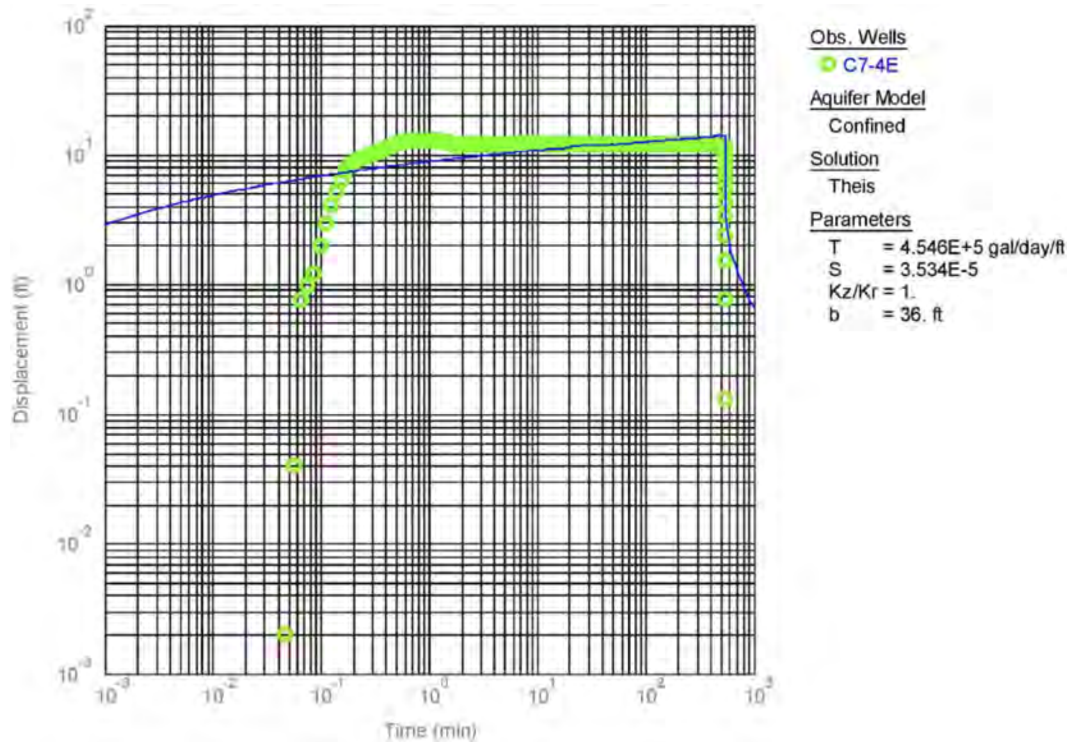


Figure 11 of Attachment 2BB-4 Time-Drawdown Graph for C7-4E Using Hantush Method

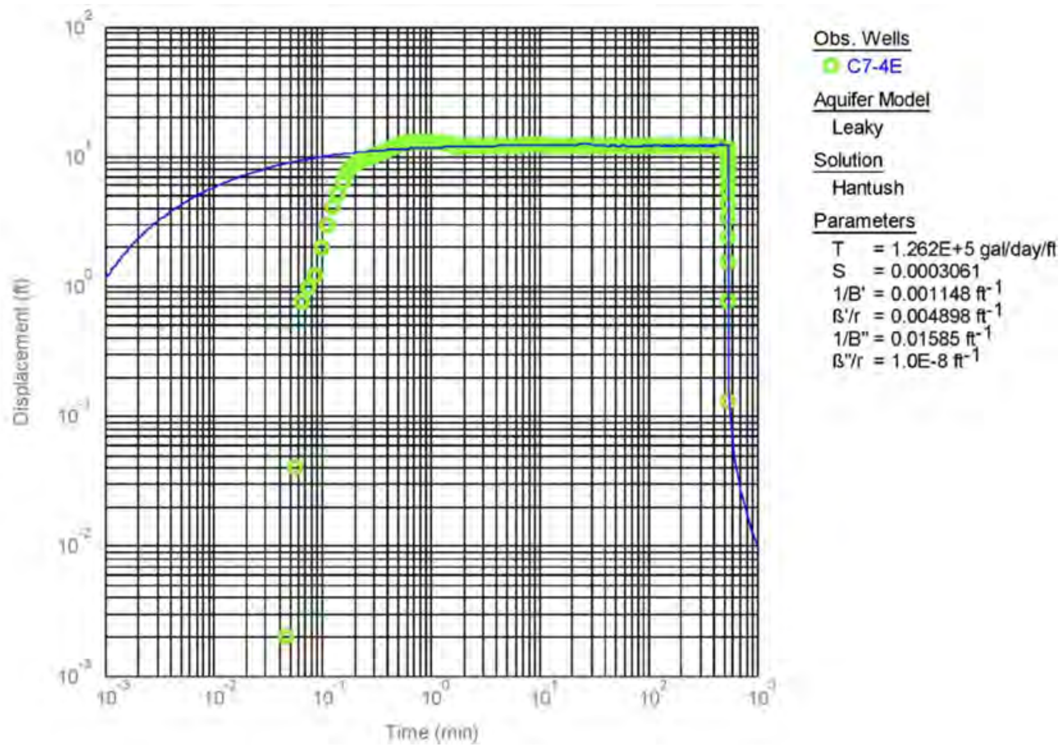


Figure 12 of Attachment 2BB-4 Time-Drawdown Graph for C7-5E Using Theis Method

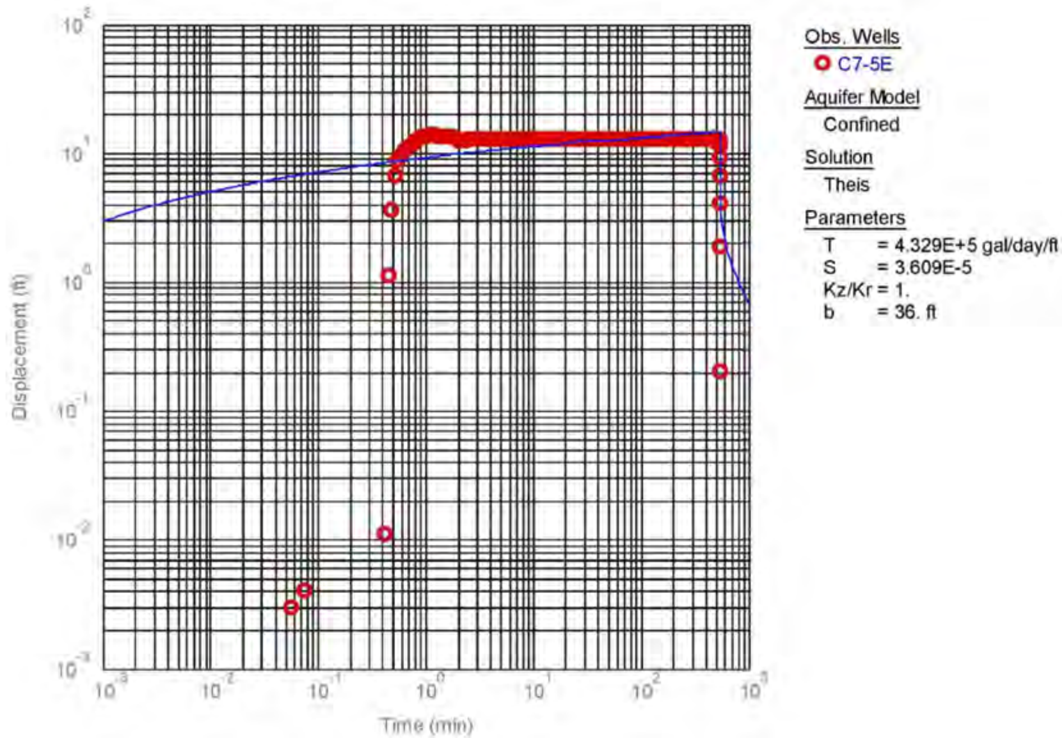
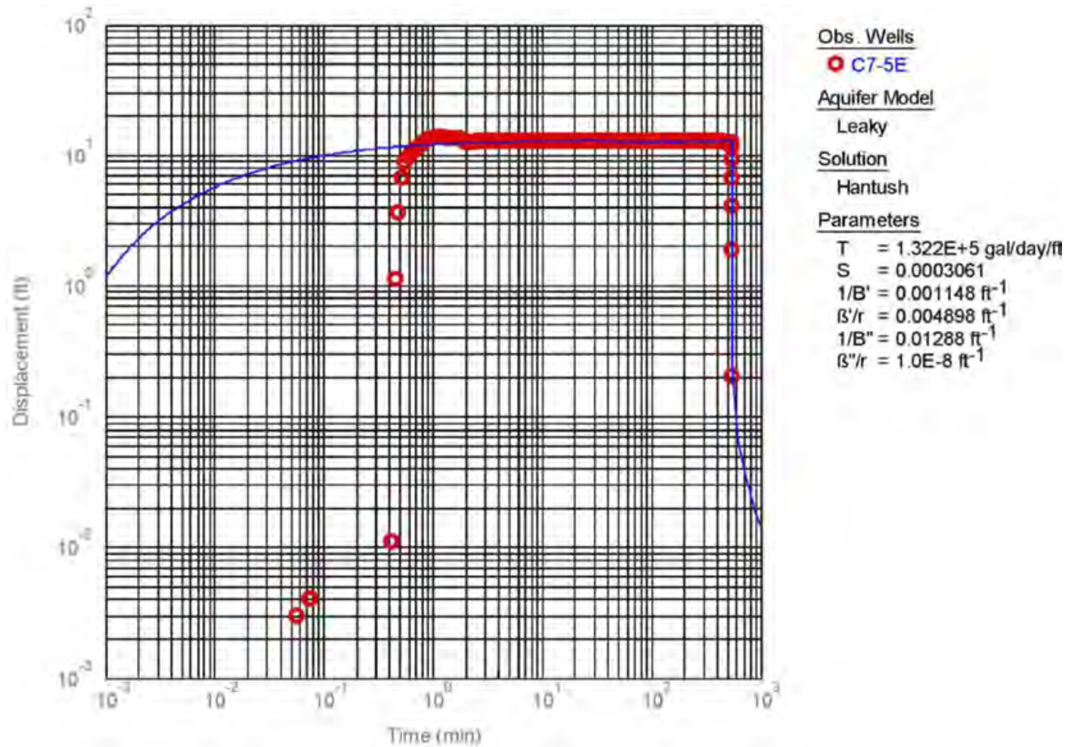


Figure 13 of Attachment 2BB-4 Time-Drawdown Graph for C7-5E Using Hantush Method



APPENDIX 2CC

GROUNDWATER MODEL DEVELOPMENT AND ANALYSIS

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Appendix 2CC Table of Contents (Cont.)

Appendix 2CC Table of Contents (Cont.)

Appendix 2CC List of Tables

Appendix 2CC List of Figures

Appendix 2CC List of Figures (Cont.)

Appendix 2CC List of Figures (Cont.)

UNITS

ft	feet
m	meter
cm/s	centimeters per second
ft/day	feet per day
ft/s	feet per second
in/yr	inches per year
ft^2/day	feet squared per day
gpm	gallons per minute
gpd	gallons per day
kg/m^3	kilograms per meter cubed

ABBREVIATIONS

ARM	Absolute Residual Mean
bgs	Below Ground Surface
CCS	Cooling Canal System
COLA	Combined License Application
DEM	Digital Elevation Model
DRN	Drain Package (MODFLOW)
epm	Equivalent Porous Media
FPL	Florida Power & Light
GHB	General-Head Boundary Package (MODFLOW)
GMG	Geometric Multigrid (MODFLOW)
HFB	Horizontal Flow Boundary Package (MODFLOW)
Kh	Horizontal Hydraulic Conductivity
Kv	Vertical Hydraulic Conductivity
M_d	Mass Balance Discrepancy
MNW	Multi-Node Well Package (MODFLOW)
MODFLOW	Modular Groundwater Flow Model
MRGIS	Marine Resources Geographic Information System
MSE	Mechanically Stabilized Earth (Retaining Wall)
MWR	Makeup Water Reservoir
NED	National Elevation Database
NAVD 88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
NRMS	Normalized Root Mean Square
OCS	Office of Coast Survey
RCW	Radial Collector Well
RMS	Root Mean Squared
RIV	River Cell Package (MODFLOW)

SEE	Standard Error of the Estimate
SEGS	Southeastern Geological Society
SFWMD	South Florida Water Management District
USGS	United States Geological Survey
US	United States
WEL	Well Package (MODFLOW)

EXECUTIVE SUMMARY

A groundwater flow model of the Florida Power & Light (FPL) Turkey Point site has been developed for Units 6 & 7. The model is a steady-state, constant-density, three-dimensional representation of the surficial aquifer system developed using the numerical code MODFLOW 2000 developed by the United States Geological Survey (USGS), as it is implemented in the user-interface software Visual MODFLOW developed by Schlumberger Water Services.

The groundwater model was developed in two phases. Phase 1 serves two purposes. The first is to evaluate groundwater control options for construction of Units 6 & 7. The second is to simulate the operation of a radial collector well system serving as a temporary source of makeup water. Phase 2 was developed to include several additional post-construction features. These post-construction features include splitting the top model layer into two layers; revision of the top elevation of the diaphragm walls to 2 feet NAVD 88; incorporation of structural backfill in the top model layer; and incorporation of the Makeup Water Reservoir (MWR) as an active feature. Phase 2 consists of four post-construction simulations: a "base-case" simulation, a sensitivity simulation to evaluate the effect of high recharge, a simulation to assess the failure of the MWR north wall, and a simulation to assess the effect of sea-level rise on groundwater elevations.

Hydrostratigraphic layer elevations were developed from geotechnical and geophysical logs for Units 6 & 7, pumping test wells in the Turkey Point Units 6 & 7 plant area and Turkey Point peninsula, pumping wells from the 1975 Turkey Point plant property Upper Floridan Aquifer study, from historical borings and well logs from the Turkey Point plant property, and from logs for wells in the Florida Geological Survey Lithologic database.

Hydraulic conductivity values were based on results from three historical pumping tests in the Biscayne Aquifer on the Turkey Point plant property, regional groundwater models that include the Turkey Point plant property within their domain, recent pumping tests at the plant area and the Turkey Point peninsula, and literature values.

The interaction between surface water and groundwater was simulated by including Biscayne Bay, the cooling canals, L-31E Canal, Card Sound Canal, Florida City Canal, and Model Land Canal (C-107) in the model. Spatially-variable groundwater recharge and evapotranspiration are considered based on land-use classification.

Calibration was approached with a multi-faceted methodology. Initially, the response to three pumping tests (PW-7L, PW-1, and PW-7U) was simulated by adjusting hydraulic conductivities of the various hydrostratigraphic units comprising the Biscayne Aquifer. The conductance values of the various head-dependent boundary conditions were also primary calibration parameters.

Following the calibration, groundwater flow directions were compared to historical data, and a qualitative comparison of calculated groundwater discharge/recharge between cooling water canals and groundwater beneath Biscayne Bay to results from pre-existing surface water modeling was performed. The groundwater model was then validated by simulating an additional pumping test (PW-6U) and comparing the modeled and observed drawdown values.

The conclusion from Phase 1 model simulations of construction dewatering for the Unit 6 and Unit 7 nuclear islands was that by utilizing cut-off walls and implementing a grout blanket between the base of the excavation and the base of the cut-off walls, construction dewatering rates were reduced to approximately 100 gpm for each unit. Phase 1 particle tracking and water balance calculations from the proposed radial collector wells at the Turkey Point peninsula in Biscayne Bay indicate that approximately 97.8 percent of the water pumped from the radial collector wells originates in Biscayne Bay. A suite of sensitivity analyses addressing parameter and water level uncertainty indicate that this percentage remains similar for the tested range of variability.

For Phase 2 model simulations, water table elevations at Units 6 & 7 satisfied the Design Control Document (DCD) criteria. For all simulations, maximum post-construction water table elevations within the nuclear islands, which include the containment, shield, and auxiliary buildings, were estimated to be approximately 2 feet NAVD 88. The maximum increase in water table elevations with high recharge near Units 6 & 7 was estimated to be approximately 0.3 feet higher than the base-case simulation. Maximum post-construction water table elevations, assuming a failure of the MWR north wall, were estimated to be 2.07 feet NAVD 88 at the Units 6 & 7 nuclear islands. The maximum increase in water table elevations at the Units 6 & 7 nuclear islands with sea-level rise was estimated to be approximately 0.03 feet higher than the base-case simulation.

1.0 OBJECTIVE & SCOPE

The objective is to document the development, calibration, and simulation results of a groundwater flow model for the Turkey Point Units 6 & 7 Project at the Turkey Point facility.

A three-dimensional groundwater model was used to simulate steady-state, constant-density groundwater flow in the Biscayne Aquifer to evaluate construction and post-construction activities related to the construction and operation of two new nuclear units (Units 6 & 7).

2.0 AQUIFER DESCRIPTION & AVAILABLE DATA

2.1 Site Overview

Turkey Point plant property is located in Miami-Dade County, Florida, approximately 25 miles south of Miami (Figure 2.4.1-201) and approximately 9 miles southeast of Homestead. It is bordered on the east by Biscayne Bay, on the west by the FPL Everglades Mitigation Bank, and on the northeast by Biscayne National Park. The 5900-acre Industrial Wastewater Facility (approximately 2 miles wide and 5 miles long), of which 4370 acres is water (approximately 75 percent), is a predominant feature within the Turkey Point plant property (Figure 2.4.12-210). Just west of the Industrial Wastewater Facility is the L-31E canal, which is part of the regional drainage system.

The Units 6 & 7 plant area covers an area of approximately 218 acres and is situated south of Units 1 through 5 within the Industrial Wastewater Facility. The units occupy a relatively small portion of the Turkey Point plant property. The preconstruction ground surface in the Units 6 & 7 plant area is generally flat, with elevations ranging from -2.4 to 0.8 feet NAVD 88.

Surface waters are a dominant feature of the Turkey Point plant property and surrounding region given that the plant is located between Biscayne Bay and the Everglades. A network of regional canals surrounds the site boundary and provides drainage for areas west of the Turkey Point plant property. The Units 6 & 7 plant area is within the Industrial Wastewater Facility and is surrounded by cooling canals that return water back to the intake structures for Units 1 through 4.

2.2 Regional Hydrostratigraphy

As discussed in FSAR Subsection 2.4.12, the hydrostratigraphic framework of Florida consists of a thick sequence of Cenozoic sediments that comprise three main units (Reference 1):

- The surficial aquifer system (containing the Biscayne Aquifer and semi-confining Tamiami Formation).
- The intermediate confining unit, referred to as the Hawthorn Group.
- The Floridan aquifer system.

In southern Florida, the surficial aquifer system consists of the Tamiami, Caloosahatchee, Fort Thompson, and Anastasia Formations; the Key Largo and Miami Limestones; and undifferentiated sediments. The thickness of the surficial aquifer system ranges from approximately 20 feet to 400 feet and is approximately 220 feet under the Units 6 & 7 plant area.

The intermediate confining unit separates the Biscayne aquifer from the underlying Floridan aquifer system. It is characterized regionally by a sequence of relatively low hydraulic conductivity, largely clayey deposits, but it can locally contain transmissive units that act as an aquifer system. The Southeastern Geological Society (SEGS) (Reference 1) define the intermediate confining unit as "all rocks that lie between and collectively retard the exchange of water between the overlying surficial aquifer system and the underlying Floridan aquifer system." This unit is also referred to as the Hawthorn Group, with a thickness of approximately 900 feet in southern Florida.

Beneath the intermediate aquifer system/confining unit is the Floridan aquifer system which underlies all of Florida. The system formally consists of three hydrogeologic units: the Upper Floridan aquifer, the middle confining unit, and the Lower Floridan aquifer. The Upper Floridan aquifer is a major source of potable water in Florida, however, in the southeastern portion of the state (including Miami-Dade County) the water is brackish.

Hydrostratigraphic columns are presented in Figures 2.4.12-202 and 2.4.12-204.

2.3 Biscayne Aquifer

The surficial aquifer system within the Turkey Point plant property does not contain all of the regionally identified units. Those units identified within the plant

property as a result of the 1971 (Reference 2), 2008 (Reference 3), and 2009 (Reference 4) subsurface investigations are summarized as:

- Muck — The surface of the site consists of approximately 2 to 6 feet of organic soils called muck. The muck is composed of recent light gray calcareous silts with varying amounts of organic content. This unit does not extend into Biscayne Bay, where exposed rock and sandy material is present in its place.
- Miami Limestone — The Pleistocene Miami Limestone is a white, porous sometimes sandy, fossiliferous, oolitic limestone.
- Upper Higher Flow Zone — At the boundary between the Miami Limestone and Key Largo Limestone is a laterally continuous relatively thin layer of high secondary porosity. The Upper Higher Flow Zone was defined based on a review of geophysical logs and drilling records. The primary identifier was the loss of drilling fluid identified at the boundary of the Key Largo Limestone and Miami Limestone. This observation was also coincident with an increase in the boring diameter as identified by the caliper logging.
- Key Largo Limestone (interpreted as the Fort Thompson Formation elsewhere) — This is a coralline limestone (fossil coral reef) believed to have formed in a complex of shallow-water, shelf-margin reefs and associated deposits along a topographic break during the last interglacial period.
- Freshwater Limestone — At the base of the Key Largo Limestone is a layer of dark-gray fine-grained limestone, referred to as the Freshwater Limestone. Where present, the limestone is generally two feet or more thick and often possesses a sharp color change from light to dark gray at its base marking the transition from the Key Largo Limestone to the Fort Thompson Formation. It is not laterally continuous across the Turkey Point plant property.
- Fort Thompson Formation — The Pleistocene Fort Thompson Formation directly underlies the Key Largo Limestone. The Fort Thompson Formation is generally a sandy limestone with zones of uncemented sand interbeds, some vugs, and zones of moldic porosity after gastropod and/or bivalve shell molds and casts.
- Lower Higher Flow Zone — At the location of Units 6 & 7, a zone of secondary porosity was evident from the drilling and geophysical logs. This occurred at a depth of approximately 15 feet below the top of the Fort Thompson Formation and was assumed to extend across the model domain. The regional drilling

conducted by the USGS (Reference 5) did not identify a laterally persistent layer but rather more isolated zones at varying depths below the Upper Higher Flow Zone. As represented in the model, the Lower Higher Flow Zone represents an aggregation of these observations and is conservative due to the fact it is modeled as laterally extensive.

- Tamiami Formation — The Pliocene Tamiami Formation directly underlies the Fort Thompson Formation. The contact between the Tamiami Formation and the Fort Thompson Formation is an inferred contact picked as the bottom of the last lens of competent limestone encountered. The Tamiami Formation represents a semi-confining unit.

The most permeable portions of the Miami Limestone and Key Largo Limestone are considered to be acting as one hydrogeological unit and designated the "Upper Monitoring Zone." The underlying Fort Thompson is designated the "Lower Monitoring Zone."

The geology is shown in the following cross sections:

- Hydrostratigraphic cross section in the vicinity of the Units 6 & 7 as shown in Figure 2CC-201 and Figure 2CC-202 (Reference 2).
- Geologic cross section across in the vicinity of the Units 6 & 7 as shown in Figure 2CC-203 (Reference 6).
- Boring plan and stratigraphic cross sections parallel to and across Units 6 & 7 as shown in Figure 2CC-204, Figure 2CC-205, and Figure 2CC-206.
- Plan and geologic cross section at the Turkey Point peninsula from exploratory drilling and aquifer testing program as shown in Figure 2CC-207 (Reference 4).

The following list summarizes the stratigraphic picks for the top of each stratum identified above from geotechnical boring logs and well logs:

- Stratigraphic picks from geotechnical boring logs for Units 6 & 7 (Reference 3) B-601 to B-639, B-701 to B-739, and B-802 to B-814.
- Stratigraphic picks from boring logs for the 1971 site investigation (Reference 2), L-1 through L-6, and GH-1 through GH-15.

- Stratigraphic picks from Upper Floridan aquifer study pumping wells (Reference 2), GB-1 and GB-2.
- Geotechnical boring logs from the Feasibility Geological Investigation of Potential Plant Site borings B-1000 through B-1003.
- Additional water well logs available from Florida Geological Survey lithologic database (Reference 7) and the USGS (Reference 8).
- Stratigraphic picks from boring logs for the Turkey Point peninsula (Reference 4) and Units 6 & 7 pumping tests.

In 2010, 14 borings were drilled in and around the Turkey Point plant area as part of the FPL Unit 3 & 4 Uprate Conditions of Certification (Reference 5). Biscayne aquifer monitoring well clusters were subsequently installed at each of the 14 core borings as part of a monitoring plan (Reference 9). The plan was developed and implemented to satisfy Conditions of Certification IX and X of the Turkey Point Units 3 & 4 Uprate Certification. These well clusters were not included in the stratigraphic picks used to develop the model because they were not available at the appropriate time, but downhole logs (caliper and acoustic) performed by the USGS from these borings were qualitatively assessed to confirm zones of secondary porosity.

2.4 Groundwater Levels

During the 2008 subsurface investigation for Units 6 & 7, 22 groundwater monitoring locations were installed within the Units 6 & 7 plant area. Ten observation wells were installed in the Key Largo and Miami Limestone (referred to as the Upper Monitoring Zone) and ten were installed in the Lower Fort Thompson Formation (referred to as the Lower Monitoring Zone). Two piezometers were installed in the Tamiami Formation, one at each proposed reactor site. The 20 observation wells were installed as 10 well pairs, enabling the determination of the vertical gradient between the upper and lower monitoring units. A description of the field activities and groundwater level data evaluation are presented in Reference 3.

Figure 2.4.12-209 shows the 22 monitoring locations within the Units 6 & 7 plant area. The observation wells are named in three series, which represent the location and screened intervals as described below:

- OW-600 series wells are located in the Unit 6 power block area and include "U," "L," and "D" suffix wells monitoring the Miami Limestone, the lower Fort Thompson Formation, and the upper Tamiami Formation.

- OW-700 series wells are located in the Unit 7 power block area and include "U," "L," and "D" suffix wells monitoring the Miami Limestone, the lower Fort Thompson Formation, and the upper Tamiami Formation.

- OW-800 series wells are located outside of the power block areas and include "U" and "L" suffix wells that monitor the Miami Limestone and the lower Fort Thompson Formation.

The U and L observation wells recorded hourly water level measurements between June 2008 and June 2010, after which point the transducers were removed and monitoring ceased. Comparison of well clusters (U and L wells) show an upward gradient during both high and low tides at all monitored locations.

Two regional historic Biscayne Aquifer potentiometric surface maps are also available. They cover the following months:

- May 1993, Figure 2.4.12-219

- November 1993, Figure 2.4.12-220

2.5 Surface Water

Surface water features around the Turkey Point plant property are shown on Figure 2.4.12-210 and include the following:

- Biscayne Bay — This feature is located east of Units 6 & 7 and is a shallow, subtropical lagoon along the southeastern coast of Florida. Biscayne Bay is a fairly recent geological feature and has been modified and dredged with average depths ranging from 6 feet to 10 feet. Surface water flow into Biscayne Bay is primarily controlled by the system of canals, levees, and control structures maintained by the South Florida Water Management District (SFWMD). The National Oceanic and Atmospheric Administration (NOAA) maintains a tidal water level and meteorological data collection station (#8723214) on Virginia Key in Biscayne Bay. The station is located on a pier just to the southwest of the causeway that connects Virginia Key to Key Biscayne (Reference 10). Station #8723214 is the closest active station to the study area. The diurnal range, difference in height between mean higher high

water and mean lower low water for the station is approximately 2.19 feet (Reference 10).

- Cooling Canal System (CCS) (also referred to as the Industrial Wastewater Facility) — The cooling canals are a closed system and do not directly discharge to adjacent surface water, however, the canals are unlined and hence the water interacts with groundwater.

  — After cooling water passes through the Units 1 through 4 condensers and gains heat, the water is released to the northern end of the 32 westernmost canals. These westernmost canals are approximately 4 feet deep and oriented north-south. The warm water flows towards the southern end of the westernmost canals where it then flows eastward across the southern end of the canals to the seven easternmost canals. These easternmost canals provide the cooling water return, and the circulating pumps are located on the return side, in the northeastern corner of the closed loop system. The pumps in the northeastern corner maintain a head difference of four to five feet relative to the release location. This head difference is the driving force for circulation through the system. Blowdown from Unit 5 also contributes to flow in the CCS.

  — The head differential created by the circulating water pumps is maintained despite or in addition to the tidal fluctuations. The head differential is a maximum at the northern end of the system; the highest head is in the northern end of the westernmost canals and the lowest head is in the northern end of the easternmost canals. The release of warm water to the northern end of the cooling canals means that the water level in the westernmost canals is always higher than the water level in Biscayne Bay. The intake of return water from the easternmost canals by the circulating pumps, means that the water level in the easternmost canals is always lower than that of Biscayne Bay. At the southern end of the system, the influence of the enforced head differential is relatively lower and water levels are approximately equal to the water level in Biscayne Bay/Card Sound.

  — Interceptor Ditch — The Interceptor Ditch was constructed in conjunction with the cooling canals to limit inland movement of the water from the cooling canals in the upper portion of the aquifer. This ditch is approximately 30 feet wide, 19 feet deep, and has a total

length of approximately 29,000 feet. The Interceptor Ditch is located approximately 1000 feet to the southeast of the L-31E canal. Operation of the Interceptor Ditch prevents seepage from the industrial wastewater facility from moving landwards towards the L-31E Canal in the upper portion of the aquifer. The Interceptor Ditch is operated (seasonally) only when required to maintain a seaward hydraulic gradient from L-31E.

- L-31E (SFWMD Salinity Structure) — The L-31E Canal (shown in Figure 2.4.12-210) is a stormwater control structure and also provides a salinity barrier that is designed to help prevent saltwater from moving inland. L-31E was constructed prior to the cooling canals being built.

2.6 Recharge and Evapotranspiration

The net infiltration, or groundwater recharge, accounts for the rate of net gain of the groundwater system resulting from surface infiltration. Recharge to the Biscayne Aquifer is controlled by land use, and in southern Florida the recharge occurs mainly through wetland areas. Figure 2CC-208 indicates major land use classifications used by Langevin (Reference 11) for a regional model of the Biscayne Aquifer.

Based on land use and the Turkey Point facility-related surface conditions, three recharge/evapotranspiration zones are considered for the model domain:

- Surface water bodies with continuous head of water, such as Biscayne Bay, the cooling canal system, and regional canals.
- Areas of wetland.
- Buildings and paved areas.

Surface water bodies, buildings, and paved areas in the model are assumed to have zero recharge and zero evapotranspiration. Recharge applied to the wetland areas is determined by using monthly rainfall data from SFWMD Station S20F (Reference 12) located on canal L-31E. Historically, up to four different rainfall data recorders have been used at Station S20F. The NRG recorder (which reports rain gauge data augmented with radar-based rainfall data), is the preferred data source, but is only available for the most recent two years. The TELE (telemetry, i.e. radio network) and OMD (data received from operation/ main, with multiple sources) recorders are considered to be equally reliable secondary sources of data, for years prior to the NRG record. In years when both TELE and OMD data

were available, but NRG data were not, the TELE and OMD records were averaged. Finally, the BELF (Belfort rain gauge) recorder data are used prior to 1992, before the other recorders were available. For the calibration/validation models, a value of 42.6 in/yr is used for the wetlands recharge rate. This value is calculated by summing the total rainfall data for the months during which the on-site 2009 pumping tests were conducted (February to May 2009) and then scaling the total to a year, as shown in Table 2CC-201. For the predictive runs, the long-term average rainfall for the period of record at Station S20F was used, giving a recharge rate of 46.75 in/yr, as shown in Table 2CC-202.

The evapotranspiration rate and extinction depth for the wetland areas is determined using values from Langevin (Reference 11) presented in Table 2CC-203. For the calibration/validation, using maximum evapotranspiration from February to May gives an evapotranspiration rate of 54.52 in/yr. For the predictive runs, maximum evapotranspiration for every month is used to calculate an evapotranspiration rate of 59.50 in/yr. For all models, the extinction depth of 0.69 meters (2.26 feet) for wetlands is used (Table 2CC-203).

2.7 Hydraulic Conductivity

The following sections describe the results from pumping tests and slug tests to evaluate hydraulic conductivity for the Biscayne Aquifer.

2.7.1 Pumping Tests

Pumping tests performed within the footprints of Units 6 & 7 nuclear islands, which consist of the containment, shield, and auxiliary buildings, are summarized as follows:

- PW-6U (Key Largo Limestone) — This pumping test was performed in March 2009, with the test well pumped at an average rate of 5103 gpm for eight hours. The test well is located in the footprint of the Unit 6 reactor building. The hydraulic conductivity was estimated to be 3.3 cm/s.

- PW-7U (Key Largo Limestone) — This pumping test was performed in February 2009, with the test well pumped at an average rate of 4181 gpm for approximately nine hours. The test well is located in the footprint of the Unit 7 reactor building. The hydraulic conductivity was estimated to be 4.3 cm/s.

- PW-6L (Fort Thompson Formation) — This pumping test was performed in March 2009, with the test well pumped at an average rate of 3342 gpm for

eight hours. The test well is located in the footprint of the Unit 6 reactor building. The hydraulic conductivity was estimated to be 0.1 cm/s.

- PW-7L (Fort Thompson Formation) — This pumping test was performed in March 2009, with the test well pumped at an average rate of 3403 gpm for nine hours. The test well is located in the footprint of the Unit 7 reactor building. The hydraulic conductivity was estimated to be 0.2 cm/s.

A pumping test at Turkey Point peninsula to characterize the hydrogeology for a potential radial collector system is summarized as follows (Reference 4):

- PW-1 (Miami Limestone/Cemented Sand/Key Largo Limestone) — This pumping test was performed in April and May 2009, with the test well pumped at an average rate of 7100 gpm for seven days. The hydraulic conductivity of the test zone was estimated to be between 10.3 cm/s and 17.6 cm/s based on a reported range of transmissivity between 700,000 ft^2/day and 1,200,000 ft^2/day.

On the Turkey Point plant property, aquifer pumping tests in the Biscayne Aquifer have been performed in three test wells (Reference 2). Figure 2CC-201 shows locations of test wells GH-11B, GH-14A, and GH-14B. Pumping test results are summarized as follows:

- GH-14A (Miami Limestone) — This pumping test is located to the southeast of L-31E, adjacent to the northwest portion of the cooling canal system. The test was performed in June 1971, with the test well pumped at 1386 gpm for four hours. The hydraulic conductivity was estimated to be 7.9E-02 cm/s.

- GH-11B (Key Largo Limestone) — This pumping test is located between Model Land Canal and L-31E. The test was performed in June 1971, with the test well pumped at 1386 gpm for four hours. The hydraulic conductivity was estimated to be 5.1 cm/s.

- GH-14B (Fort Thompson Formation) — This pumping test is located to the southeast of L-31E adjacent to the northwest portion of the cooling canals. The test was performed in June 1971, with the test well pumped at 1386 gpm for two hours. The hydraulic conductivity was estimated to be 1.6 cm/s.

2.7.2 Literature Values

Several investigations of the Biscayne Aquifer have provided estimates for the hydraulic conductivity of various units of the Biscayne Aquifer. All of these studies have been conducted by either the USGS or SFWMD. Presented in Table 2CC-204 is a summary of hydraulic conductivity values for the Biscayne Aquifer.

2.8 Water Wells

No water supply wells are located in the Biscayne Aquifer within the plant property. Three production wells (PW-1, PW-2, and PW-4) are located in the Upper Floridan aquifer (Figure 2.4.12-211) and provide process water for Units 1 and 2, and process and cooling tower makeup water for Unit 5. The average production of these wells is approximately 170 million gallons per month.

The Biscayne Aquifer at Turkey Point Units 3 & 4 is also used for disposal of domestic wastewater. A single Class V, Group 3 gravity injection well is used to dispose of up to 35,000 gpd of domestic wastewater at the Turkey Point Units 3 & 4 wastewater treatment plant. The well, designated IW-1, is open from 42 to 62 feet bgs and is 8 inches in diameter. Due to the low injection rate (up to 24 gpm) this well is not included in the numerical model.

3.0 MODEL DEVELOPMENT

3.1 Conceptual Hydrogeologic Model

The Biscayne Aquifer is conceptualized as consisting of eight hydrostratigraphic units. The base of the model (bottom of the Tamiami Formation) is designated as a no-flow boundary as leakage through the confining Hawthorn Formation is assumed to be negligible.

Recharge to the Biscayne Aquifer occurs primarily in areas of wetland and along the regional series of canals. Discharge from the Biscayne Aquifer occurs to Biscayne Bay, a portion of the cooling canals, and the regional series of canals. The cooling canals are the dominant stress at the Units 6 & 7 Site. Evapotranspiration is also a dominant stress on the groundwater system.

The model domain was selected to minimize the impact of assumptions regarding boundary conditions at model sides. The boundaries of the model domain were placed where reasonable assumptions regarding local conditions could be made. Figure 2CC-209 shows the model domain. The model area extends several miles

beyond the plant property and covers a total area of 47,500 feet by 37,000 feet (approximately 63 square miles).

The northern and southern model boundaries were extended several miles beyond the plant property, however they do not coincide with any hydrogeologic features. The eastern model boundary extends into Biscayne Bay, and the western boundary was extended beyond the L-31E canal.

3.2 Numerical Model

3.2.1 Numerical Code

The conceptual hydrogeologic model is developed into a three-dimensional numerical groundwater model using the code MODFLOW-2000 (Reference 13) hereafter referred to as MODFLOW. MODFLOW solves the three-dimensional groundwater flow equation using a finite-difference method. This code is widely used in the industry since its development by the USGS (Reference 14 and Reference 15).

MODFLOW has a modular structure that allows the incorporation of additional modules and packages to solve other equations that are often needed to handle specific groundwater problems. Over the years several such modules and packages have been added to the original code. MODFLOW-2000 is major revision of the code that expands upon the modularization approach that was originally included in MODFLOW.

The modeling pre-processor Visual MODFLOW (Reference 16) is used to facilitate the development of the FPL Turkey Point Units 6 & 7 groundwater flow model. Visual MODFLOW is developed by Schlumberger Water Services.

3.2.2 Numerical Solver

The geometric multigrid solver (GMG) in Visual MODFLOW produces converged solutions for the model, and is used for all simulations presented. The GMG solver uses two convergence criteria, the head change between successive outer iterations and the residual criterion, which is based on the change between successive inner iterations. The model uses the default values of 0.01 feet for the head change criterion and 0.01 feet for the residual criterion.

3.2.3 Model Grid

Figure 2CC-210 shows the model grid and site features for the power block vicinity. At its finest, the model grid spacing is approximately three feet by three

feet within the plant area for Units 6 & 7, and expands to 100 feet by 100 feet at the model perimeter. The grid spacing is also refined in the vicinity of the Turkey Point peninsula, to enable simulation of pumping test PW-1 and the radial collector wells. In this area, the grid spacing is reduced to 25 feet by 25 feet.

3.2.4 Model Layers

The model is bounded by the ground surface and bottom of Biscayne Bay on top and the bottom of the Tamiami Formation at the model bottom. A topobathy surface referenced to NAVD 88 was developed for the ground surface topography of the FPL Turkey Point Units 6 & 7 groundwater flow model. A topobathy surface is a surface that combines land elevation and seafloor topography with a uniform vertical datum (Reference 17). Several data sources were reviewed for potential integration into the topobathy surface. The final topobathy surface was developed from the USGS's National Elevation Dataset (NED) Digital Elevation Models (DEMs) (Reference 18) and NOAA's Office of Coast Survey (OCS) harbor soundings (Reference 19). The selection of the final datasets was based primarily on which two datasets produced the smoothest shoreline transition.

Fourteen model layers are included in the Phase 1 model as follows:

- Model Layer 1 — Onshore: organic soils, referred to as muck and marl. Offshore: sand/sediment and Miami Limestone.
- Model Layers 2/3 — Marine limestone, referred to as the Miami Limestone.
- Model Layer 4 — Marine limestone, referred to as the Upper Higher Flow Zone.
- Model Layer 5/6 — Marine limestone, referred to as the Key Largo Limestone (divided into two areal zones based on prior information).
- Model Layer 7 — Freshwater limestone, referred to as the Freshwater Limestone, and where this is absent the Key Largo Limestone.
- Model Layer 8/9 and 11/12/13 — Marine limestone, referred to as the Fort Thompson Formation.
- Model Layer 10 — Marine limestone, referred to as the Lower Higher Flow Zone.

- Model Layer 14 — Marine limestone or sandstone, referred to as the Tamiami Formation.

Elevations are assigned to each model cell based on the results of the interpolation of stratigraphic picks. Figure 2CC-211 and Figure 2CC-212 show cross sections of the model with relevant features highlighted.

3.2.5 Boundary Conditions

The model incorporates several types of boundary conditions, including river cells, recharge cells, evapotranspiration cells, general-head cells, horizontal flow barrier cells, and no-flow cells. A brief description of boundary conditions as they are used in the model is provided below:

- River Boundary — (1) Cooling Canal System, (2) L-31E, (3) C-107, (4) Card Sound Canal, and (5) Florida City Canal: The river boundary condition allows leakage into the model or leakage out of the model based on (a) specified surface water elevation in the canal, (b) simulated groundwater elevations in adjoining grid cells, and (c) sediment conductance at the bottom and sides of the canals. River cells are employed in lieu of constant head cells to allow flexibility to adjust the conductance and hence flow to adjoining cells during calibration.

- Recharge Boundary — Model Layer 1: The recharge boundary condition is applied at the ground surface (top of model layer 1) and simulates the effect of infiltration from precipitation (before evapotranspiration losses). Recharge in the model is only applied to land surfaces (no recharge is applied to surface water features).

- Evapotranspiration Boundary — Model Layer 1: The evapotranspiration boundary condition is applied at the ground surface (top of model layer 1) and simulates the effects of plant transpiration and direct evaporation by removing water from the saturated groundwater regime. Evapotranspiration is applied only over land surfaces in the model.

- General-Head Boundary (GHB):

  — (1) Model Sides: General-head boundary conditions are assigned to the perimeter of all layers. The general-head boundary represents the influence of conditions beyond the model area. Flow through the

onshore general-head boundaries is influenced by aquifer recharge in the Everglades area.

— (2) Biscayne Bay: General-head boundary conditions are assigned to the top of model layer 1 to represent the exchange of water between Biscayne Bay and the underlying aquifer. The specified head in the GHB cell is based on tidal monitoring at Virginia Key. Use of the GHB condition rather than the constant head condition allows for limiting the exchange of water between Biscayne Bay and the underlying aquifer based on the properties of the sea floor sediments.

- Horizontal Flow Barrier Boundary — Mechanically Stabilized Earth (MSE) Retaining Wall and Cut-Off Walls for Units 6 & 7: The horizontal flow barrier boundary is used to simulate the effects of the excavation cut-off walls surrounding the power blocks for Units 6 & 7 for construction dewatering and also the MSE retaining wall surrounding the Units 6 & 7 plant area (excluding the makeup water reservoir). This package was developed to simulate the effects of thin, vertical, low hydraulic conductivity features that restrict the horizontal flow of groundwater.

- No-Flow Boundary — Bottom of Model: The bottom of the model is designated a no-flow boundary because water levels in the Biscayne Aquifer are expected to be negligibly affected by upward leakage through the Lower Tamiami Formation and Hawthorne Group, which is several hundred feet thick and acts as a confining layer.

- No-Flow Boundary — Units 6 & 7 Excavations: The excavations are designated as inactive to flow. Minor seepage will occur through the cut-off walls into the excavations but the quantities will be insignificant.

3.3 Assumptions

The model development includes the assumptions described below.

3.3.1 Equivalent Porous Media

Assumption: The flow regime is simulated using an equivalent porous media (epm).

Rationale: The effects of small-scale heterogeneities become averaged when used in an analysis of this scale. Preferential higher flow zones identified at

the site are relatively thin and are expected to have laminar flow; therefore, they can be represented in the model by assigning higher hydraulic conductivities to these zones using an epm approach (as opposed to conduit flow).

3.3.2 Steady-State Condition

3.3.2.1 Pumping Tests

Assumption: The pumping tests can be modeled by matching the steady-state drawdown values in each observation well rather than a transient simulation matching the entire drawdown curve.

Rationale: Steady-state conditions from the pumping tests are reached after a very short period of time due to 1) the confined nature of the test zones, and 2) the high hydraulic conductivity of the test zones.

3.3.2.2 Groundwater Flow

Assumption: The cooling canals are assumed to be in steady-state.

Rationale: Previous modeling of the cooling canals assumed the system was in equilibrium and hence steady state. Figure 2CC-213 presents the balance of flows as documented in a previous study. This balance assumes that the existing units are operating at capacity. This assumption is conservative for determination of origins of water to the radial collector wells.

3.3.3 Constant-Density

Assumption: The flow regime is simulated with a constant-density groundwater model.

Rationale: The primary purpose of this groundwater model is to estimate quantities for excavation dewatering and to evaluate the influence of the radial collector wells. For these two localized areas of interest the pressure influences of density variation are insignificant relative to the hydraulic gradient imposed by pumping.

Assumption: Seawater is used as the reference fluid.

Rationale: For a constant density model, water levels should be normalized to a reference fluid to satisfy the steady-state, constant-density equation. Water levels in the model are normalized to a saline reference density of 1022.4 kg/

m[3]. The hypersaline water of the cooling canal system and the freshwater of the drainage canals are adjusted to seawater using the following equation:

$$h_r = \frac{\rho_w}{\rho_r} h_w - \frac{\rho_w - \rho_r}{\rho_r} z_w$$

Where:

h_r is the head at the reference density

h_w is the observed head at the natural density

z_w is the water (canal) depth at the natural density

ρ_w is the natural density of the water

ρ_r is the reference density

For the calibration cases where the Biscayne Bay level is -1.05 feet NAVD 88, normalized head values at locations around the cooling canals and stormwater management canals are presented in Table 2CC-205.

3.3.4 Hydrostratigraphic Units

Assumption: The Freshwater Limestone is assumed to be absent if the contoured thickness is less than 1.5 feet.

Rationale: It is possible that this layer is laterally continuous and where it is not observed it is due to the method of drilling used. A more likely explanation is that due to the freshwater nature of the deposit it is not laterally continuous and the assumed distribution is a reasonable interpretation. Figure 2CC-214 shows the extent of the Freshwater Limestone in the model.

Assumption: The Upper and Lower Higher Flow Zones are assumed to be laterally continuous. The Upper Higher Flow Zone is assumed to be present on top of the Key Largo Limestone over the model domain. The Lower Higher Flow Zone is assumed to be present 15 feet below the top of the Fort Thompson Formation over the model domain.

Rationale: Review of borings logs indicates mud loss at the contact between the Miami Limestone and Key Largo Limestone. Caliper logs also indicate an enlarged boring diameter at this depth. This layer is identified across the site

and designated the Upper Higher Flow Zone. At Units 6 & 7, where the majority of borings exist, another higher flow zone is identified at approximately 15 feet below the top of the Fort Thompson Formation. Its lateral continuity across the site is not as obvious as the Upper Higher Flow Zone; however, for the purposes of this model it is assumed to be laterally extensive. Uprate monitoring borings, drilled as part of FPL Units 3 & 4 Uprate Conditions of Certification (Reference 5) in 2010 confirm these interpretations

Assumption: The Upper and Lower Higher Flow Zones are assumed to have a thickness of one foot.

Rationale: A study conducted by Renken et al. (Reference 20) suggested a thickness of three feet for an aerially extensive zone of higher hydraulic conductivity. Because the transmissivity of the units needs to be preserved during calibration, selecting a smaller thickness for these units will permit a higher hydraulic conductivity, which will facilitate preferential flow and hence be conservative.

Assumption: Hydrostratigraphic units in layer 1 are assumed to be distributed as shown in Figure 2CC-215.

Rationale: Layer 1 of the model represents the hydrostratigraphic units located at ground surface on land or on the floor of Biscayne Bay. Muck is known to be present on land (Reference 3); however, this unit does not extend into Biscayne Bay, where exposed rock and sandy material is present in its place. Hydrostratigraphic units in Biscayne Bay were assigned using the Marine Resources Geographic Information System (MRGIS) "Benthic Habitats—South Florida" file (Reference 21). Benthic zones designated as "Continuous Seagrass" were designated as sandy material in layer 1 as loose material is necessary to support seagrass. "Patchy (Discontinuous) Seagrass" and "Hardbottom with seagrass" benthic zones were designated as rock in layer 1.

3.3.5 Boundary Conditions

Assumption: Upward leakage through the Hawthorn Group to the Biscayne Aquifer is assumed to be sufficiently small that it will have negligible effect on flow paths within the Biscayne Aquifer, so the bottom of the Tamiami Formation is assumed to be a no-flow boundary for this model.

Rationale: The Hawthorn Group has a relatively low hydraulic conductivity and is hundreds of feet thick in South Florida.

Assumption: The cooling canals and regional canals can be modeled by the MODFLOW River Package (RIV).

Rationale: The River Package is applicable to surface water bodies that can either contribute water to the groundwater system, or act as groundwater discharge zones, depending on the hydraulic gradient between the surface water body and the groundwater system.

Assumption: Biscayne Bay has a surface water elevation of -1.05 feet NAVD 88 in the model for the model calibration and validation phases.

Rationale: This value is the average of the monthly average surface water elevation between February 2009 and May 2009. This time period is when the pumping tests used for calibration and validation occurred.

Assumption: The head difference between release and intake structures of the cooling canals is assumed to be 4.66 feet.

Rationale: Field monitoring during the period of the pumping tests showed an average head difference of 2.33 feet between the barge canal (Biscayne Bay) and the intake basin. Because the southern end of the cooling canal system is assumed to be equal to the water level in Biscayne Bay, and the head difference assumed to be equal between the intake and release sides, the head difference across the circulating water pumps is therefore twice the difference between the barge canal and intake basin, or 4.66 feet. Additional observations to confirm the field monitoring indicate that the water level on the east or intake side of the cooling canal system is drawn down approximately three feet lower than the water level on the west or release side of the cooling canal system. Field observations in 2009 also provide a similar number for the head difference.

Assumption: The 4.66-foot head drop between release and intake structures of the cooling canals can be equally distributed between the south flowing cooling canals and the north flowing cooling canals. Based on the surface water elevation for Biscayne Bay, the following water levels are assigned to the intake and release sides for Units 1 through 4:

— Release side of Units 1 though 4 is 1.28 feet NAVD 88.

— Lake Rosetta (intake structure) is -3.38 feet NAVD 88.

Rationale: The flowpath length for the release side and return canals is approximately equal.

Assumption: Water level at the southern end of the cooling canals is assumed to be equal to the water level in Biscayne Bay/Card Sound.

Rationale: Site information indicated that at the southern end of the cooling canal system the water level is approximately equal to the water level in Biscayne Bay/Card Sound.

Assumption: A thickness of 0.1 feet of sediment is assumed to have built up in the cooling canals.

Rationale: Negligible silt build up is assumed to occur due to the scouring action of the water and the flushing as a result of tide changes and the high hydraulic conductivity of the Miami Limestone.

Assumption: Water level in:

- L-31E is 0.02 feet NAVD 88.
- Interceptor Ditch is -0.28 feet NAVD 88 at the northern end, and remains constant until the point where the water level in L-31E minus the water level in C32 is less than 0.2 feet. At this point, the water level in the Interceptor Ditch reduces linearly to -1.05 feet NAVD 88 at the southern end.
- Westernmost release side cooling canal is 1.08 feet NAVD 88 at northern end dropping linearly to -1.05 feet NAVD 88 at the southern end.

Rationale: Water level in the interceptor ditch is maintained (by pumping) at a certain level to induce a seaward hydraulic gradient, ensuring that water from the cooling canals does not move inland in the upper portion of the aquifer. The Interceptor Ditch is operated (seasonally) only when required to maintain a seaward hydraulic gradient.

3.3.6 Hydraulic Conductivities

Assumption: The anisotropy ratio is determined by calibration and limited to a value between 1:1 and 15:1 for all layers (Kh:Kv).

Rationale: Anisotropy was estimated from Figure 2.4.12-238, which tends to cluster between a value of 1:1 and 10:1. This figure presents the results of USGS studies by Cunningham et al. of horizontal and vertical air permeability measurements on core samples from the Biscayne Aquifer (References 22 and 23). Subsequent work by the same author (Reference 24) indicates similar anisotropy ratios. An upper limit of 15:1 was designated to allow for large-scale features not represented by the core samples.

Assumption: The hydraulic conductivity of material accumulated in the bottom of the cooling canals is assumed to be 1.0E-05 cm/s.

Rationale: This represents a standard value for the hydraulic conductivity of silty sand (Reference 25).

3.3.7 Precipitation and Evapotranspiration

Assumption: Groundwater recharge zones are separated into two zones.

Rationale: Two groundwater recharge zones are used in the model. These zones represent 1) a recharge value of zero applied to: open water and the existing plant area that is paved and impermeable, and 2) wetlands, which have a constant recharge rate. These recharge zones are based on the land use classifications of Langevin as shown in Figure 2CC-208 (Reference 11).

Assumption: Evapotranspiration zones are the same as the groundwater recharge zones.

Rationale: Impermeable areas and open water will also have zero evapotranspiration. Wetland areas will have a constant evapotranspiration rate.

3.3.8 Groundwater Control: Dewatering

Assumption: Figure 2.5.4-222 shows the location of the excavation cut-off walls for constructing Units 6 & 7 structures. The elevation of the base of the excavation is -35 feet NAVD 88 and the cut-off wall depth has been revised from -65 to -60 feet NAVD 88. The thickness of the cut-off walls is 3 feet.

Rationale: The cut-off wall depth has been raised to -60 feet NAVD 88 to avoid setting the toe within the Lower Higher Flow Zone. Borings logs at Units 6 & 7 indicate that the Lower Higher Flow Zone occurs at approximately -65 feet NAVD at this location.

Assumption: The walls are assumed to have a hydraulic conductivity of 1.0E-08 cm/s.

Rationale: The design value for the hydraulic conductivity of the diaphragm (cut-off) walls is 8.3E-10 cm/s (Reference 26). A value of 1.0E-08 cm/s is a conservative estimate that will provide an upper bound on the dewatering rate.

Assumption: Units 6 & 7 are excavated and dewatered sequentially.

Rationale: The construction schedule shows the nuclear island excavations to be excavated sequentially.

Assumption: The rock between the base of the cut-off walls and base of the excavation can be grouted to a hydraulic conductivity of 1.0E-04 cm/s.

Rationale: A value of 1.0E-4 cm/s is an industry standard for this type of formation (Reference 27 and 28).

3.3.9 Radial Collector Wells

Assumption: The three western-most radial collector wells and laterals are modeled as operational for plant operations. Figure 2.4.12-218 shows the general location where all four of the radial collector wells will be located.

Rationale: This simulation will provide a conservative estimate of the quantity of water originating from inland due to the proximity of the radial collector wells to land.

Assumption: Operation of the radial collector wells is simulated using the MODFLOW WEL package.

Rationale: Use of the WEL package is a documented method of simulating horizontal wells (Reference 29). Other methods within MODFLOW of simulating the radial collector wells could include the drain package (DRN) and the multi-node well package (MNW).

Assumption: Operation of the radial collector wells is simulated as steady-state.

Rationale: The radial collector wells are intended to be operated only when the primary source of makeup water is not available. Simulating the radial collector wells on a steady-state basis provides the maximum drawdown from the wells and is therefore a conservative approach.

Assumption: The laterals are assumed to be less than 700 feet in length, with approximately 300 feet of screened casing or open hole at the end of the lateral.

Rationale: A conceptual engineering study (Reference 30) provided an upper estimate of 900 feet for the length of the laterals. This value was adjusted during modeling to remain outside the boundary of the Biscayne National Park. A shorter lateral provides a more conservative estimate. It should also be noted that the layout will go through a formal design process at a later stage.

Assumption: Flow to the radial collector wells is distributed non-linearly along the laterals.

Rationale: The head difference between the water level in the lateral and outside the lateral is greatest closest to the caisson and smallest at the end of the lateral.

4.0 MODEL CALIBRATION

A multi-faceted approach to calibration was taken that included the following:

- Calibration to pumping tests on the Turkey Point plant property.
- Verification using a pumping test on the Turkey Point plant property.
- Performing a qualitative comparison of calculated groundwater flows to and from the cooling canal system with an analytical water balance.
- Qualitatively comparing model wide groundwater flow directions with published potentiometric surface maps.

4.1 Calibration Measures and Statistics

Several parameters providing different measures of the agreement between simulated and observed drawdown levels were used for the calibration of the model. These parameters are defined in terms of the calibration residuals of the drawdown defined as the difference between calculated and observed drawdown. The calibration residual, R_i at a point i is defined as:

$$R_i = {}^{model}X_i - {}^{obs}X_i \qquad (1)$$

Where:

$^{model}X_i$ is the calculated drawdown at point i; and

$^{obs}X_i$ is the observed drawdown at point i.

The residual mean, $\bar{R}$ is a measure of the average residual value and is defined by the equation:

$$\bar{R} = \frac{1}{n}\sum_{i=1}^{n} R_i \qquad (2)$$

Where n is the number of points where calculated and observed values are compared.

The absolute residual mean (ARM), $\bar{R}$ is a measure of the average absolute residual value and is defined as:

$$|\bar{R}| = \frac{1}{n}\sum_{i=1}^{n} |R_i| \qquad (3)$$

The Root Mean Squared (RMS) residual is defined by:

$$RMS = \left[\frac{1}{n}\sum_{i=1}^{n} R_i^2\right]^{1/2} \qquad (4)$$

The normalized root mean squared (NRMS) is the RMS divided by the maximum difference in the observed drawdown values. It is given by the following equation:

$$NRMS = \frac{RMS}{^{obs}X_{max} - {}^{obs}X_{min}} \qquad (5)$$

A measure of the numerical convergence of each run is the discrepancy between inflows and outflows from the model domain. To satisfy the overall mass balance, this discrepancy should be zero. In practice, however, a mass balance of zero may not be possible. The aim in obtaining a converged numerical solution is to

achieve a mass balance discrepancy as small as possible. The numerical mass balance discrepancy, M_d, is calculated using the following equation:

$$M_d = \frac{V_{in} - V_{out}}{\frac{1}{2}\left(V_{in} + V_{out}\right)} \qquad (6)$$

where

V_{in} is total flow into the model domain; and

V_{out} is total flow out of the model domain.

The final measure of the adequacy of the calibrated model is the discrepancy between the cooling canal system inflows and outflows determined by the groundwater model and the steady-state water balance determined by the site surface water model. Flow values for the groundwater model are determined by assigning flow zones across the discharge and recharge sides of the cooling canal system. Fluxes into and out of these zones are then calculated and compared with the water balance. In a successful calibration, the mass balance discrepancy between the two models will be as small as possible.

4.2 Calibration Criteria

The following criteria for calibration measures and statistics were used for model calibration:

- Root mean squared residual (RMS) < 1 foot.
- Normalized root mean squared residual (NRMS) < 10 percent.
- Absolute residual mean (ARM) < 1 foot.
- Numerical mass balance discrepancy (M_d) < 0.1 percent.
- Physical mass balance in the cooling canal system within an order of magnitude of the water balance from the surface water model.

4.3 Calibration Parameters

The primary calibration parameters were the hydraulic conductivity, and also the conductance for head dependent boundary conditions (cooling canals, regional canals, Biscayne Bay and model sides). These parameters were varied to

achieve satisfactory agreement between simulated and observed pumping test drawdowns, regional flow directions, and flow magnitudes.

4.4 Calibration Results

The original intent was to utilize the steady-state drawdown values from pumping tests PW-7L and PW-1 as the calibration data set and then validate the model using an additional pumping test from the suite conducted in the vicinity of the proposed Units 6 & 7 power blocks. Following calibration to the two tests, the validation case was run (pumping test PW-7U) and the results demonstrated that the model could not replicate the drawdown values observed at the end of this test. As a result, the validation data set subsequently became part of the calibration data set and an additional pumping test (PW-6U) was used for model validation. As the model was able to adequately replicate the drawdown values from the PW-6U pumping test, model validation was achieved.

4.4.1 Simulation of Pumping Tests

Parameter estimation was performed using manual optimization, whereby model parameters were changed on a trial-and-error basis until a satisfactory match was observed between observed and modeled drawdowns. The procedure used to calibrate the model to the drawdown data was to run the model to steady state with no wells operating for an assumed set of model parameters. Following this run, the steady-state head at each of the monitoring well locations was noted and used as the initial head for the simulation with the pumps operating. Following the execution of the model with the pumping well operating, the model drawdown at each well was calculated by subtracting the final head from the starting head values. This model-determined drawdown was then compared to the observed drawdown to calculate calibration statistics. Model parameters were then adjusted to match the observed drawdown values, and the process described above was then repeated. In addition to adjusting the hydraulic conductivity of the hydrogeologic units, the conductance of the general-head boundaries was also adjusted to represent changes in the properties of the layers, thereby tying the conductance of all general-head boundary cells to the hydraulic conductivity of the layer that the boundary cell is contained within.

Initially, the model was calibrated to two pumping tests: PW-7L and PW-1. During the calibration process, the hydraulic conductivity of all layers was allowed to vary within a predefined range, which was determined from the literature and site hydrogeologic parameters given in Table 2CC-204. Following adequate calibration to these two tests, pumping test PW-7U was simulated with the

parameters determined from the prior utilization. This simulation provided a poor match to test PW-7U, and as a result a series of forward runs were conducted where the hydraulic conductivity of the Key Largo Limestone was varied to improve the match. Following an adequate match to PW-7U, it was observed that PW-1 was unacceptably degraded. It was then concluded that a satisfactory match to both the PW-7U and PW-1 drawdown data could not be achieved by treating the hydraulic conductivity of the Key Largo Limestone as a homogeneous property.

The final phase in calibrating involved holding constant parameters below the Freshwater Limestone from the first optimization and further optimizing to the two tests conducted in the Key Largo Limestone. In order to achieve satisfactory calibration, it was necessary to introduce two hydraulic conductivity zones within the Key Largo Limestone, which were delineated based on two pieces of prior information. The first piece of prior information was an observation from the 2010 drilling program that the upper portion of the Fort Thompson Formation (synonymous here with the Key Largo Limestone) exhibited heterogeneity across the model domain. The second was from the type-curve analysis of pumping tests conducted at the nuclear islands (the Units 6 & 7 containment building, shield building, and auxiliary building) and at the Turkey Point peninsula; the tests at the nuclear island consistently demonstrated a lower hydraulic conductivity than the one conducted at the Turkey Point peninsula. The zones were established by drawing a line between PW-1 on the Turkey Point peninsula and the nuclear island, bisecting the line, and then extending another line perpendicular from this point until it intersected the boundaries of the model domain. The two zones are displayed in Figure 2CC-216. The strategy behind this approach was to fix the dominant parameters controlling test PW-7L, hence trying to maintain an optimal calibration and then only allowing parameters above the Freshwater Limestone to vary, which provide primary control on the tests in the Key Largo Limestone. It was important to check this final phase of calibration by simulating all tests separately to ensure that well interference from simulating multiple tests at the same time did not affect the results. In addition, following each round of optimization, the starting heads were updated, and the conductance value for each general head boundary cell was updated to reflect the new hydraulic conductivity value in the direction of flow. These steps were necessary because the optimization runs only updated the hydraulic conductivity of the model layers. The final hydraulic conductivity values determined from the model calibration are presented in Table 2CC-206 and fall within the limits defined by the literature and site review of hydrogeologic parameters.

4.4.1.1 Pumping Test PW-7L

Calibration to pumping test PW-7L results was performed by simulating the steady-state response to pumping from the Fort Thompson Formation within the footprint of the proposed reactor building for Unit 7. This test was one of four conducted in the first quarter of 2009 to assess the feasibility of construction dewatering. Two tests were conducted within the footprint of each of the reactor buildings for Units 6 & 7, one in the Key Largo Limestone (U or upper test zone), and one in the Fort Thompson Formation (L or lower test zone). The layout of the test (test well and monitoring wells) for this phase of calibration is shown in Figure 2CC-217. The notation used for the observation well naming is as follows:

CX-#$

where:

C	=	Well cluster
X	=	Reactor building (6 or 7)
#	=	Number indicating well position
1	=	approximately 10 feet east of upper zone test well
2	=	approximately 10 feet north of upper zone test well
3	=	approximately 25 feet north of upper zone test well
4	=	approximately 40 feet north of upper zone test well
5	=	approximately 10 feet east of lower zone test well
$	=	Alphabetic character designating the well monitoring zone
A	=	Miami Limestone
B	=	Freshwater Limestone
C	=	Tamiami Formation
D	=	Key Largo Limestone
E	=	Fort Thompson Formation

The constant rate test of well PW-7L was conducted in March 2009, with an average discharge rate of 3403 gpm for nine hours.

The rationale for selecting test well PW-7L is:

- The hydrogeological units overlying the Fort Thompson formation and within the footprint of the excavation will be contained by a cut-off wall with the implication that the deeper zone tests are more relevant.

- The PW-7L pumping test data were considered more complete than the PW-6L data.

The refined grid in the area of Unit 7 is presented in Figure 2CC-218 along with a close-up showing the test and observation wells in Figure 2CC-219. The model interpolates the numerical results calculated at the grid nodes to the input locations of the observation wells. Because water levels in the Fort Thompson

Formation stabilized within ten minutes of turning on the pump, the test was simulated by matching the drawdown values at the end of the test only. The rationale for this is that the test had reached steady-state and hence a transient simulation was not necessary.

Results of the pumping test simulation are tabulated in Table 2CC-207. This shows simulated and measured drawdown values in each of the monitoring wells that were instrumented. The drawdown response was well matched.

A plot of observed versus simulated drawdown is presented in Figure 2CC-220 for all monitored layers. The normalized root mean square for all layers is 7.9 percent, which is considered acceptable for this model and is within the calibration criteria established in Section 4.2.

4.4.1.2 Pumping Test PW-1

An exploratory drilling and aquifer testing program was performed on the Turkey Point peninsula to assess the hydraulic properties of the Biscayne Aquifer (Reference 4). The program provided data to determine whether a radial collector well system could be implemented at this location to meet the water-supply requirements for Units 6 & 7.

The pumping well, PW-1 was open across the Key Largo Limestone. Five monitoring wells were installed at radial distances of between 75 feet and 2070 feet of the pumping well. Monitoring wells at all radial distances are screened in the Key Largo Limestone to monitor water levels in the test zone. In the case of the closest monitoring well, the zones immediately above (Miami Limestone) and below (Fort Thompson Formation) the test zone are also monitored. The layout of the test (test well and monitoring wells) is shown in Figure 2CC-221. The constant rate test of well PW-1 was conducted in April and May of 2009, with an average discharge rate of 7100 gpm for seven days.

The finite-difference grid in the area of the Turkey Point peninsula and the wells (pumping and observation) is presented in Figure 2CC-223. Results of the pumping test simulation are tabulated in Table 2CC-208. This shows simulated and measured drawdown values in each of the monitoring wells that were instrumented. The drawdown response was well matched.

A plot of observed versus simulated drawdown is presented in Figure 2CC-223 for all monitored layers. The normalized root mean square for all layers is 5.3 percent, which is considered acceptable for this model and is within the calibration criteria established in Section 4.2.

4.4.1.3 Pumping Test PW-7U

Calibration to pumping test PW-7U results was performed by simulating the steady-state response to pumping from the Key Largo Limestone within the footprint of the proposed reactor building for Unit 7. The layout of the test (test well and monitoring wells) for this phase of calibration is shown in Figure 2CC-217 and follows the same notation as test PW-7L described in Subsection 4.4.1.1.

The constant rate test of well PW-7U was conducted in March 2009, with an average discharge rate of 4181 gpm for just under nine hours. Observation wells were constructed in the Miami Limestone, Freshwater Limestone, Tamiami Formation, Key Largo Limestone, and Fort Thompson Formation to monitor the water level response to pumping.

PW-7U was selected as part of the calibration data following its unsuccessful use to validate the model after calibration to PW-7L and PW-1 alone. The grid refinement presented for PW-7L also covers the same area for PW-7U and is presented in Figure 2CC-218 along with a close-up showing the test and observation wells in Figure 2CC-224.

Because water levels in the Key Largo Limestone stabilized within ten minutes of initiating pumping, the test was simulated by matching the drawdown values at the end of the test only. The rationale for this is that the test had reached steady-state and hence a transient simulation was not necessary.

Results of the pumping test simulation are tabulated in Table 2CC-209, which shows simulated and measured drawdown values in each of the monitoring wells that were instrumented. The drawdown response was well matched with the exception of monitoring well C7-1D, which shows greater drawdown compared to C7-2D, both of which are equidistant from the test well. The difference in drawdown between the observation wells could suggest localized heterogeneity and/or well construction issues or instrument malfunction. Review of the well construction information and both the raw data and processed data files did not indicate any obvious well construction or data collection issues that would cause the difference in drawdown. The difference in drawdown between these two wells is likely attributable to small-scale heterogeneities that are not captured in the model. A plot of observed versus simulated drawdown is presented in Figure 2CC-225 for all monitored layers.

The normalized root mean square for all layers is 11.3 percent. Although the NRMS is marginally outside the criterion established in Section 4.2, the RMS,

ARM, and Md are all within limits. This result is considered adequate because the model is also calibrated to two other pumping tests, compared to the regional flow regime, and additionally calibrated to a water balance for the cooling canal system.

4.4.2 Comparison to Regional Flow Regime

For matching of regional flow direction and patterns, simulated groundwater contours and levels were compared to potentiometric surface maps for the Biscayne Aquifer from May and November 1993 (Figure 2.4.12-219 and Figure 2.4.12-220).

The intention of this is to qualitatively capture the overall flow paths and direction. Figure 2CC-226 through Figure 2CC-233 show the simulated heads for each of the hydrostratigraphic units, indicating a predominant flow direction from west to east, which is in agreement with Figure 2.4.12-219 and Figure 2.4.12-220. Flows are more complex in the vicinity of the cooling canals due to the exchange of water between the canals and groundwater. These nuances are not captured in the larger flow picture shown in Figure 2.4.12-219 and Figure 2.4.12-220.

4.4.3 Comparison with Cooling Canal System

The interaction of groundwater with the surface water comprising the cooling canal system was assessed by comparing model results against estimates obtained from an independent water balance model on a steady-state basis. The water balance model for the cooling canal system is displayed schematically in Figure 2CC-213. The model accounts for flow from the release side of the cooling canals downward to the groundwater beneath the canal system and flow from underneath Biscayne Bay inward and upward to the return canals. This figure has been updated to include the simulated flow rates from the groundwater model and is shown in Figure 2CC-234. The area outlined in blue shows that part of the surface water model that is replicated in the current groundwater model. The top figure for each parameter (net blowdown and net makeup) represents that from the surface water model while the lower figure is the calculated value from the groundwater model. Values for comparison were determined from the groundwater model by assigning flow zones across the release and return sides of the cooling canal system. Fluxes into and out of these zones were then calculated for comparison with the water balance. A comparison of the values indicates that the groundwater model shows up to 31 percent higher cooling canal system makeup and blowdown values than the surface water. This is considered

an acceptable match given that the cooling canal system water balance is a simple analytical model.

4.5 Model Validation

The PW-6U test, conducted in the Key Largo Limestone at the location of the proposed site of the Unit 6 nuclear island, was used for model validation. The test and monitoring well layout is depicted in Figure 2CC-235 and uses the same numbering system as described in Subsection 4.4.1.1.

The constant rate test of well PW-6U used an average discharge rate of 5103 gpm for eight hours. Observation wells were constructed in the Miami Limestone, Freshwater Limestone, Tamiami Formation, Key Largo Limestone, and Fort Thompson Formation to monitor the water level response to pumping.

Results of the pumping test simulation are tabulated in Table 2CC-210. This shows simulated and measured drawdown values in each of the monitoring wells that were instrumented. The drawdown response was well matched.

A plot of observed versus simulated drawdown is presented in Figure 2CC-236 for all monitored layers. Although the NRMS of 11.4 percent is marginally outside the criterion established in Section 4.2, the RMS, ARM, and M_d are all within limits. These results are considered acceptable for model validation, considering that PW-6U data are completely independent.

4.6 Conclusions

The model is calibrated based on the following observations:

- Calibration to pumping tests at PW-7L, PW-1, and PW-7U indicate a good match between observed and modeled drawdown values.
- Matching of regional flow patterns.
- Comparison with an independent cooling canal system water model shows similar flow exchanges between the cooling canals and the groundwater beneath them.
- Validation of the model to pumping test PW-6U indicates a good match between observed and modeled drawdown values.
- Hydraulic conductivity values obtained by model calibration are within the range of values reported in the literature.

5.0 PHASE 1 CONSTRUCTION & POST-CONSTRUCTION SIMULATIONS

Predictive simulations are used for two purposes: evaluating groundwater control options during construction of Units 6 & 7, and operation of the radial collector well system and its influence of the existing groundwater regime.

A concrete cut-off wall for construction groundwater dewatering control will be installed around the excavations for Units 6 & 7. It is estimated that the cut-off wall will extend to an elevation of -60 feet NAVD 88 with the base of the excavation at an elevation of -35 feet NAVD 88. The top of the cut-off wall will extend up to an elevation of 2 feet NAVD 88. In addition, the rock between the base of the excavation and the base of the cut-off walls will be grouted. The purpose of modeling the construction dewatering is to estimate discharge rates required to maintain the water table below the base of the excavation.

Radial collector wells will be installed on Turkey Point peninsula in order to provide backup cooling tower makeup water for the proposed AP1000 units at Units 6 & 7 when the primary supply of makeup water is not available. These simulations are performed to determine the origins of water that supply the RCW system, using MODPATH (Reference 31) and ZoneBudget (Reference 32).

5.1 Groundwater Control During Construction

Groundwater flow simulations for dewatering of the nuclear island excavations were performed with the calibrated base model. For these simulations, the muck is left in place in the model. It is likely that during earthworks, the muck will be stripped and replaced with backfill to provide a stable working platform. This simplification is expected to have no impact on the dewatering rates.

Several refinements were made to the Phase 1, base model to represent the excavations:

- The interior of the excavation (ground surface to -35 feet NAVD 88) was defined as inactive to flow.
- The Horizontal Flow Boundary (HFB) package (Reference 33) was used to simulate the cut-off walls from the base of the excavation down to an elevation of -60 feet NAVD 88.
- Constant head cells were added to the layer below the excavation to represent the sump pumps in the base of the excavation used to maintain dry working conditions. The constant head level was set to -35 feet NAVD 88 (the floor of

the excavation), and pumping rates were calculated from the simulated inflows to the constant head cells. The grid elevations of the cells immediately below the base of the excavation were adjusted to provide a uniform, thin layer within which the constant head cells could be placed.

- A new hydraulic conductivity zone was added from the base of the excavation to the base of the cut-off walls to simulate grouting.
- The water level in Biscayne Bay was set to the long-term average of -0.81 feet NAVD 88.
- Water levels in the cooling canal system, L-31E Canal, Card Sound Canal, and the Model Land Canal (C-107) were adjusted based on the long-term average Biscayne Bay water level.

Figure 2.5.4-222 shows an excavation profile at the power block while Figure 2CC-237 illustrates the implementation of the excavation in the model. Figure 2CC-237 shows the model grid, excavation walls, and sump pumps. A cross section through the model illustrating the depth of the excavation and cut-off walls is presented in Figure 2CC-238.

The two excavations were dewatered sequentially to represent the construction schedule. For each unit, the model was run to steady-state, starting with previously derived steady-state heads under no pumping conditions. ZoneBudget was used along with the simulation to determine the quantity of water being extracted from the interior dewatering wells.

To aid in construction-related groundwater control, grout plugging will be performed between the bottom of the excavation and the bottom of the cut-off wall. The rationale behind this methodology is to reduce the hydraulic conductivity by injecting grout into a pattern of holes within the excavation between the bottom of the excavation and the bottom of the cut-off wall. By reducing the hydraulic conductivity of the rock, lower discharge rates are achieved, such that sump pumps in the floor of the excavation rather than active dewatering wells can be used to keep the excavation dry during construction. Additional dewatering methods may be implemented during excavation to assist in the removal of groundwater storage within the area to be excavated.

Figure 2CC-239 shows the proposed methodology whereby grout is injected in a series of "Primary" borings until refusal is achieved. Subsequent borings are then drilled in between the borings of the prior step. Three series of borings are

possible after the "Primary" set: a "Secondary," "Tertiary," and "Quarternary" set. Each set is drilled and grout injected until refusal occurs. "Quarternary" borings may not be required at all locations; only where excessive seepage is observed as the excavation progresses.

In the base case, a hydraulic conductivity of 1.0E-04 cm/s is used for the grouted formations. Discharge rates obtained from this model yield a value of 96 gpm for each unit. A series of runs evaluating different values for the hydraulic conductivity of the grouted formations were performed to determine a feasible range of discharge rates that may be achievable with grouting. In addition to the run described above, values of 1.0E-03 cm/s, 1.0E-05 cm/s, and 1.0E-06 cm/s were simulated. The results are displayed graphically in Figure 2CC-240.

5.2 Post-Construction Radial Collector Well Simulation

Groundwater flow simulations for the radial collector wells were performed with the calibrated base model. Several refinements were made to represent the conditions at the site post-construction:

- Cut-off walls installed during construction (and represented in dewatering simulations) are left in place.
- Concrete fill added within the cut-off walls between -35 feet NAVD 88 (base of excavation) and -16 feet NAVD 88 with a hydraulic conductivity of 1.0E-08 cm/s.
- Concrete mud mat for reactor building added within cut-off walls between -16 feet NAVD 88 and -14 feet NAVD 88 with a hydraulic conductivity of 1.0E-08 cm/s.
- Reactor building included as inactive to flow.
- Redefined new zones of recharge at the Units 6 & 7 plant area as represented in Figure 2CC-241. The values of recharge for grass and gravel of 2 in/yr and 10 in/yr, respectively, were selected to represent the land surface and also the relatively lower recharge expected compared to the wetlands, which dominates a large majority of the model area beyond the plant area.
- Backfill added between reactor building and cut-off walls with a hydraulic conductivity of 0.01 cm/s.

- Muck removed from area in immediate vicinity of reactor buildings and replaced with backfill (hydraulic conductivity of 0.01 cm/s).
- The water level in Biscayne Bay set to the long-term average of -0.81 feet NAVD 88.
- Recharge and evaportranspiration set to long-term average values.
- Water levels in the cooling canal system shifted to account for the change in Biscayne Bay water level.
- Mechanically Stabilized Earth (MSE) retaining walls, as shown in Figure 2.5.4-201 installed around the perimeter of the Turkey Point Units 6 & 7 plant area down to 0 feet NAVD 88. The MSE retaining wall is also shown as implemented in the numerical model in Figure 2CC-261.

To simulate the radial collector wells and laterals, other changes were made to the model:

- Four pumping wells placed on approximately the last 300 feet of each lateral to represent the screened intervals. Flows were distributed along the laterals based on head loss calculations. The flows are as follows: 872 gpm at the end, 881 gpm at 100 feet from the end, 909 gpm at 200 feet from the end, and 956 gpm at 300 feet from the end of the lateral. Total flows are 3618 gpm per lateral or 28,944 gpm per radial collector well (8 laterals per radial collector well x 3618 gpm per lateral). In the model, the pumping wells are located at approximately 100-foot intervals.
- Three of the four radial collector wells are operational, resulting in a total system pumping rate of 86,832 gpm (3 radial collector wells x 28,944 gpm per radial collector well). To maximize the allocation of water from inland areas to the radial collector wells, the three wells closest to the shore were modeled as operational.
- Zones defined around the model domain to estimate the volume of water coming from land or Biscayne Bay.
- The radial collector wells pumped from the Upper Higher Flow Zone. An alternate scenario was also modeled in which the radial collector wells are pumped from the Key Largo Limestone.

- The top of the cut-off walls truncated at the boundary of the Miami Limestone and muck (approximate elevation -4 feet NAVD 88). The actual elevation will be 2 feet NAVD 88, however this simplification is expected to have no effect on the RCW calculations of approach velocity and origin of flow to the RCW. (Post-construction groundwater levels at Units 6 & 7 are discussed in Section 6.0.)

Figure 2CC-242 shows the modeled location of the radial collector wells on the Turkey Point peninsula with the finite-difference grid overlaid and also the location of the pumping wells (light blue) representing the screened portion of the laterals. Figure 2CC-243 shows the potentiometric surface after model execution in the Upper Higher Flow Zone. Figure 2CC-244 shows the head contours in layer 1. Figure 2CC-245 is a section across the most centrally located radial collector well showing groundwater contours for all modeled layers. Figure 2CC-246 and Figure 2CC-247 show the drawdown in the vicinity of the Turkey Point peninsula in layer 1 and the Upper Higher Flow Zone (pumped zone) respectively. In the alternate case where the radial collector wells are instead placed in the Key Largo Limestone, the water table, groundwater contours, and drawdown plots are virtually identical to those produced when the radial collector wells are pumped from the Upper Higher Flow Zone.

5.2.1 Origins of Water Supplying Radial Collector Wells

To determine the origins of water supplying the radial collector wells a multi-step process is followed. The first step is to place a particle in each boundary condition cell representing a source of water (River, General-Head, and Recharge). Particles are not placed in other cells because the model is steady-state and therefore all water discharging from the RCWs has to originate from a boundary condition. MODPATH is then run in forward tracking mode and the endpoint file reviewed to identify only those particles that end up in the pumping cells representing the RCWs. Once those particles have been identified their starting locations are set up as a separate zone within ZoneBudget for tracking purposes. Following execution of ZoneBudget, the separate fluxes from each of the boundaries (River, General-Head, and Recharge minus Evapotranspiration) are summed and compared to the discharge from the RCW system as a check. For both the base case with the laterals in the Upper Higher Flow Zone and the alternate case with the laterals in the Key Largo Limestone, 99.9 percent of the expected flow to the RCW system is accounted for by the ZoneBudget boundary fluxes. The results presenting the origins of the water to the RCW are presented in Table 2CC-211 and broken down into two main components. The first of these is flow from Biscayne Bay, which includes vertical flow down through the Bay floor

and lateral flow from the sides of the model in the Bay. The second component is flow from inland, which is further broken down into water originating from the CCS, and that originating from recharge by precipitation.

Figure 2CC-248 and Figure 2CC-249 present the output for layers 1 and 2 for the base case where the laterals are placed in the Upper Higher Flow Zone. The blue colored clusters on these figures show the starting location of particles that ultimately discharge to the RCW. In the alternate case where the radial collector wells are pumped from the Key Largo Limestone, the flow distribution is the same as the base case, as is shown in Table 2CC-211.

The cumulative induced flow quantities of the radial collector wells were examined by comparing the difference in flow into the model across the western, northwestern, and southeastern boundaries when the radial collector wells are operating at steady-state, versus the steady-state case when no wells are running. Eastward flow is defined as the flow across the western boundary and the flow across the northern boundary from the western edge of the model to L-31E. Flow quantities were determined using ZoneBudget. In both cases, 26 gpm of additional flow into the model domain is induced across the model boundaries as compared to the case with no pumps operating. When compared to the total RCW system pumping rate of 86,832 gpm (Section 5.2), an induced flow across the model domain of 26 gpm is relatively small.

5.2.2 Approach Velocity at Bay/Aquifer Interface

In order to provide a range of expected approach velocities through the floor of Biscayne Bay, three separate velocities were calculated while simulating the operation of the radial collector wells. Using the Biscayne Bay capture zone identified in Figure 2CC-248 and the additional zones identified in Figure 2CC-250, three values for the approach velocity were calculated representing the following:

1. Average approach velocity for entire control volume (blue in NE corner of Figure 2CC-248).
2. Average approach velocity for immediate area defined by the radial collector wells (green in Figure 2CC-250).
3. Average approach velocity for the laterals (colored zones along laterals in Figure 2CC-250).

The volumetric flow rate for each of these zones was calculated using ZoneBudget and then divided by the area of the zone to calculate an approach

velocity. The following values were obtained for the three zones for the base case with the radial collector wells pumping from the Upper Higher Flow Zone:

- Entire RCW Catchment: 3.3E-05 cm/s (1.1E-06 ft/s)
- Immediate RCW Area: 5.2E-04 cm/s (1.7E-05 ft/s)
- Average of all RCW Laterals: 6.2E-04 cm/s (2.0E-05 ft/s)

To further illustrate these results, a plot of the Darcy velocities in the top layer of the model showing the spatial variation in approach velocity (ft/day) through the floor of Biscayne Bay is given in Figure 2CC-251. Irregularities in the contours of the Darcy velocity are related to the hydraulic conductivity distribution for layer 1 (Figure 2CC-215). When the radial collector wells are instead located in the Key Largo Limestone, the approach velocities are only slightly different compared to the base case (Table 2CC-212).

5.2.3 Sensitivity Analysis

A suite of sensitivity analyses was performed on the radial collector well simulations to address parameter uncertainty and water level variation. The radial collector wells pump from the Upper Higher Flow Zone in all sensitivity runs. The Upper Higher Flow Zone is used because it is the shallowest zone of higher hydraulic conductivity.

Two sensitivity runs were performed to address the variation in Biscayne Bay water levels. These runs considered that Biscayne Bay water levels vary seasonally. One case was run with Biscayne Bay set at the seasonal high water level, and another case was run with Biscayne Bay set at the seasonal low level. The seasonal extreme values were determined by taking the highest and lowest monthly mean sea level measurements at NOAA's tidal water level and meteorological data collection station (#8723214) on Virginia Key in Biscayne Bay. Based on data from February 1994 to March 2010, the seasonal low level of Biscayne Bay is -1.40 feet NAVD 88 while the seasonal high level of Biscayne Bay is 0.09 feet NAVD 88 (Reference 10). Using the equation given in Subsection 3.3.3, water levels in the cooling canals, L-31E Canal, Card Sound Canal, and Model Land Canal (C-107) were adjusted based on the water level in Biscayne Bay. The areal extent of the GHB cells representing Biscayne Bay was not adjusted for this sensitivity analysis. Results of the seasonal water level runs indicate that either increasing or decreasing the Biscayne Bay water level has no observable effect on the approach velocities for the RCW. Increasing the Biscayne Bay water level slightly increases the percent contribution to the radial collector wells from Biscayne Bay, while lowering the Biscayne Bay water level

slightly decreases the percent contribution to the radial collector wells. Changing the Biscayne Bay level induces an additional flow into the model domain of 23 gpm for the high water level case and 27 gpm for the low water level case when compared to the case with no pumps operating.

Two additional sensitivity runs were performed to assess the impact of the anisotropy ratio in Biscayne Bay on the radial collector well simulations. In the base model, an anisotropy ratio of 15:1 (Kh:Kv) is used. In the sensitivity runs, the vertical hydraulic conductivity (Kv) is either doubled or halved, producing anisotropy ratios of 7.5:1 and 30:1, respectively. This change is only made offshore to the first three layers of the model, which represent the Miami Limestone (and a small area of sediment in layer 1). Results of the anisotropy sensitivity runs indicate that for the RCW laterals and the immediate RCW area, the approach velocities increase as the Kv increases, and decrease as the Kv decreases. Doubling the Kv slightly increases the percent contribution to the radial collector wells from Biscayne Bay, while halving the Kv slightly decreases the percent contribution to the radial collector wells. Changing the anisotropy ratio in Biscayne Bay induces an additional flow into the model domain of 7 gpm for the double Kv case and 82 gpm for the half Kv case, when compared to the case with no pumps operating.

A final set of sensitivity runs were performed to evaluate the impact of the hydraulic conductivity of the Key Largo Limestone on the radial collector well simulations. The reason for this additional suite is because the Key Largo Limestone is divided into two zones of hydraulic conductivity based on information identified in Subsection 4.4.1. These zones were defined to improve the calibration and these sensitivity runs are intended to determine if the difference in hydraulic conductivity between the zones results in any change in the induced flow across the western boundary. The results indicate that an additional 11 gpm of flow is induced across the model boundaries when the horizontal hydraulic conductivity is 5.9 cm/s and 34 gpm when the horizontal hydraulic conductivity is 10 cm/s when compared to the case with no pumps operating.

A compilation of the results for the base case and sensitivity cases can be found in Table 2CC-211 for the origin of water to the radial collector wells and Table 2CC-212 for the approach velocities of each zone. As was done with the base case, a comparison of the RCW discharge was made with the ZoneBudget boundary fluxes as a check. For these sensitivity cases, between 99.8 percent and 100.4 percent of the expected flow to the RCW system is accounted for by the ZoneBudget boundary fluxes. For both the base case with the laterals in the Upper Higher Flow Zone and the alternate case with the laterals in the Key Largo

Limestone, 99.9 percent of the expected flow to the RCW system is accounted for by the ZoneBudget boundary fluxes. In addition to the tabulated summary a graphical representation of the sensitivity of these parameters to the 0.1 foot drawdown contour is presented in Figures 2CC-252, 2CC-253, and 2CC-254 for the aforementioned cases.

6.0 PHASE 2 REVISIONS TO THE GROUNDWATER MODEL

The post-construction simulations for the Phase 1 groundwater model were developed to evaluate the impact on the groundwater system from RCW pumping. The Phase 2 simulations were developed to estimate maximum water table elevations at Units 6 & 7 and do not include pumping of the RCW system. Phase 2 revisions to the model are documented in Sections 6.1 to 6.3. Assumptions corresponding with these changes are described in Section 7.0.

The Phase 2 simulations include four post-construction simulations (Cases 1 through 4). Each case is described below.

Case 1: Base-case model with the hydraulic conductivities of the structural backfill and the non-structural backfill as shown in Figure 2CC-256 and further explained in Section 7.1. Recharge rates for the uppermost active layer at Units 6 & 7 are shown in Figure 2CC-257. The same recharge assumption is applied for Cases 3 and 4.

Case 2: Sensitivity case for high recharge rates for grass and gravel (46.75 in/yr for each surface type, respectively).

Case 3: Simulation of a catastrophic failure of the MWR north wall. The north wall is selected as a limiting case with respect to the potential impact on Units 6 & 7.

Case 4: Simulation assuming sea-level rise at the Units 6 & 7 site. The assumptions for this simulation are discussed in Section 7.3.

6.1 New Model Layer to Incorporate a Revised Top Elevation of the Diaphragm Walls

The post-construction simulations developed for Phase 1 were revised to include new features in the top model layer, which was split into two layers. A new model layer was added to represent the top of the diaphragm walls for Units 6 & 7 (Figure 2CC-255). The locations of the diaphragm walls in plan view are shown in Figure 2.5.4-201. The top of the diaphragm walls was placed at elevation 2 feet

NAVD 88. With the addition of a new layer, the model is a fifteen-layer model. The model developed in Phase 1 was a fourteen-layer model. General head and river boundary conditions affected by splitting the top layer were adjusted to approximate their volumetric flux rates from the fourteen-layer, post-construction model. Based on a comparison of the volumetric flux rates of general head and river leakage boundary conditions, the fourteen-layer model and the fifteen-layer model were verified to be equivalent; the flux rates for the two models matched within 1 percent.

6.2 Modifications to the Structural Fill in the Top Model Layer

Structural fill was added to the top model layer for the nuclear island areas (Figure 2CC-258). In Phase 1, the structural backfill and non-structural backfill were included as one zone in the top model layer. For Phase 2, structural fill is located within the diaphragm walls, as shown in Figure 2CC-255. Structural fill will be used within the nuclear island areas and beneath nonsafety-related power block structures. The hydraulic conductivity for the structural fill is 1.0E-02 cm/s. Assumptions regarding this zone are discussed further in Subsection 7.1.1.

6.3 Modifications to the Makeup Water Reservoir Simulated in the Model

Located approximately a quarter-mile south of Units 6 & 7, the MWR supplies makeup water to replace water lost as evaporation, drift and blowdown due to operation of the wet cooling towers that are part of the circulating water system used for normal plant cooling. The MWR is located approximately 700 feet south of the Units 6 & 7 nuclear island areas. The west, south, and east sides of the MWR lie approximately 50 feet to 100 feet from the bordering cooling water canals as shown in Figure 2.4.2-202. The MWR is roughly a right-angled trapezoid in plan view with a footprint of approximately 37 acres.

In Phase 1, the MWR was represented as inactive cells. For Phase 2, however, the representation of the MWR was revised to simulate operational water losses and to reflect the water stored in the MWR. The water level in the MWR was set at a constant elevation of 24 feet NAVD 88 and the sidewalls were represented with HFB boundary conditions. Assumptions for the MWR are documented in Sections 7.2 and 7.4.

7.0 PHASE 2 MODEL ASSUMPTIONS

In addition to the assumptions presented in Section 3.3, assumptions used for Phase 2 are presented below. Note that some of the assumptions are case specific.

7.1 Backfill

Two types of backfill are proposed for the Units 6 & 7 site: Category I Engineered Fill ("structural backfill") and Category II Engineered Fill ("non-structural backfill") (FSAR Subsection 2.5.4.5.3). The hydraulic conductivity of structural fill is referred to as "K_{95}" since structural fill will be compacted to a minimum of 95 percent of maximum dry density (FSAR Subsection 2.5.4.5.3). The hydraulic conductivity of non-structural fill is referred to as "K_{92}," since non-structural fill will be compacted to a minimum of 92 percent of maximum dry density (FSAR Subsection 2.5.4.5.3).

7.1.1 Structural Fill

Assumption: Structural backfill is included in the model at and within the location of the diaphragm walls (Figure 2CC-258). Structural fill will be used from an elevation of approximately -16 feet NAVD 88 to the finish grade elevation of 25.5 feet NAVD 88. Structural backfill on the excavation slope outside of the diaphragm walls was not included in the model.

> Rationale: FSAR Subsection 2.5.4.5.3 states that structural fill will be used within the nuclear island areas and beneath nonsafety-related power block structures.

Assumption: Assuming a d_{10} (percent fraction that is finer than 10 percent) of approximately 0.02 cm for a typical compacted Florida limerock, the hydraulic conductivity of the structural fill (K_{95}) is estimated as 1.0E-02 cm/s for the base-case simulation (Case 1).

> Rationale: Grain size distributions for a typical compacted Florida limerock are provided in Figure 3.1 of Reference 34. Based on a d_{10} grain size of 0.02 cm, K_{95} can be estimated using the following approximation developed by Hazen (Reference 35, p. 350):
>
> $$K(\text{cm/s}) = C_H d_{10}^2 \qquad (7)$$
>
> where K is hydraulic conductivity (cm/s); C_H is the Hazen empirical coefficient (assumed to be 100); and d_{10} is in units of centimeters. K_{95} is estimated to be 4.0E-02 cm/s. The value assumed for K_{95} was rounded to 1.0E-02 cm/s.

7.1.2 Non-Structural Fill

Non-structural fill will be used at non-structural areas of the Units 6 & 7 power blocks and as needed to build up the Units 6 & 7 plant area to post-construction grade. Non-structural fill will be used from an elevation of approximately -5 feet NAVD 88 to the finish grade elevation of 25.5 feet NAVD 88.

Assumption: For all cases, K_{92}=1.35E-02 cm/s.

Rationale: The relationship of permeability to porosity can be estimated from the Kozeny-Carman equation (Reference 36, p. 67):

$$K = C_0\left[\frac{n^3}{(1-n)^2}\right]/M_s^2 \tag{8}$$

where C_0 is a coefficient, M_s is the specific surface area of the porous matrix (defined per unit volume of solid), and n is porosity. C_0 is assumed a constant (Reference 37) and M_s is assumed to be independent of the packing arrangement. Furthermore, porosity can be related to bulk density and mineral density as follows (Reference 38, p. 30):

$$n = 1 - \frac{\rho_b}{\rho_m} \tag{9}$$

where ρ_b is bulk density and ρ_m is mineral density. Thus, Eq. (8), in combination with the definition of porosity (Reference 38, p. 29) and Eq. (9), K_{95} can be related to the hydraulic conductivity of any other compaction percentile, p:

$$\frac{K_{95}}{K_p} = \left(\frac{n_{95}}{n_p}\right)^3\left(\frac{\rho_p}{\rho_{95}}\right)^2 \tag{10}$$

Assuming that the maximum bulk density of the structural backfill is 2.10 g/cm^3 (131 pcf) (see Figure 4.13 of Reference 34) and that the mineral density for a typical Florida limerock is 2.73 g/cm^3 based on the specific gravity of Miami Limestone (Table 2.5.4-205), Eq. (9) and Eq. (10) can be used to estimate the ratio of K_{95}/K_{92}. With K_{92}/K_{95} equal to 0.73, K_{92}= 1.35E-02 cm/s.

7.2 Makeup Water Reservoir

As discussed in Section 6.3, the Makeup Water Reservoir (MWR) supplies makeup water to replace water lost as evaporation, drift and blowdown due to operation of the wet cooling towers that are part of the circulating water system used for normal plant cooling. Several model characteristics were used to represent the MWR. The use of inactive cells is discussed in Subsection 7.2.1, constant head boundary conditions in Subsection 7.2.2, horizontal flow barriers in Subsection 7.2.3, and hydraulic conductivity in Subsection 7.2.4. Assumptions regarding the MWR leakage are documented in Subsection 7.2.4. The use of ZoneBudget to assess vertical and lateral leakage from the MWR is discussed in Section 7.4.

In the model, the top elevation of the MWR sidewalls was set to 24 feet NAVD 88. The top elevation of the reservoir bottom slab was set to -2 feet NAVD 88 and the bottom of the slab was set to an elevation of -4 feet NAVD 88.

7.2.1 Inactive Cells

Assumption: The Mechanical Draft Cooling Towers and Circulating Water Pumphouse were set as inactive cells.

> Rationale: The Mechanical Draft Cooling Towers and Circulating Water Pumphouse associated with the MWR are concrete/solid structures.

7.2.2 Constant Head

Assumption: The water level inside the MWR was simulated by a constant head boundary condition, with a head elevation of 24 feet NAVD 88 (Figure 2CC-261).

> Rationale: The head elevation is equal to the top elevation of the reservoir. As stated in FSAR Subsection 2.4.8, the maximum operating water level in the MWR basin is assumed to be 22.5 feet NAVD 88. However, there are extreme conditions when the water level could be higher, such as during extreme rainfall events. For example, for a one-half probable maximum precipitation storm event, a maximum water level of elevation 24.2 feet NAVD 88 (FSAR Subsection 2.4.4) was considered, which is 0.2 feet above the top elevation of the MWR wall at elevation 24.0 feet NAVD 88. As this event would occur for only a few hours, a water surface elevation of 24 feet NAVD 88 was assumed for the MWR.

7.2.3 Horizontal Flow Barriers

Assumption: The MWR sidewalls were simulated as horizontal flow barrier (HFB) boundary conditions to account for operational leakage (Figure 2CC-259). The walls were assumed to be 2 feet thick, with a hydraulic conductivity of 1.0E-08 cm/s.

> Rationale: The MWR sidewall thickness of 2 feet is based on preliminary design. As discussed in Subsection 3.3.8, the design value for the diaphragm (cut-off) walls is 8.3E-10 (Reference 26). A value of 1.0E-08 cm/s will provide a conservative estimate for operational leakage.

Assumption: For Case 3, HFBs along the north wall of the MWR were removed. The HFB boundary conditions along the west, south, and east edges of the MWR sidewalls and bottom reservoir slab were included in the simulation.

> Rationale: HFB boundary conditions were removed along the north wall of the MWR to simulate the impact on water table elevations near Units 6 & 7 from a catastrophic failure of the MWR north wall. The failure was restricted to the north wall as a limiting case.

7.2.4 Hydraulic Conductivity

Assumption: A new hydraulic conductivity zone was introduced for the concrete slab below the MWR to allow for a fixed 0.1 percent leakage from the MWR (Figure 2CC-259). For all cases but Case 4, which simulates the effect of sea-level rise, the hydraulic conductivity of the MWR bottom reservoir slab was assumed to be 1.46E-06 cm/s. For Case 4, the hydraulic conductivity of the MWR bottom reservoir slab was assumed to be 1.58E-06 cm/s.

> Rationale: The assumption of a 0.1 percent leakage is based on a general recommendation of no more than a 1/10th of one-percent volume loss per day for concrete-lined reservoirs (Reference 39). Therefore, assuming the MWR volume is approximately 300,000,000 gallons, the allowable leakage to the surrounding area is 300,000 gpd. In order to reflect a leakage of 300,000 gpd, a reservoir bottom slab hydraulic conductivity of 1.46E-06 cm/s was implemented in the model. Lateral leakage and vertical leakage from the MWR were assessed using ZoneBudget (Reference 32), which is discussed in Section 7.4.

7.3 Sea-Level Rise Boundary Conditions

In Case 4, general head and river boundary conditions were revised to evaluate the impact of expected long-term sea-level rise on groundwater levels in the nuclear island areas.

Assumption: For the simulation that considers sea-level rise (Case 4), a sea-level rise of 1 foot over the seasonal high water value of 0.09 feet (1 foot + 0.09 feet NAVD 88 = 1.09 feet NAVD 88) was assumed for general head boundary conditions in Biscayne Bay.

> Rationale: As discussed in FSAR Subsection 2.4.5.2.2.1, the long-term sea-level rise trend is 0.78 feet in 100 years. Therefore, a conservative sea-level rise estimate of 1 foot was assumed for this analysis. The seasonal high water level of elevation 0.09 feet NAVD 88 for Biscayne Bay is documented in Reference 10.

Assumption: For Case 4, general head and river boundary conditions were based on a sea level elevation of 1.09 feet NAVD 88.

> Rationale: For the FPL site, head values for general head boundary conditions and river boundary conditions vary with sea level fluctuations. Water levels in the cooling water canals, L-31E Canal, Card Sound Canal, and Model Land Canal (C-107) were adjusted based on the water level in Biscayne Bay. The general head and river boundary conditions for the sea-level rise case were 1.9 feet higher than those for the base-case simulation.

For this case, a sea-level rise of 1 foot is added to the seasonal high sea level of 0.09 feet NAVD 88, whereas the long-term average value is -0.81 feet NAVD 88 (Sections 5.1 and 5.2).

7.4 ZoneBudget

ZoneBudget (Reference 32) was used to assess lateral and vertical leakage from the MWR. ZoneBudget was used in conjunction with the MWR leakage and sidewall assumptions that are discussed in Section 7.2.

Assumption: Three zones were introduced into the model to assess leakage from the MWR. A zone was created to represent the MWR. A separate zone was created to represent the area beyond the MWR sidewalls. A zone was also created below the MWR bottom reservoir slab.

Rationale: As discussed in Section 7.2, a target vertical leakage of 0.1 percent of the reservoir capacity (300,000 gpd) was assumed for the predictive model simulations. ZoneBudget values indicate negligible (<0.1 percent) lateral leakage. The ZoneBudget analysis also indicates that the target vertical leakage of 300,000 gpd was achieved for all simulation cases within 1 percent.

8.0 PHASE 2 POST-CONSTRUCTION SIMULATIONS

The Phase 2 simulations include four post-construction simulations (Case 1 through Case 4). Each case is described below. A summary of the simulated maximum water table elevations is provided in Table 2CC-213.

For estimating maximum water table elevations, six observation points were incorporated into Layer 1 of the model at the northwestern corner of each unit, inside the diaphragm wall (Figure 2CC-260). Observation points were placed at these locations due to the northwest to southeast gradient that was observed in Figure 2CC-262. The gradient indicates that higher water table elevations are expected to occur at the northwest corner of each unit.

Case 1: Base-case model with K_{95}=1.0E-02 cm/s (Figure 2CC-258). Recharge rates for the uppermost active layer are provided in Figure 2CC-257. The same recharge assumption is applied for Cases 3 and 4. Post-construction water table elevations for the Units 6 & 7 nuclear islands and surrounding areas assuming K_{95}=1.0E-02 cm/s are shown in Figure 2CC-262. The figure indicates a northwest to southeast hydraulic gradient across the site. Table 2CC-213 and Figure 2CC-262 indicate water table elevations of approximately 2 feet NAVD 88 in the Units 6 & 7 nuclear island areas for the base-case simulation. Model observation points indicate maximum water table elevations of 2.07 feet NAVD 88 within the Units 6 & 7 nuclear islands. The water table mounds within the diaphragm walls because recharge occurring within the perimeter of these walls (Figure 2CC-256) is constrained laterally on all sides by the diaphragm walls and vertically by the underlying concrete fill. Outside the nuclear island areas, however, water table elevations range from approximately -0.4 to -0.9 feet NAVD 88. As shown in Figure 2CC-262, the simulation does not indicate water table mounding in the area between the Units 6 & 7 nuclear islands. Mounding does not occur in this region because recharge entering the groundwater system between the two nuclear islands is constrained to the east and west by the Units 6 & 7 diaphragm walls, respectively, but is not constrained to the north, south or vertically downward by any low hydraulic conductivity material. Therefore,

groundwater recharged in this area can flow to the north, south or downward through the relatively high hydraulic conductivity fill and native materials.

Case 2: Sensitivity case for high recharge rates for grass and gravel (46.75 in/yr for each surface type) (Figure 2CC-257). Maximum post-construction water table elevations with a higher rate of non-paved recharge (46.75 in/yr) were estimated to be 2.34 feet NAVD 88 within the Units 6 & 7 nuclear islands (Table 2CC-213).

Case 3: Simulation of a catastrophic failure of the MWR north wall. The collapse was limited to the north wall as a limiting case with respect to the potential impact on Units 6 & 7. Maximum post-construction water table elevations assuming a failure of the MWR north wall were estimated to be 2.07 feet NAVD 88 within the Units 6 & 7 nuclear islands (Table 2CC-213). Because of its high hydraulic conductivity, the Miami Limestone acts as a sink for water released from the location of the north wall. Consequently, the effects of a catastrophic failure only extend a couple of hundred feet from the MWR and do not influence water levels in the nuclear island areas. Simulated groundwater contours for Case 3 are provided in Figure 2CC-263.

Case 4: Simulation assuming sea-level rise at the Units 6 & 7 site. The assumptions for this simulation are discussed in Section 7.3. Maximum post-construction water table elevations assuming sea-level rise were estimated to be approximately 2.10 feet NAVD 88 at the Units 6 & 7 nuclear islands (Table 2CC-213). Outside of the Units 6 & 7 plant area, some areas of inland flooding occurred for this case for land elevations below 1.09 feet NAVD 88. Simulated groundwater contours on the Units 6 & 7 plant area are provided in Figure 2CC-264.

9.0 CONCLUSIONS

A steady-state, constant-density, three-dimensional model was developed to simulate groundwater flow at the Turkey Point Units 6 & 7 Site. The model was developed and calibrated using available historic data and data collected in support of the Combined License Application (COLA).

The groundwater model was developed in two phases. Phase 1 evaluates groundwater control options for construction of Units 6 & 7 and also simulates the operation of a radial collector well system to serving as a temporary source of makeup water. The Phase 2 model simulates operational MWR leakage, the failure of the MWR north wall and the effect of sea-level rise on groundwater

elevations at Units 6 & 7. Phase 2 simulations include post-construction features not represented in Phase 1.

The Phase 1 calibrated model was used to simulate construction dewatering for the Unit 6 and Unit 7 nuclear islands. Calculated pumping rates to enable dry working conditions are 96 gpm for each excavation, when each unit is constructed separately. These simulations for groundwater control involve injecting grout between the bottom of the excavation and the bottom of the cut-off wall and using sump pumps in the base of the excavation to remove seepage through the grout plug into the excavation.

The Phase 1 model was also used to determine the origin of water supplying the radial collector wells by a combination of particle tracking and evaluating flows through different parts of the model. These simulations indicate that approximately 97.8 percent of the pumped water will originate from Biscayne Bay while the remainder will originate from inland.

For Phase 2 simulations, water table elevations satisfied the Design Control Document (DCD) criteria for normal water level elevation of up to 2 feet below plant elevation for the Westinghouse Advanced Passive 1000 (AP1000). For all simulations, maximum post-construction water table elevations within the nuclear islands were estimated to be approximately 2 feet NAVD 88 (Table 2CC-213). The maximum increase in water table elevations under Units 6 & 7 with high recharge near Units 6 & 7 was estimated to be approximately 0.3 feet higher than the base-case simulation. The maximum increase in water table elevations at Units 6 & 7 with sea-level rise was estimated to be approximately 0.03 feet higher than the base-case simulation.

10.0 REFERENCES

1. Southeastern Geological Society, *Hydrogeological Units of Florida*, Special Publication 28, Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986.

2. Dames & Moore, *Geohydrologic Conditions Related to the Construction of Cooling Ponds*, *Florida Power & Light Company, Steam Generating Station, Turkey Point, Florida*, prepared for Brown and Root, Inc., 1971.

3. MACTEC Engineering and Consulting, Inc., *Final Data Report—Geotechnical Exploration and Testing: Turkey Point COL Project Florida City, Florida*, Rev. 2, included in COL Application Part 11, October 6, 2008.

4. HDR Engineering, Inc., *Turkey Point Exploratory Drilling and Aquifer Performance Test Program*, prepared for Florida Power & Light Company, August 2009. Available at http://publicfiles.dep.state.fl.us/Siting/Outgoing/FPL_Turkey_Point/Units_6_7/Completeness/Plant_Associated_Facilities/1st_round_Completeness/FPL_Response_1st_Incompleteness/Attached%20Reports/HDR/Aquifer%20Performance%20Test_August-2009Report_HDR%20APT_FPL_081909.pdf, accessed October 17, 2011.

5. JLA Geosciences Inc., *Geology and Hydrogeology Report for FPL Turkey Point Plant Groundwater, Surface Water, & Ecological Monitoring Plan,* 2010. Available at http://www.sfwmd.gov/portal/page/portal/xrepository/sfwmd_repository_pdf/fpl_tp_geo_and_h2ogeo_rept.pdf, accessed October 17, 2011.

6. Dames & Moore, *Florida Aquifer Water Supply Investigation, Turkey Point Area, Dade County, Florida*, prepared for Florida Power & Light Company, 1975.

7. Florida Geological Survey, Lithologic Database, 2008. Available at http://www.dep.state.fl.us/geology/gisdatamaps/litholog.htm, accessed September 6, 2008.

8. Reich, C., R. Halley, T. Hickey, and P. Swarzenski, *Groundwater Characterization and Assessment of Contaminants in Marine Areas of Biscayne National Park*, Technical Report/NPS/NRWRD/NRTR-2006/356, 2006. Available at http://sofia.usgs.gov/publications/reports/bisc_gw_char/Bisc_gw_char.pdf, accessed May 17, 2012.

9. Florida Power & Light Company, *FPL Turkey Point Power Plant Groundwater, Surface Water, and Ecological Monitoring Plan,* Exhibit B. October 2009. Available at http://publicfiles.dep.state.fl.us/siting/Outgoing/FPL_Turkey_Point/Units_6_7/Completeness/Plant_Associated_Facilities/2nd_round_Completeness/FPL_Response_Part_A_Information/Attachments/2nd%20Round%20Attachments/101409%20Final%20Turkey%20Point%20Monitoring%20Plan.pdf, accessed November 10, 2010.

10. National Oceanic and Atmospheric Administration,*Tides & Currents Virginia Key, FL #8723214 web page* 2010. Available at http://

tidesandcurrents.noaa.gov/station_info.shtml?stn=8723214%20Virginia%20Key,%20FL, accessed October 13, 2010.

11. Langevin, C., *Simulation of Ground-Water Discharge to Biscayne Bay, Southeastern Florida*, U.S. Geological Survey, Water-Resources Investigations Report 00-4251, 2001.

12. South Florida Water Management District. *South Florida Water Management District DBHYDRO database query, Station S20F,* 2010. Available at http://www.sfwmd.gov/dbhydroplsql/show_dbkey_info.date_selection?v_js_flag=Y&v_db_request_id=2802506&v_parameter_string=&v_dbkey=05816%2FVN225%2FK8666%2F16692&v_frequency=&v_sdate=19680522&v_edate=20101025, accessed October 14, 2010.

13. Harbaugh, A., E. Banta, M. Hill, and M. McDonald, MODFLOW-2000, The U.S. Geological Survey Modular Ground-Water Model — User Guide to Modularization Concepts and the Ground-Water Flow Process, U.S. Geological Survey, Open-File Report 00-92, 2000. Available at http://pubs.er.usgs.gov/usgspubs/ofr/ofr200092, accessed September 30, 2008.

14. McDonald, M, and A. Harbaugh. *A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model,* U.S. Geological Survey, Open-File Report 83-875, 1984. Available at http://pubs.er.usgs.gov/usgspubs/ofr/ofr83875, accessed September 29, 2008.

15. McDonald, M. and A. Harbaugh,. *Chapter A1 — A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model,* Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 6, Modeling Techniques, 1988. Available at http://pubs.er.usgs.gov/usgspubs/twri/twri06A1, accessed September 29, 2008.

16. Schlumberger Water Services. *Visual MODFLOW Professional Ver. 4.3*, User's Manual, 2008.

17. National Oceanic and Atmospheric Administration, Coastal Services Center, *Topographic and Bathymetric Data Considerations: Datums, Datum Conversion Techniques and Data Integration, Part II: A Roadmap to a Seamless Topobathy Surface*, Technical Report NOAA/CSC/20718-PUB, 2008.

18. National Oceanic and Atmospheric Administration, *VDatum — Online User's Guide*. Available at http://vdatum.noaa.gov/docs/usersguide.html, accessed October 13, 2010.

19. National Oceanic and Atmospheric Administration, *FME SpatialDirect*, Office of Coast Survey Harbor Sounding2010. Available at http://ocs-spatial.ncd.noaa.gov/SpatialDirect/translationServlet?SSFunction=prepareFetch, accessed May 13, 2010.

20. Renken, R., K. Cunningham, A. Shapiro, R. Harvey, M. Zygnerski, D. Metge, and M. Wacker, *Pathogen and Chemical Transport in the Karst Limestone of the Biscayne Aquifer: 1. Revised Conceptualization of Groundwater Flow*, Water Resources Research, Vol. 44, 2008.

21. Fish and Wildlife Research Institute, Marine Resources Geographic Information System GIS Data, Benthic Habitats — South Florida. Available at http://ocean.floridamarine.org/mrgis_ims/Description_Layers_Marine.htm, accessed June 25, 2010.

22. Cunningham, K., J. Carlson, G. Wingard, E. Robinson, and M. Wacker,*Characterization of Aquifer Heterogeneity Using Cyclostratigraphy and Geophysical Methods in the Upper Part of the Karstic Biscayne Aquifer, Southeastern Florida*, U.S. Geological Survey, Water-Resources Investigations Report 03-4208, 2004.

23. Cunningham, K., M. Wacker, E. Robinson, J. Dixon, and G. Wingard, *A Cyclostratigraphic and Borehole-Geophysical Approach to the Development of a Three-Dimensional Conceptual Hydrogeologic Model of the Karstic Biscayne Aquifer, Southeastern Florida*. U.S. Geological Survey, Scientific Investigations Report 2005-5235, 2006.

24. Cunningham, K., M. Sukop, H. Huang, P. Alvarez, H. Curran, R. Renken, and J. Dixon, *Prominence of Ichnologically Influenced Macroporosity in the Karst Biscayne Aquifer: Stratiform "Super-K" Zones,* Geological Society of America Bulletin, Vol. 121, No. 1/2, pp. 164–180, 2009.

25. Fetter, C., *Applied Hydrogeology*, 3d ed., Prentice Hall, 1994.

26. Rice, R. and J. Walton, *Design Factors Affecting the Flow of Water through Below-Ground Concrete Vaults*, Journal of Environmental Engineering Vol. 132, No. 10, pp. 1346–1354, October 2006,

27. Warner, J., *Practical Handbook of Grouting: Soil, Rock, and Structures,* John Wiley and Sons, 2004.

28. Weaver, K. and D. Bruce, *Dam Foundation Grouting, Revised and Expanded Edition*, American Society of Civil Engineers, Subsection 14.2.1 Permeability Criteria, 2007.

29. Gamble, B. and S. Stowe, *Approaches to Modeling Collector Wells and Horizontal Wells with MODFLOW,* MODFLOW and More 2008: Groundwater and Public Policy, Conference proceedings, pp. 489–493, 2008.

30. HDR Engineering Inc., *Cooling Water Supply and Disposal Conceptual Design Report — Florida Power & Light Proposed Units 6 & 7 at Turkey Point — March 2009*. Available at http://publicfiles.dep.state.fl.us/Siting/Outgoing/FPL_Turkey_Point/Units_6_7/Completeness/Plant_Associated_Facilities/1st_round_Completeness/FPL_Response_1st_Incompleteness/Attached%20Reports/HDR/Cooling%20Water_%20March-2009/Report_HDR_CoolingWater_ConceptualDesign.pdf, accessed October 17, 2011.

31. Pollock, D., User's Guide for MODPATH/MODPATH-PLOT, *Version 3: A Particle Tracking Post-Processing Package for MODFLOW, the U.S. Geological Survey Finite-Difference Ground-Water Flow Model* U.S. Geological Survey, Open-File Report 94-464, 1994. Available at http://water.usgs.gov/software/MODPATH/code/doc/ofr94464.pdf, accessed January 31, 2011.

32. Harbaugh, A., *A Computer Program for Calculating Subregional Water Budgets Using Results from the U.S. Geological Survey Modular Three-Dimensional Ground-Water Flow Model*, U.S. Geological Survey, Open-File Report 90-392, 1990.

33. Hsieh, P., and J. Freckleton, *Documentation of Computer Program to Simulate Horizontal-Flow Barriers Using the United States Geological Survey's Modular Three-Dimensional Finite-Difference Ground-Water Flow Model,* U.S. Geological Survey, Open-File Report 92-477, 1993. Available at http://water.usgs.gov/nrp/gwsoftware/modflow2005/ofr92_477_HFB.pdf, accessed May 27, 2009.

34. McVay, M., and J. Ko, *Evaluating Thick Lift Limerock-Base Course SR-826*, Miami, Florida, FDOT No. C-7984, April 2005.

35. Freeze, R., and J. Cherry, *Groundwater*, Prentice Hall, Englewood Cliffs, New Jersey, 1979.

36. Bear, J., *Hydraulics of Groundwater*, originally published by McGraw-Hill, Dover edition reprint, published in 2007, Mineola, New York, 1979.

37. Carman, P., *Fluid Flow Through a Granular Bed*, Transactions of the Institution of Chemical Engineers, London, 15, pp. 150–156, 1937.

38. Jury, W., W. Gardner, and W. Gardner, *Soil Physics*, 5th ed., John Wiley and Sons, Inc., New York, 1991.

39. American Concrete Institute, *Tightness Testing of Environmental Concrete Structures* (ACI 350.1/350.1R-7), Chap., Hydrostatic Test, HST, For Open or Covered Tanks, 2010.

40. Krupa, A., and M. Mullen, *Literature Review And Assessment Of Geologic Logs To Determine The Extent Of A Dense Limestone Layer In The Upper Portion Of The Biscayne Aquifer In The Pennsuco Wetlands, Miami-Dade County, Florida,* 2005.

41. Sonenshein, R., *Methods to Quantify Seepage Beneath Levee 30, Miami-Dade County, Florida*, U.S. Geological Survey, Water-Resources Investigations Report 2001-4074, 2001.

42. Merritt, M., *Simulation of the Water-Table Altitude in the Biscayne Aquifer, Southern Dade County, Florida, Water Years 1945-89*, U.S. Geological Survey, Water Supply Paper 2458, 1996.

43. Swain, E., B. Howie, and J. Dixon, *Description and Field Analysis of a Coupled Ground-Water/Surface-Water Flow Model (MODFLOW/BRANCH) with Modifications for Structures and Wetlands in Southern Dade County, Florida*, U.S. Geological Survey, Water-Resources Investigations Report 1996-4118, 1996.

44. Fish, J. and M. Stewart, *Hydrogeology of the Surficial Aquifer System, Dade County, Florida*, U.S. Geological Survey, Water-Resources Investigations Report 90-4108, 1991.

Table 2CC-201
Station S20F: Rainfall Data for February to May 2009

2009		Total Precipitation (inches)
Month	**Days**	**VN225**
Feb	28	0.34
Mar	31	3.72
Apr	30	0.27
May	31	9.63
Total	120	13.96

Rounded to nearest tenth	14.0	
Scaled to Year	**42.6**	**in/yr**

Source: Based on Reference 12.

Table 2CC-202
Station S20F: Annual Rainfall Data

Water Year	Precipitation (inches)					Combined Series (inches)
	BELF 5618	OMD 16692	TELE K866	NRG VN225	Recorder Selected	
1969	67.52				BELF	67.52
1970	40.67				BELF	40.67
1971	32.16				BELF	32.16
1972	54.38				BELF	54.38
1973	40.60				BELF	40.60
1974	35.48				BELF	35.48
1975	43.08				BELF	43.08
1976	43.68				BELF	43.68
1977	43.89				BELF	43.89
1978	38.06				BELF	38.06
1979	33.89				BELF	33.89
1980	41.17				BELF	41.17
1981	45.46				BELF	45.46
1982	46.19				BELF	46.19
1983	59.62				BELF	59.62
1984	36.92				BELF	36.92
1985	37.37				BELF	37.37
1986	38.75				BELF	38.75
1987	41.54				BELF	41.54
1988	73.31				BELF	73.31
1989	46.84				BELF	46.84
1990	39.89				BELF	39.89
1991	40.41				BELF	40.41
1992	46.26	60.38			OMD	60.38
1993	38.59	36.18			OMD	36.18
1994	55.10	60.06			OMD	60.06
1995	74.75	86.11			OMD	86.11
1996	49.55	49.56			OMD	49.56
1997	53.25	49.98			OMD	49.98
1998	48.01	57.41	64.32		OMD/TELE	60.87
1999	36.46	44.62	44.90		OMD/TELE	44.76
2000	38.87	41.23	41.64		OMD/TELE	41.44
2001	57.35	47.41	47.66		OMD/TELE	47.54
2002		48.91	48.48		OMD/TELE	48.70
2003		43.75	43.48		OMD/TELE	43.62
2004		32.60	32.90		OMD/TELE	32.75
2005		47.91	44.98		OMD/TELE	46.45
2006		44.54	44.97		OMD/TELE	44.76
2007		51.14	51.42		OMD/TELE	51.28
2008		44.11	45.47	45.61	NRG	45.61
2009		44.89	44.00	45.86	NRG	45.86

Average 46.75 in/yr

Source: Based on Reference 12.

Table 2CC-203
Extinction Depth and Maximum Evapotranspiration Rate

Land-use category	Runoff Coefficient	Extinction depth (m)
Urban	0.5	0.3
Agriculture	0.5	0.43
Rangelend	0.2	0.7
Upland forests	0.2	0.7
Water	0	0.183
Wetlands	0	0.69
Barren land	0	0.15
Transportation	0.5	0.3

	January	February	March	April	May	June–October	November	December
Maximum evapotanspiration rate (cm/d)	0.20	0.28	0.36	0.43	0.46	0.53	0.30	0.28

Source: Based on Reference 11.

Table 2CC-204
Regional Hydraulic Conductivity Values Based on Onsite Tests and Literature Review

	FPL Onsite Tests				Literature Review							
HG Unit	Kh min	Kh max	Kv min	Kv max	Kh min	Ref	Kh max	Ref	Kv min	Ref	Kv max	Ref
Offshore Sediment												
Onshore Muck			*2.5E-04*	*2.5E-04*	3.5E-05	40	1.8E-02	41	3.5E-04	11	1.8E-03	41
Miami Limestone	7.9E-02	7.9E-02	5.0E-03	8.0E-03	3.5E-05	40	1.1E+01	42	3.5E-02	41	1.1E+00	43
Upper Higher Flow Zone												
Key Largo	3.3E+00	1.8E+01			1.1E+00	41	3.5E+01	44	1.1E-01	41		
Freshwater Limestone			7.0E-05	3.0E-03	3.5E-05	40	3.5E-04	41	3.5E-05	41	3.0E-03	40
Lower Higher Flow Zone												
Fort Thompson	1.0E.-01	1.6E+00			1.8E-01	42	1.1E+01	42	1.8E-02	43	1.1E+00	43
Tamiami Formation			3.0E-02	4.0E-01	3.5E-05	43	7.1E-01	44	3.5E-06	43	7.1E-03	41

Notes: Hydraulic conductivity values are in cm/s.
Italicized values indicate instances where only one hydraulic conductivity value was available and thus the maximum and minimum values are equal.

Table 2CC-205
Surface Water Levels Corrected to Reference Density

Surface Water Feature	Location	Base of Canal (ft NAVD 88)	Canal Stage (ft NAVD 88)	Water Type	Water Density (kg/m^3)	Reference Head (ft NAVD 88)
Interceptor Ditch	CHD of -0.28	-19.2	-0.28	FW	996.70	-0.76
Interceptor Ditch	Start of variable H	-19.2	-0.18	FW	996.70	-0.66
Interceptor Ditch	End of variable H	-19.2	-1.05	FW	996.70	-1.51
L-31E	All	-22.8	0.02	FW	996.70	-0.55
Southern Portion of Grand Canal Outside the CCS	All	-21.2	-1.05	SALINE	1022.40	-1.05
C-106	All	-14	-1.05	SALINE	1022.40	-1.05
E-W Release Canal	H = 1.28	-21.2	1.28	CCS	1048.00	1.84
E-W Release Canal	H = 1.08	-21.2	1.08	CCS	1048.00	1.64
N-S Shallow Canal	H = 1.08	-3.02	1.08	CCS	1048.00	1.18
N-S Shallow Canal	H = -1.05	-3.02	-1.05	CCS	1048.00	-1.00
E-W Collector	All	-21.2	-1.05	CCS	1048.00	-0.55
Grand Canal	Top	-21.2	-3.18	CCS	1048.00	-2.73
Grand Canal	Bottom	-21.2	-1.05	CCS	1048.00	-0.55
E. Return Canal	Top	-19.2	-3.18	CCS	1048.00	-2.78
E. Return Canal	Bottom	-19.2	-1.05	CCS	1048.00	-0.60
Units 6 & 7 plant area	SW	-21.2	-3.18	CCS	1048.00	-2.73
Units 6 & 7 plant area	NE	-21.2	-3.28	CCS	1048.00	2.83
Intake Basin	NE Units 6 & 7 plant area	-21.2	-3.28	CCS	1048.00	-2.83
Intake Basin	Pumps	-21.2	-3.38	CCS	1048.00	-2.93

FW — Freshwater
CCS — Hypersaline

FW ρ	996.7	kg/m^3
Ref ρ (Bisc. Bay)	1022.4	kg/m^3
CCS ρ	1048.0	kg/m^3

Table 2CC-206
Model Calibration — Hydraulic Conductivity

	Hydraulic Conductivity (cm/s)		
HG Unit	**Kh**	**Kv**	**Anisotropy Ratio**
Offshore Sediment	3.53E-02	2.4E-03	15:1
Onshore Muck	4.4E-03	4.4E-04	10:1
Miami Limestone	8.8E-02	5.9E-03	15:1
Upper Higher Flow Zone	3.0E+01	3.7E+00	8:1
Key Largo SW	5.9E+00	7.4E-01	8:1
Key Largo NE	1.0E+01	1.3E+00	8:1
Freshwater Limestone	3.4E-05	2.3E-06	15:1
Lower Higher Flow Zone	1.7E+00	1.7E-01	10:1
Fort Thompson	3.3E-01	3.3E-02	10:1
Tamiami Formation	2.8E-04	2.8E-05	10:1

Table 2CC-207
Model Calibration PW-7L — Measured Versus Simulated Drawdowns (at end of test)

				DRAWDOWN (ft)				
Well	**HG Unit**	**Easting**	**Northing**	**Observed**	**Calculated**	**Ri (Obs-Calc)**	$\lvert Ri \rvert$	$\lvert Ri \rvert^{2}$
C7-2A	**Miami Limestone**	875822.2	396944.9	0.31	0.48	-0.18	0.18	0.03
C7-2C	**Tamiami Formation**	875822.2	396944.9	1.54	1.19	0.35	0.35	0.12
C7-2D	**Key Largo Limestone**	875817.3	396944.9	0.34	0.49	-0.15	0.15	0.02
C7-2E	**Fort Thompson Formation**	875817.3	396944.9	3.56	4.44	-0.87	0.87	0.76
C7-3A	**Miami Limestone**	875922.4	396960.2	0.32	0.48	-0.16	0.16	0.03
C7-3C	**Tamiami Formation**	875822.4	396960.2	2.91	1.21	1.70	1.70	2.89
C7-3D	**Key Largo Limestone**	875817.2	396959.9	0.35	0.49	-0.14	0.14	0.02
C7-3E	**Fort Thompson Formation**	875817.2	396959.9	4.96	6.10	-1.15	1.15	1.32
C7-4A	**Miami Limestone**	875822.3	396975.2	0.32	0.48	-0.16	0.16	0.03
C7-4C	**Tamiami Formation**	875822.3	396975.2	2.03	1.22	0.81	0.81	0.66
C7-4E	**Fort Thompson Formation**	875817.3	396974.3	11.40	9.37	2.03	2.03	4.13
C7-5A	**Miami Limestone**	875829.5	396984.1	0.32	0.48	-0.16	0.16	0.02
C7-5D	**Key Largo Limestone**	875828.1	396989.3	0.38	0.48	-0.10	0.10	0.01
C7-5E	**Fort Thompson Formation**	875828.1	396989.3	12.61	10.85	1.77	1.77	3.12
PW-7L	**Fort Thompson Formation**	875819.4	396985.1					

Difference	**12.30**	**10.37**	Number	**14**	**14**
Maximum	**12.61**	**10.85**	Total	**9.72**	**13.16**
Minimum	**0.31**	**0.48**	ARM	**0.69**	
			RMS		**0.97**
			NRMS (%)		**7.9**
			M_d (%)		**0.00**

Note: Easting and Northing in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft.

Table 2CC-208
Model Calibration PW-1 — Measured Versus Simulated Drawdowns (at the end of test)

				DRAWDOWN (ft)				
Well	**HG Unit**	**Easting**	**Northing**	**Observed**	**Calculated**	**Ri (Obs-Calc)**	**|Ri|**	**|Ri|^2**
MW-1A	Miami Limestone	880083.2	401545.1	0.78	0.74	0.04	0.04	0.00
MW-1B	Key Largo Limestone	880083.2	401545.1	0.71	0.78	-0.07	0.07	0.00
MW-1D	Fort Thompson Formation	880083.2	401545.1	0.63	0.63	0.00	0.00	0.00
MW-2B	Key Largo Limestone	880967.2	402023.5	0.19	0.17	0.02	0.02	0.00
MW-3B	Key Largo Limestone	878292.6	401339.6	0.08	0.07	0.01	0.01	0.00
MW-4B	Key Largo Limestone	878331.1	400609.9	0.09	0.06	0.03	0.03	0.00
PW-1	Key Largo Limestone	880146.6	401595.4					
			Difference	**0.70**	**0.72**	Number	**6**	**6**
			Maximum	**0.78**	**0.78**	Total	**0.18**	**0.01**
			Minimum	**0.08**	**0.06**	ARM	**0.03**	
						RMS		**0.04**
						NRMS (%)		**5.3**
						M_d (%)		**0.00**

Note: Easting and Northing in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft.

Table 2CC-209
Model Calibration PW-7U — Measured Versus Simulated Drawdowns (at end of test)

Well	HG Unit	Easting	Northing	DRAWDOWN (ft)		Ri (Obs-Calc)	|Ri|	$\|Ri\|^2$
				Observed	Calculated			
C7-1A	Miami Limestone	875829.5	396932.8	0.88	1.03	-0.15	0.15	0.02
C7-1C	Tamiami Formation	875829.5	396932.8	0.42	0.52	-0.10	0.10	0.01
C71D	Key Largo Limestone	875829.6	396937.7	2.07	1.50	0.57	0.57	0.33
C7-1E	Fort Thompson Formation	875829.6	396937.7	0.50	0.62	-0.12	0.12	0.01
C7-2A	Miami Limestone	875822.2	396944.9	0.89	1.04	-0.15	0.15	0.02
C7-2C	Tamiami Formation	875822.2	396944.9	0.42	0.52	-0.10	0.10	0.01
C7-2D	Key Largo Limestone	875817.3	396944.9	1.48	1.55	-0.07	0.07	0.01
C7-2E	Fort Thompson Formation	875817.3	396944.9	0.54	0.62	-0.08	0.08	0.01
C7-3A	Miami Limestone	875822.4	396960.2	0.75	1.02	-0.27	0.27	0.07
C7-3C	Tamiami Formation	875822.4	396960.2	0.35	0.52	-0.17	0.17	0.03
C7-3D	Key Largo Limestone	875817.2	396959.9	1.27	1.30	-0.03	0.03	0.00
C7-3E	Fort Thompson Formation	875817.2	396959.9	0.42	0.61	-0.19	0.19	0.04
C7-4A	Miami Limestone	875822.3	396975.2	0.82	1.00	-0.18	0.18	0.03
C7-4C	Tamiami Formation	875822.3	396975.2	0.44	0.52	-0.08	0.08	0.01
C7-4D	Key Largo Limestone	875817.3	396974.3	1.13	1.18	-0.06	0.06	0.00
C7-4E	Fort Thompson Formation	875817.3	396974.3	0.52	0.61	-0.09	0.09	0.01
PW--7U	Key Largo Limestone	875819.3	396935.3					

	Observed	Calculated		|Ri|	$\|Ri\|^2$
Difference	**1.72**	**1.03**	Number	**16**	**16**
Maximum	**2.07**	**1.55**	Total	**2.41**	**0.60**
Minimum	**0.35**	**0.52**	ARM	**0.15**	
			RMS		**0.19**
			NRMS (%)		**11.3**
			M_d (%)		**0.00**

Note: Easting and Northing in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft.

Table 2CC-210
Model Validation PW-6U — Measured Versus Simulated Drawdowns (at end of test)

				DRAWDOWN (ft)				
Well	HG Unit	Easting	Northing	Observed	Calculated	Ri (Obs-Calc)	|Ri|	$\|Ri\|^2$
C6-1A	Miami Limestone	876678.1	396935.4	1.46	1.37	0.08	0.08	0.01
C6-1C	Tamiami Formation	876678.1	396935.4	0.53	0.53	0.01	0.01	0.00
C6-1D	Key Largo Limestone	876677.9	396940.4	1.66	1.86	-0.20	0.20	0.04
C6-1E	Fort Thompson Formation	876677.9	396940.4	0.57	0.58	-0.01	0.01	0.00
C6-2A	Miami Limestone	876670.8	396947.3	1.34	1.39	-0.05	0.05	0.00
C6-2C	Tamiami Formation	876670.8	396947.3	0.53	0.53	0.00	0.00	0.00
C6-2D	Key Largo Limestone	876665.5	396947.4	2.08	1.95	0.13	0.13	0.02
C6-2E	Fort Thompson Formation	876665.5	396947.4	0.58	0.58	0.00	0.00	0.00
C6-3A	Miami Limestone	876670.5	396962.6	1.09	1.36	-0.27	0.27	0.07
C6-3C	Tamiami Formation	876670.5	396962.6	0.51	0.53	-0.01	0.01	0.00
C6-3D	Key Largo Limestone	876665.7	396962.5	1.30	1.60	-0.30	0.30	0.09
C6-3E	Fort Thompson Formation	876665.7	396962.5	0.50	0.58	-0.07	0.07	0.01
C6-4A	Miami Limestone	876670.9	396978.1	0.98	1.30	-0.32	0.32	0.10
C6-4C	Tamiami Formation	876670.9	396978.1	0.56	0.52	0.04	0.04	0.00
C6-4D	Key Largo Limestone	876666.0	396977.9	1.01	1.43	-0.42	0.42	0.17
C6-4E	Fort Thompson Formation	876666.0	396977.9	0.52	0.57	-0.05	0.05	0.00
PW--6U	Key Largo Limestone	876668.7	396938.0					

Difference	**1.58**	**1.43**	Number	**16**	**16**
Maximum	**2.08**	**1.95**	Total	**1.96**	**0.51**
Minimum	**0.50**	**0.52**	ARM	**0.12**	
			RMS		**0.18**
			NRMS (%)		**11.4**
			M_d (%)		**0.00**

Note: Easting and Northing in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft.

Table 2CC-211
Phase 1 — Radial Collector Wells — Origin of Water (including sensitivity analysis)

	Percent Contribution to Radial Collector Wells							
Zone	**RCW in Upper High Flow Zone (Base Case)**	**RCW in Key Largo Limestone**	**Seasonal High Water Level**	**Seasonal Low Water Level**	**Double Vertical Hyd. Cond.**	**Half Vertical Hyd. Cond.**	**Key Largo All High K (Blue)**	**Key Largo All Low K (Red)**
Biscayne Bay	97.8%	97.8%	98.1%	97.6%	99.1%	95.4%	97.6%	98.5%
Flow from inland	2.2%	2.2%	1.9%	2.4%	0.9%	4.6%	2.4%	1.5%
– Via Cooling Canal System	2.0%	2.0%	1.8%	2.1%	0.8%	3.2%	2.1%	1.4%
– Regional Eastward Flow	0.2%	0.2%	0.1%	0.3%	0.1%	1.4%	0.3%	0.2%

Note: The top two rows contr bute to the total flow and sum to 100 percent. The bottom two rows are components of inland flow. Not all component flows sum to the total inland flow due to rounding. (Blue) and (Red) in final two columns refer to the colors shown for the Key Largo hydraulic conductivity distribution shown in Figure 2CC-216.

Table 2CC-212
Phase 1 — Radial Collector Wells — Approach Velocity (including sensitivity analysis)

	Approach Velocity (cm/s)							
Zone	**RCW in Upper High Flow Zone (Base Case)**	**RCW in Key Largo Limestone**	**Seasonal High Water Level**	**Seasonal Low Water Level**	**Double Vertical Hyd. Cond.**	**Half Vertical Hyd. Cond.**	**Key Largo All High K (Blue)**	**Key Largo All Low K (Red)**
Entire RCW Catchment	3.3E-05	3.3E-05	3.2E-05	3.3E-05	3.7E-05	2.9E-05	3.2E-05	3.5E-05
Immediate RCW Area	5.2E-04	5.1E-04	5.2E-04	5.2E-04	7.3E-04	3.5E-04	5.2E-04	6.3E-04
Average of all RCW Laterals	6.2E-04	6.1E-04	6.2E-04	6.2E-04	9.2E-04	4.0E-04	6.1E-04	7.7E-04

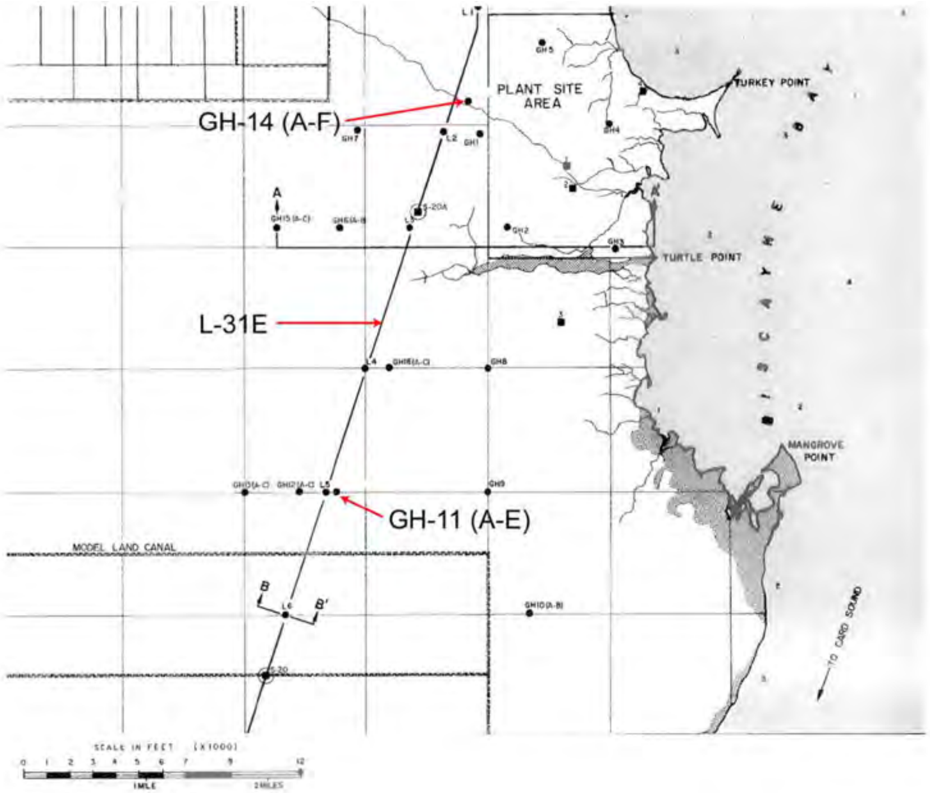
Note: (Blue) and (Red) in final two columns refer to the colors shown for the Key Largo hydraulic conductivity distribution shown in Figure 2CC-216.

Table 2CC-213
Phase 2 — Simulated Heads Observation Points in Model Layer 1 Near Units 6 & 7

SIMULATION	Head for Obs Point #1 (ft NAVD 88)	Head for Obs Point #2 (ft NAVD 88)	Head for Obs Point #3 (ft NAVD 88)	Head for Obs Point #4 (ft NAVD 88)	Head for Obs Point #5 (ft NAVD 88)	Head for Obs Point #6 (ft NAVD 88)	Maximum Head Obs. (ft NAVD 88)
Case 1: Base Case	2.01	2.05	2.07	2.01	2.05	2.07	**2.07**
Case 2: K_{95}=1.0E-02; Recharge=46.75	2.04	2.23	2.34	2.04	2.23	2.34	**2.34**
Case 3: MWR North Wall Failure	2.01	2.05	2.07	2.01	2.05	2.07	**2.07**
Case 4: Sea Level Rise	2.03	2.08	2.10	2.03	2.07	2.10	**2.10**

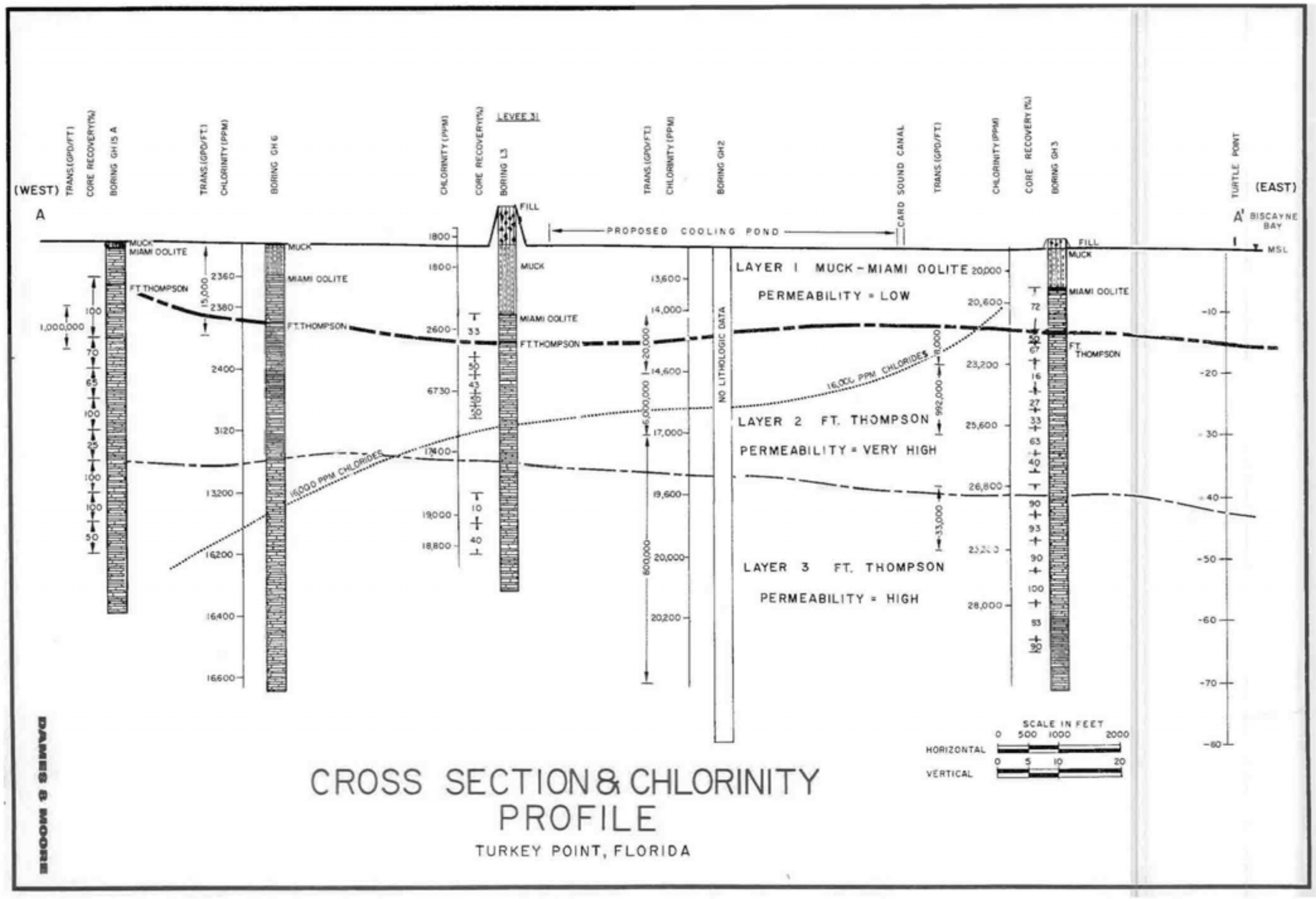
Note: Maximum water table elevations below 23.5 ft NAVD 88 satisfy the Design Control Doument (DCD) criteria. Observation points shown in Figure 2CC-260.

Figure 2CC-201 Cross Section Location



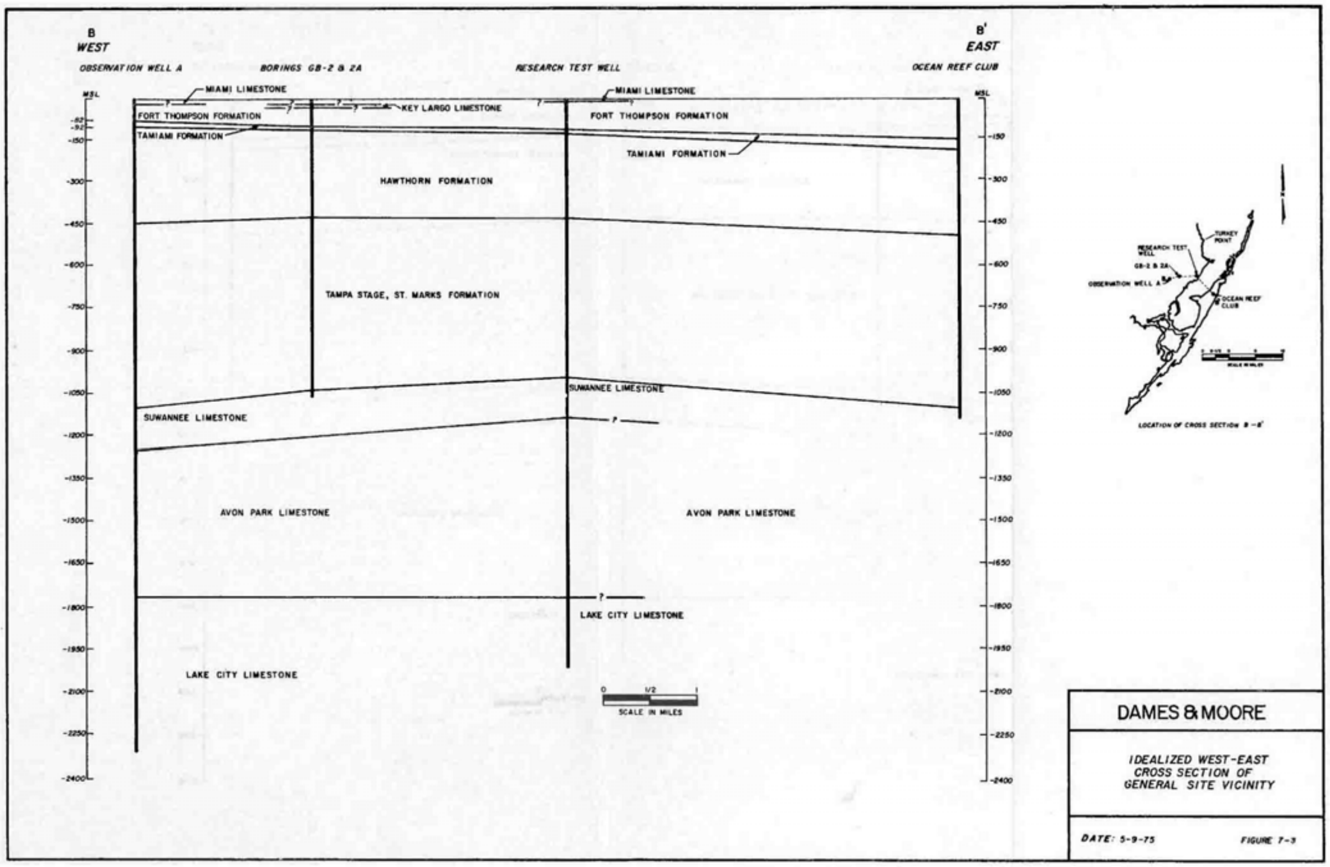
Source: Adapted from Reference 2
Note: Best available scan from original document

Figure 2CC-202 Hydrostratigraphic Cross Section A-A'



Source: Reference 2
Note: Best available scan from original document

Figure 2CC-203 West-East Cross Section in the Vicinity of the Southern End of the Turkey Point Plant Property



Source: Reference 6
Note: Best available scan from original document

Figure 2CC-204 Feasibility Geological Investigation of Potential Plant Site (2006) — Boring and Stratigraphic Cross Section Locations

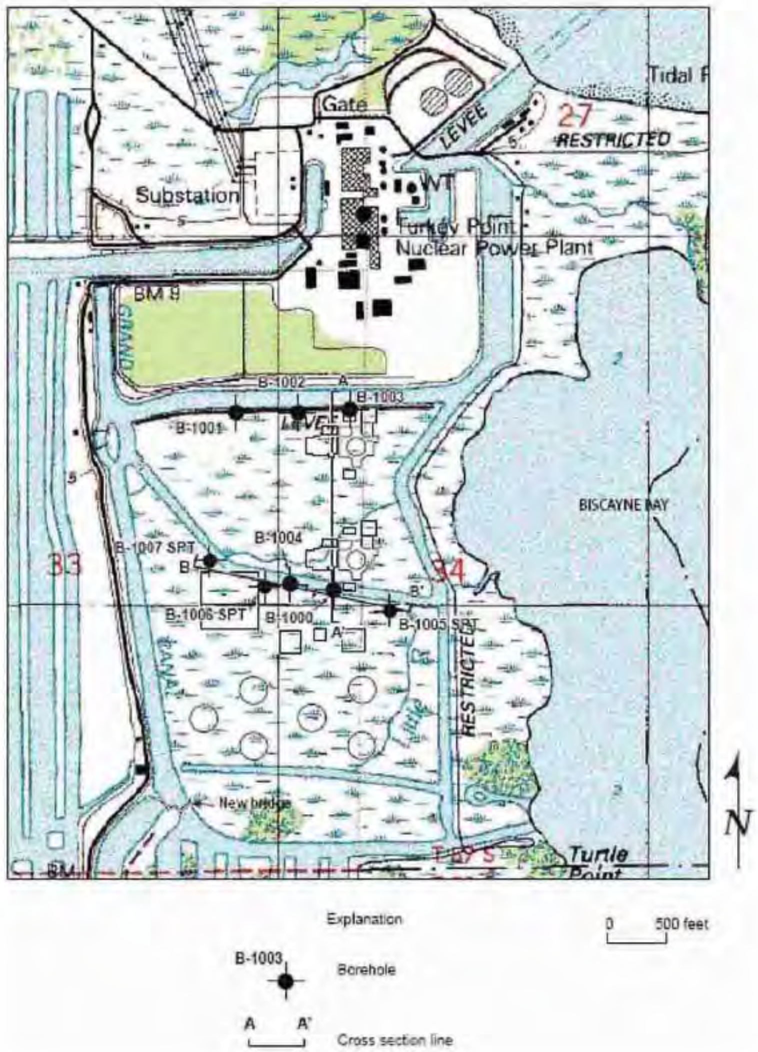


Figure 2CC-205 Feasibility Geological Investigation of Potential Plant Site (2006) — Stratigraphic Cross Section A-A'

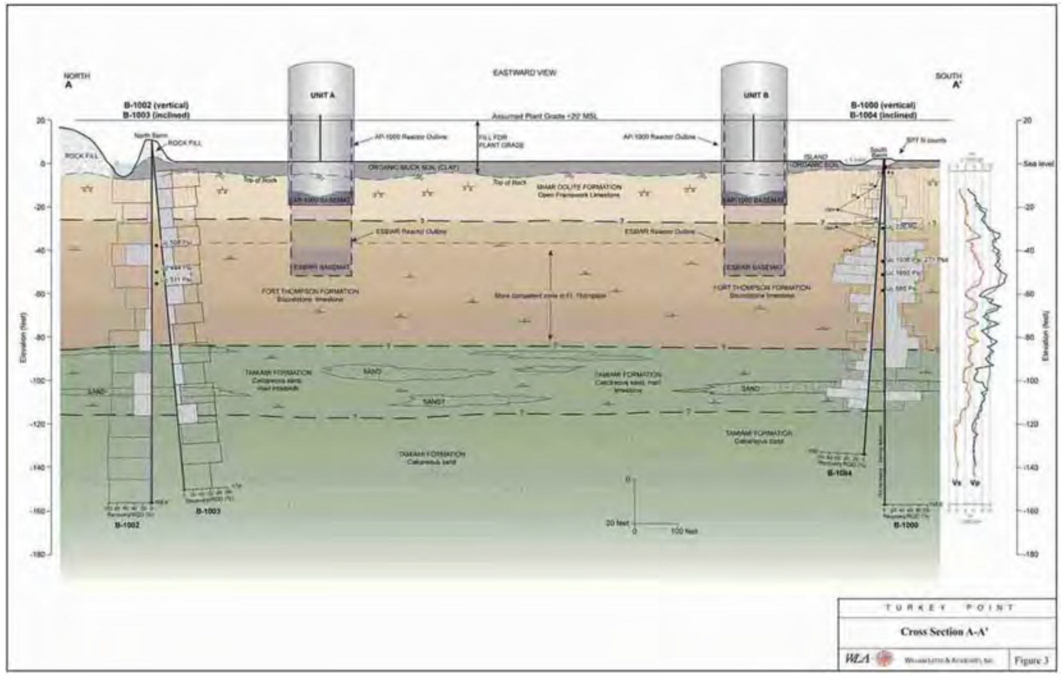


Figure 2CC-206 Feasibility Geological Investigation of Potential Plant Site (2006) — Stratigraphic Cross Section B-B’

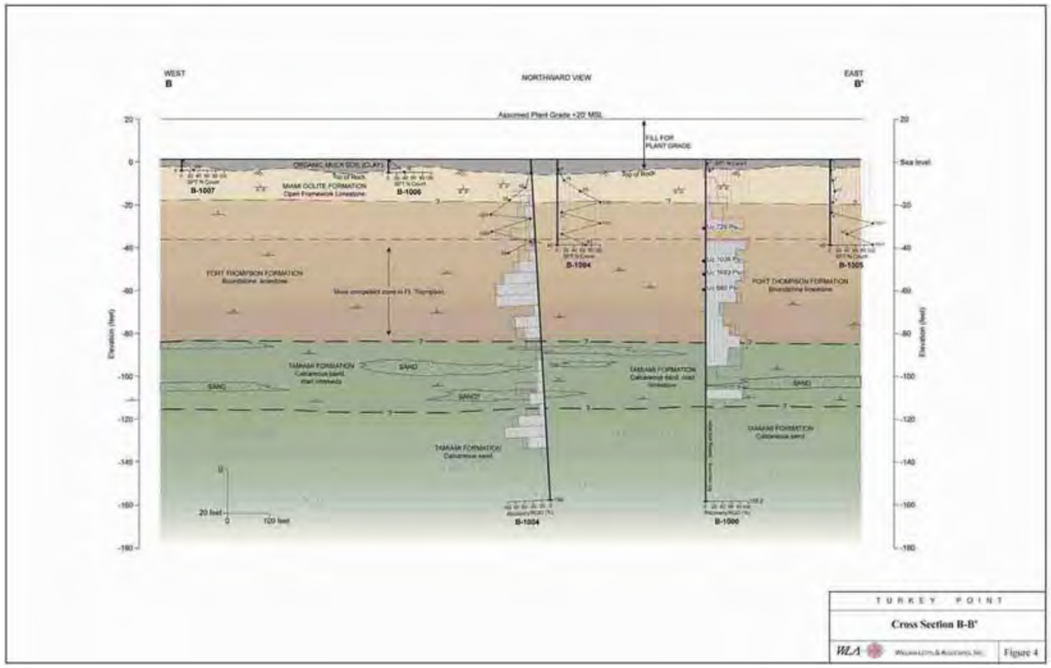


Figure 2CC-207 Stratigraphic Cross Section from Wells Drilled for Turkey Point Peninsula Aquifer Performance Test

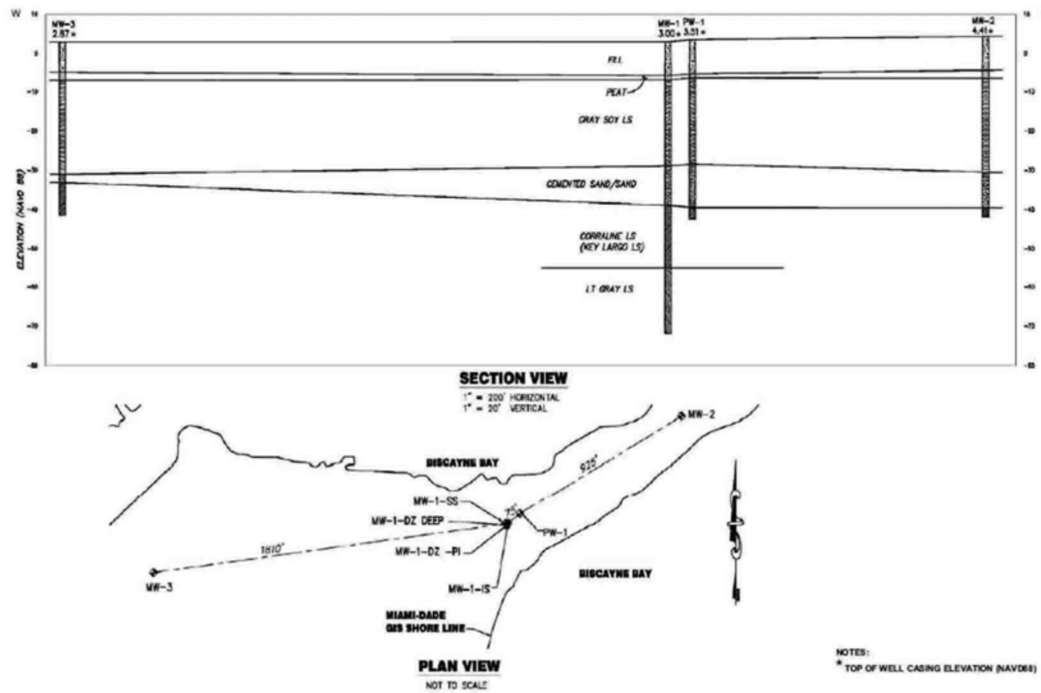
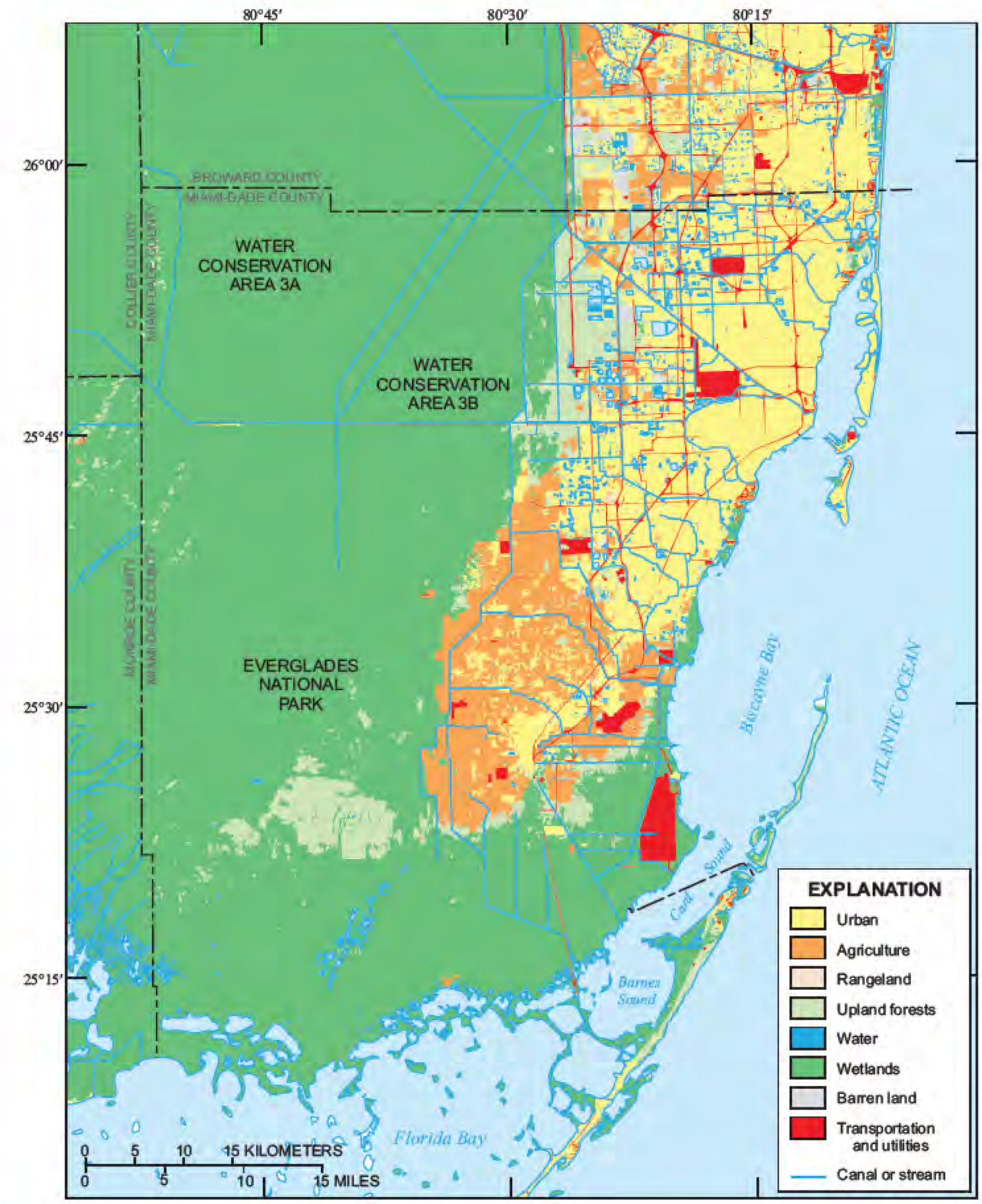
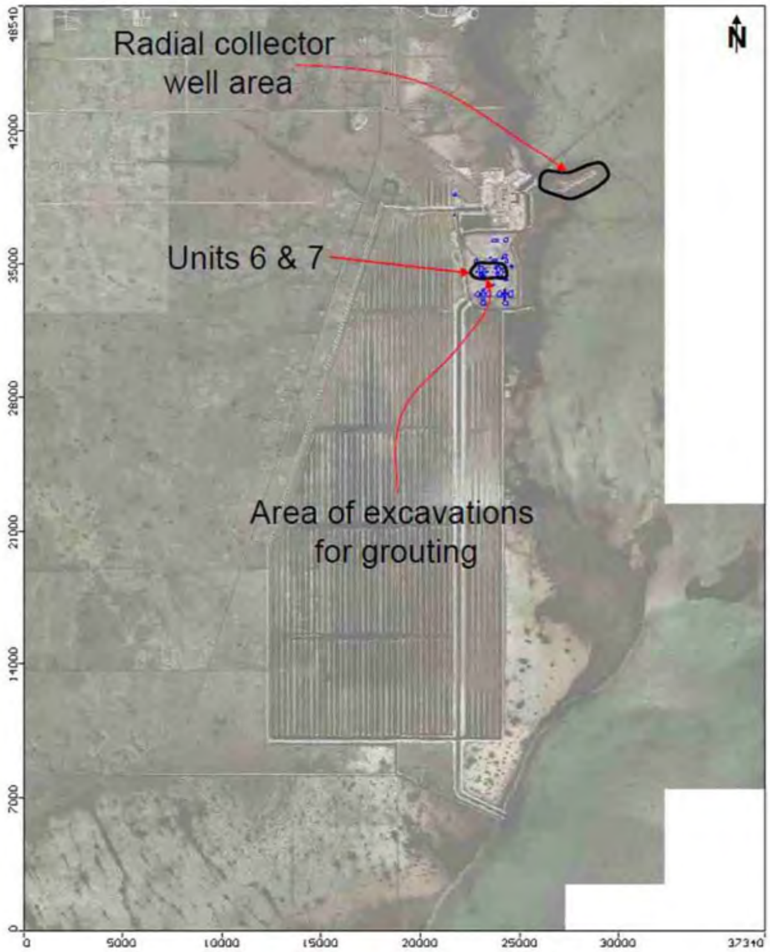


Figure 2CC-208 Land Use for Southern Florida



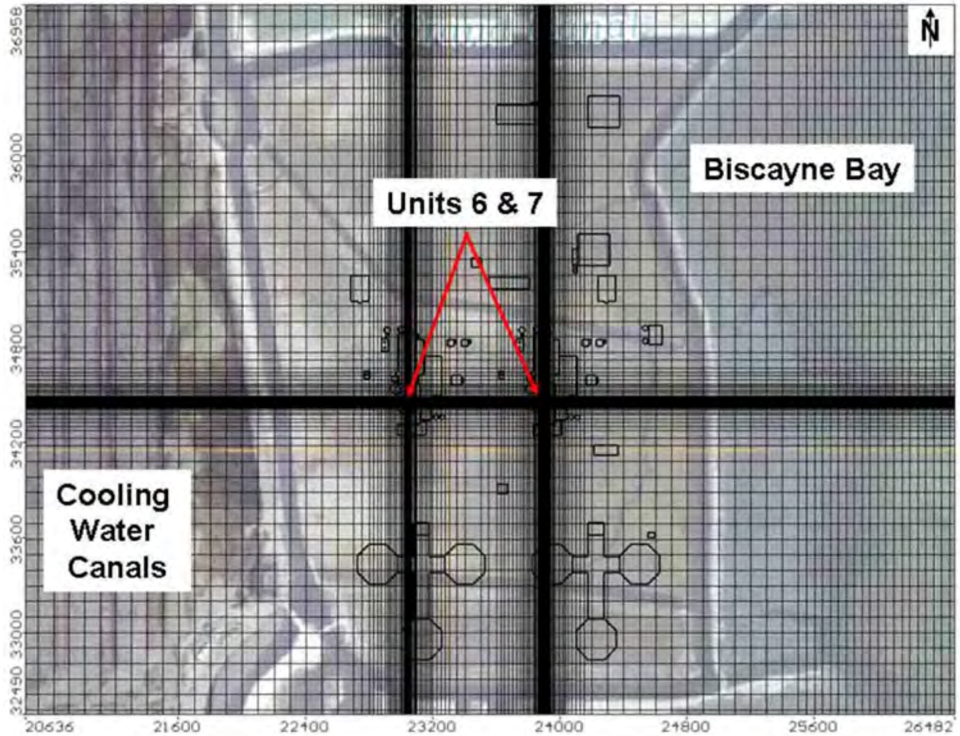
Source: Reference 11

Figure 2CC-209 Numerical Model Domain



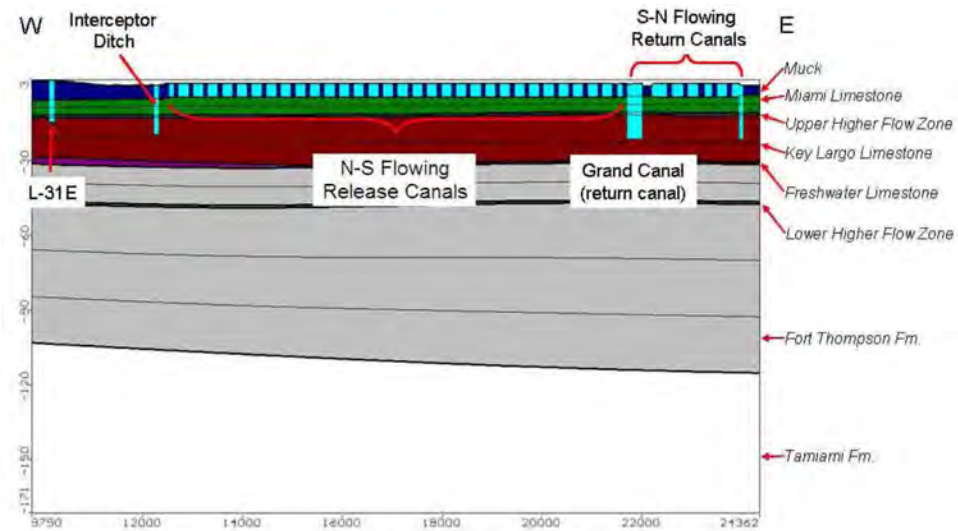
Notes: Model domain identified by extents of axes, not extents of image. While portions on right side are where aerial imagery is not available.
Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 862512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft.)

Figure 2CC-210 Model Grid and Site Features for the Units 6 & 7 Power Block



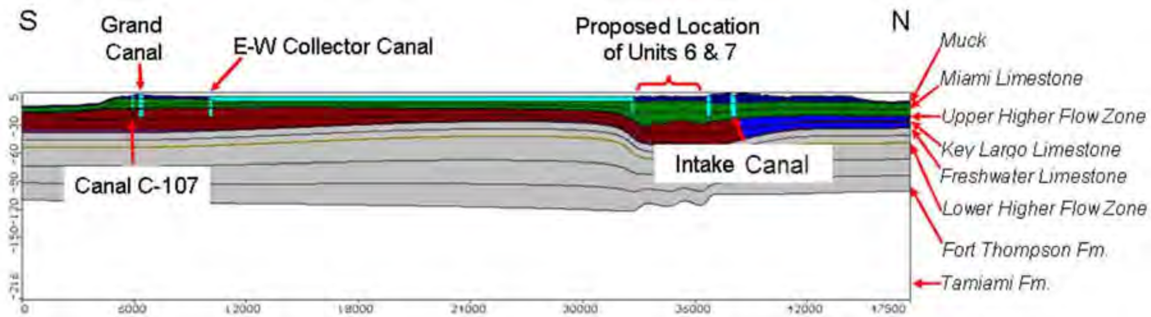
Note: Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-211 East-West Model Cross Section towards southern End of the Turkey Point Cooling Canals



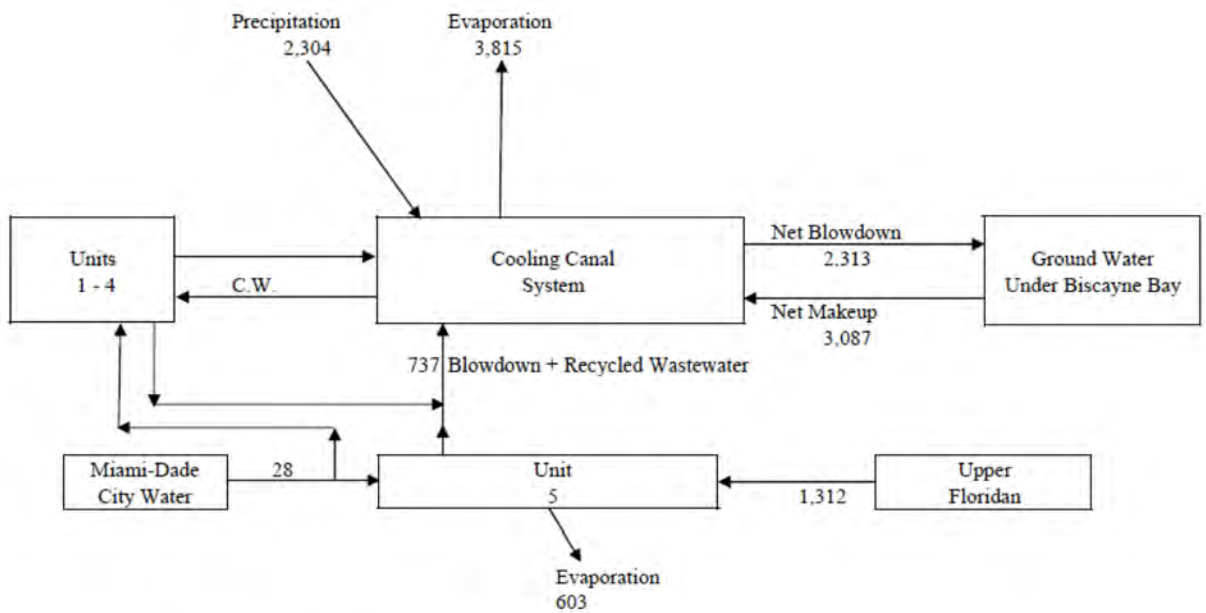
Notes: Section along Row 420, vertical exaggeration 50:1
Vertical axis represents elevation in ft NAVD 88. Horizontal axis represents model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plant Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-212 South-North Model Cross Section along Return Canal of Turkey Point Cooling Canals



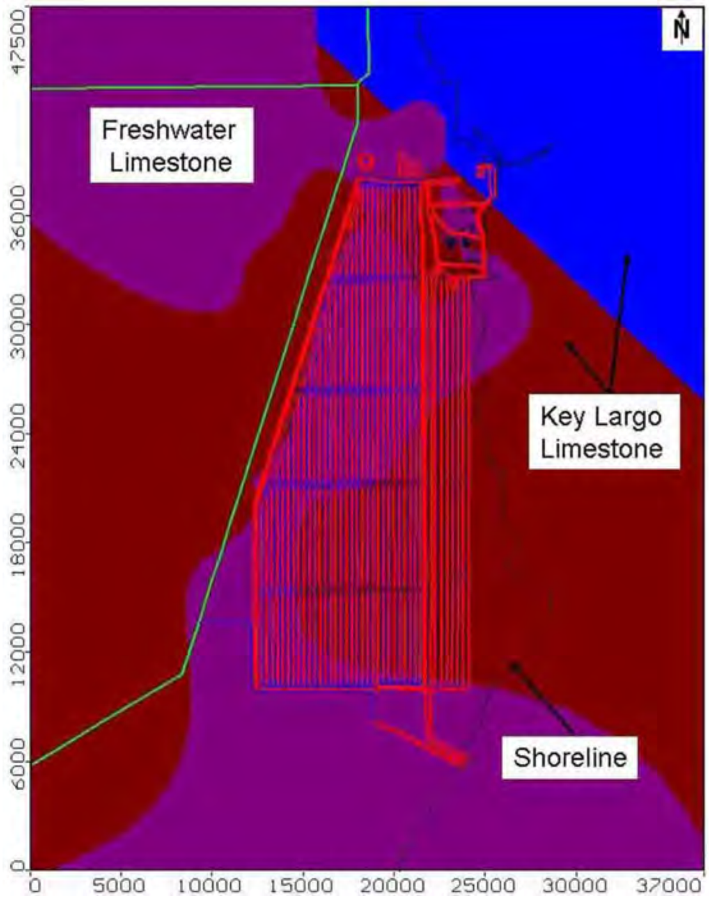
Notes: Section along Column 280, vertical exaggeration 50:1.
Vertical axis represents elevation in ft NAVD 88. Horizontal axis represents model coordinates in ft. Model origin at easting 852766, northing 362512 (in State plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-213 Cooling Canals Water Balance



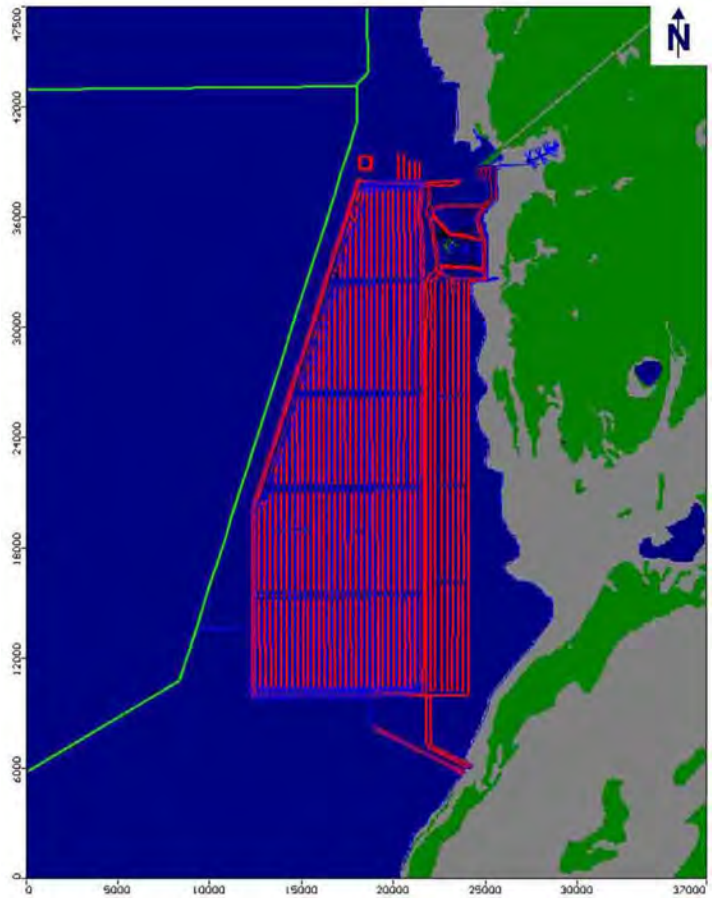
Note: Units in acre-ft/month

Figure 2CC-214 Extent of Freshwater Limestone and Key Largo Limestone in Model Layer 7



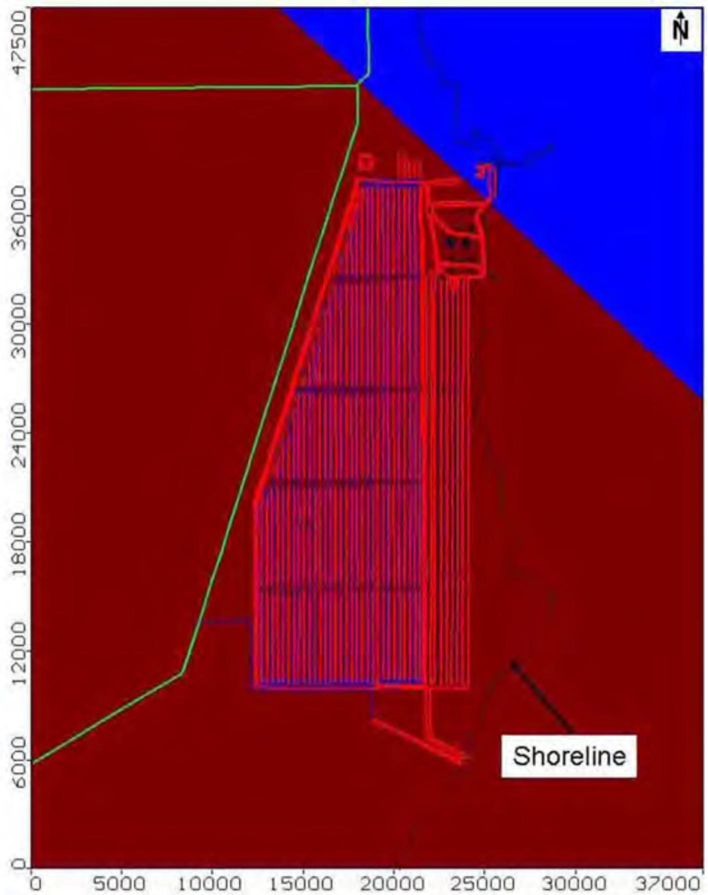
Note: Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-215 Material Distribution in Biscayne Bay



Notes: Blue = Muck. Green = Miami Limestone. Grey = Offshore Sediment.
Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-216 Model Calibration — Delineation of Hydraulic Conductivity Zones in the Key Largo Limestone



Legend: Dark Red = Key Largo Limestone Southwest. Blue = Key Largo Limestone Northeast. Green Lines = SFWMD Canals.

Note: Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft)

Figure 2CC-217 Model Calibration — Layout of Pumping Well and Observation Well Clusters for Pumping Tests PW-7L and PW-7U

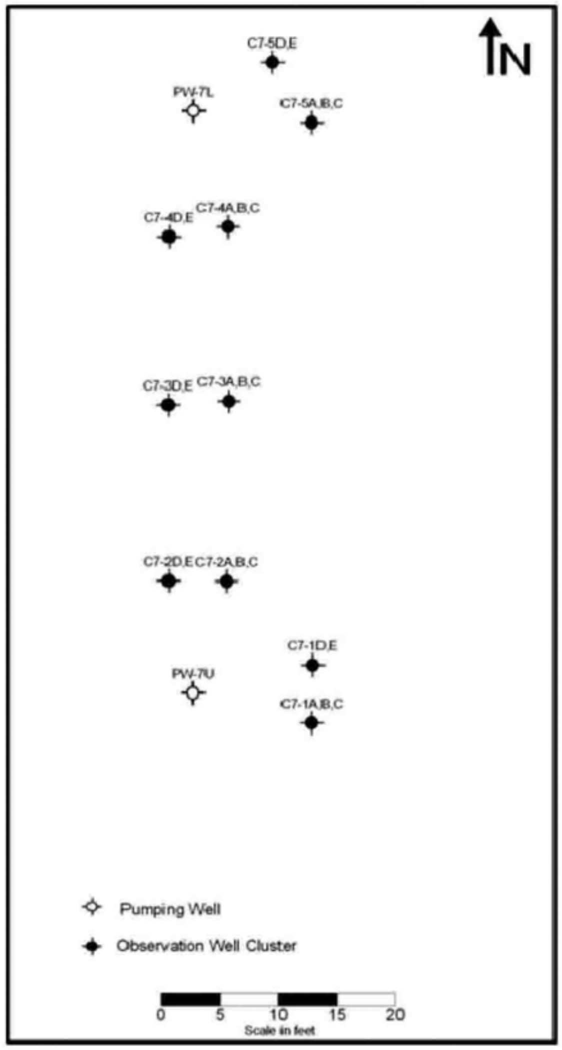
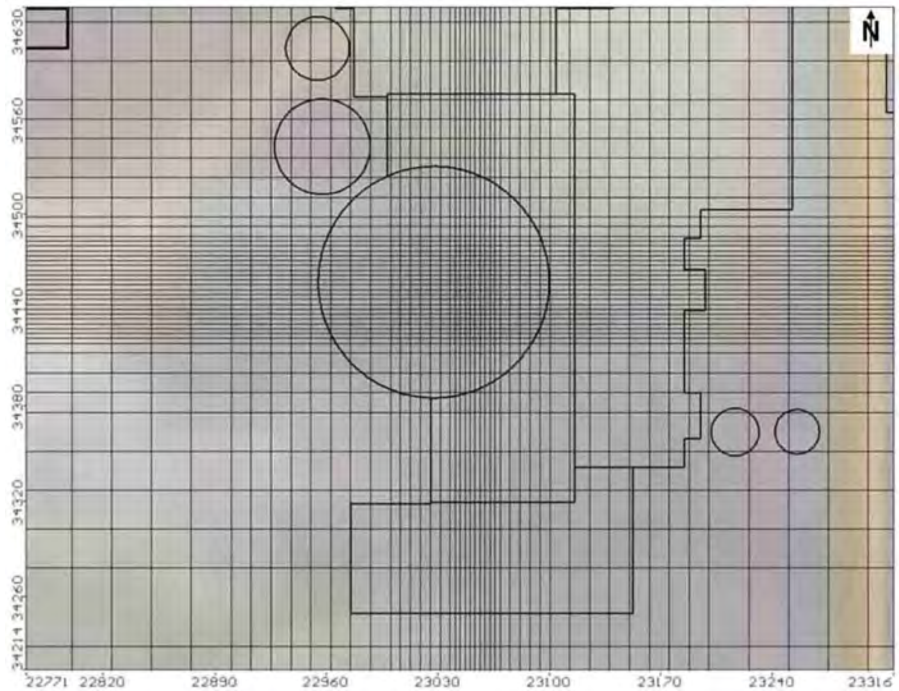
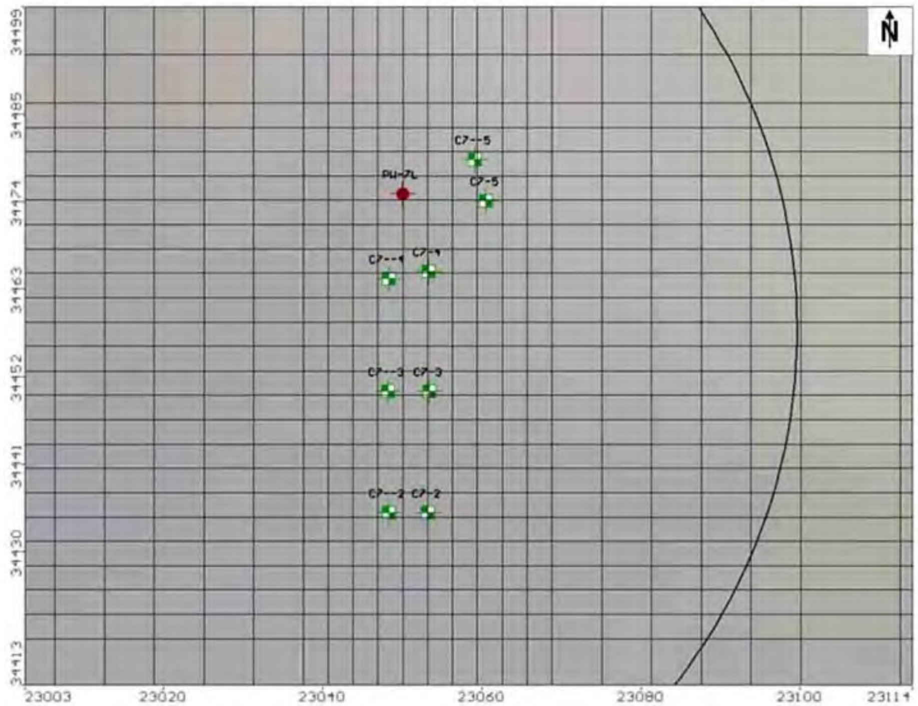


Figure 2CC-218 Grid Refinement in Vicinity of Unit 7 Reactor Footprint



Notes: Black lines represent Unit 7 reactor building and associated structures.
Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-219 Test Well PW-7L and Related Observation Wells



Notes: Red symbol = pumping well. Green symbol = observation well. Black line represents eastern edge of Unit 7 reactor building.
Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-220 Test Well PW-7L: Observed Versus Calculated Drawdowns

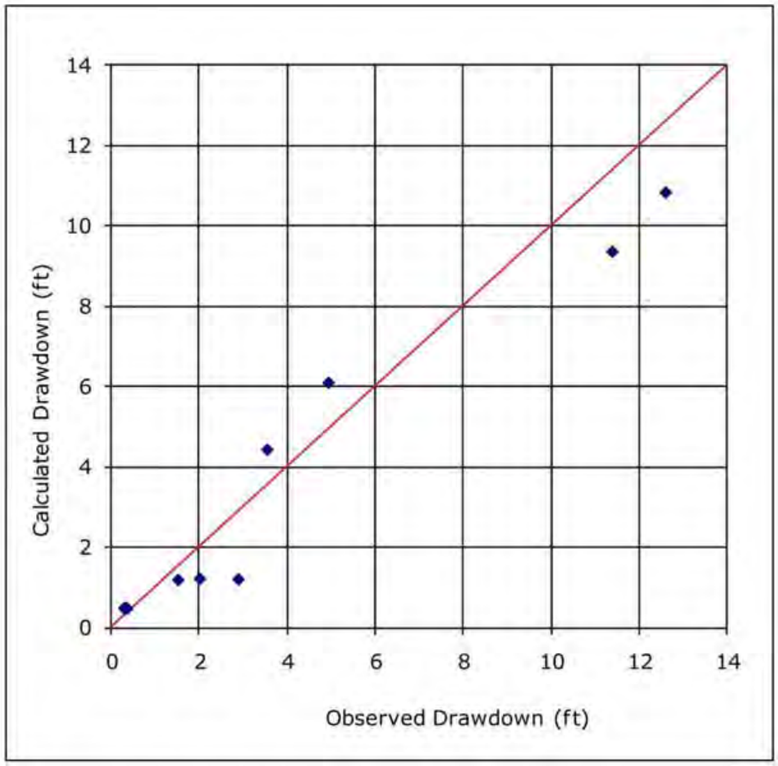


Figure 2CC-221 Model Calibration — Pumping and Monitoring Wells Layout for Pumping Test PW-1

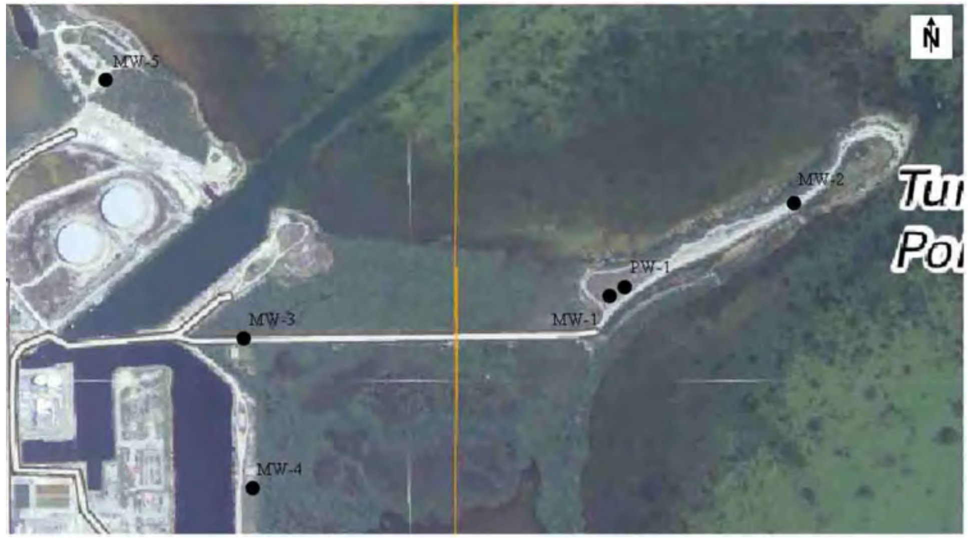
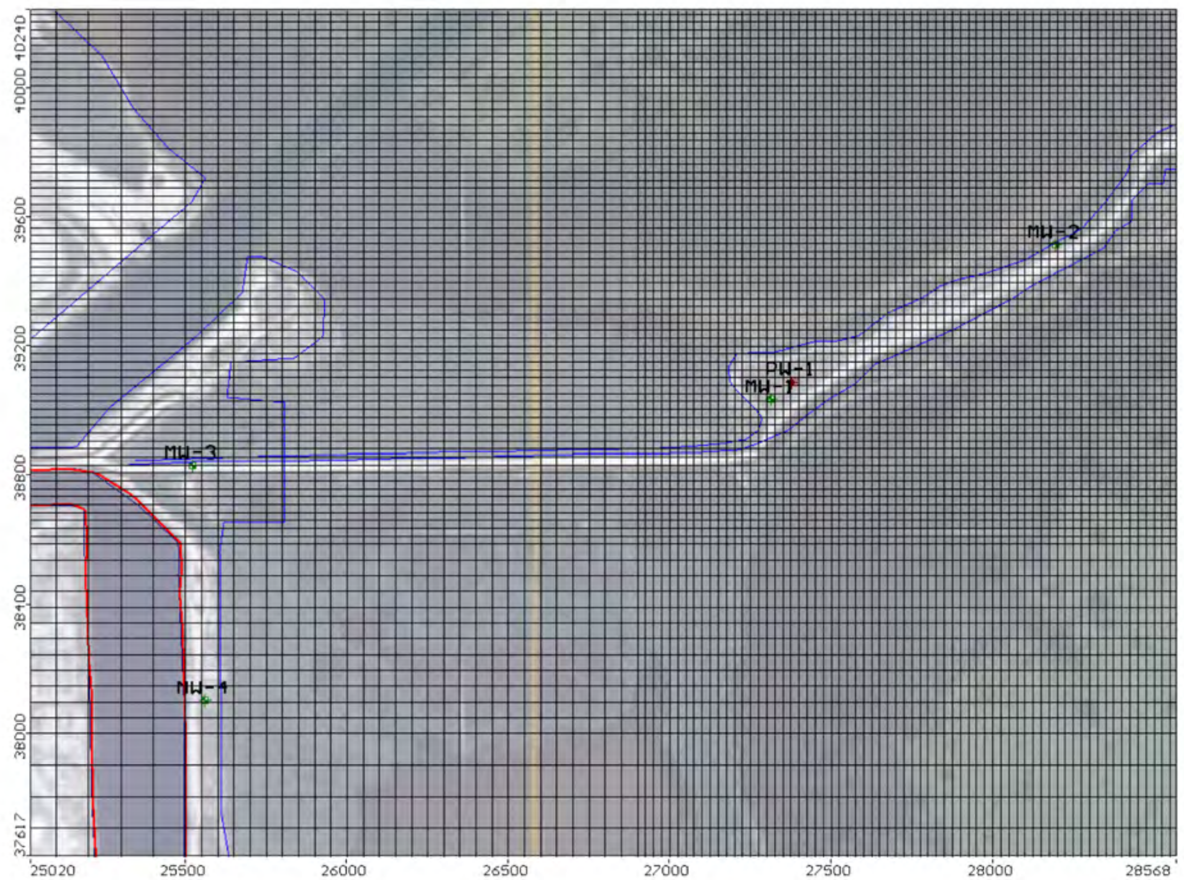


Figure 2CC-222 Model Calibration — Finite Difference Grid and Well Layout for Pumping Test PW-1



Note: Blue line = shoreline. Red line = CCS outline. Red symbol = pumping well. Green symbol = observation well. Radial collector well locations shown on Figure 2CC-242.
Vertical and horizontal axes represent model coordinates in ft. Model origin of easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990. Florida East, Zone 0901. US ft.)

Figure 2CC-223 Test Well PW-1: Observed versus Calculated Drawdowns

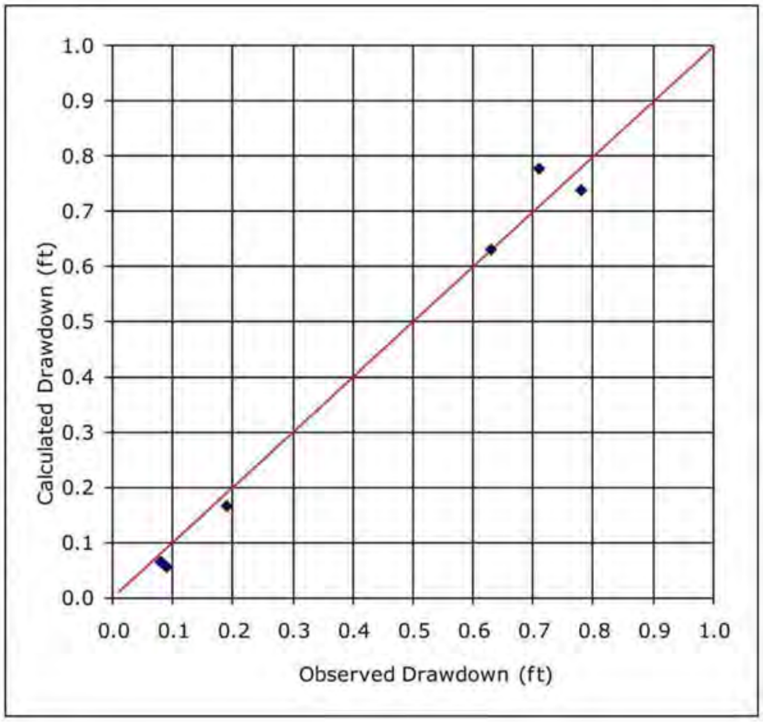
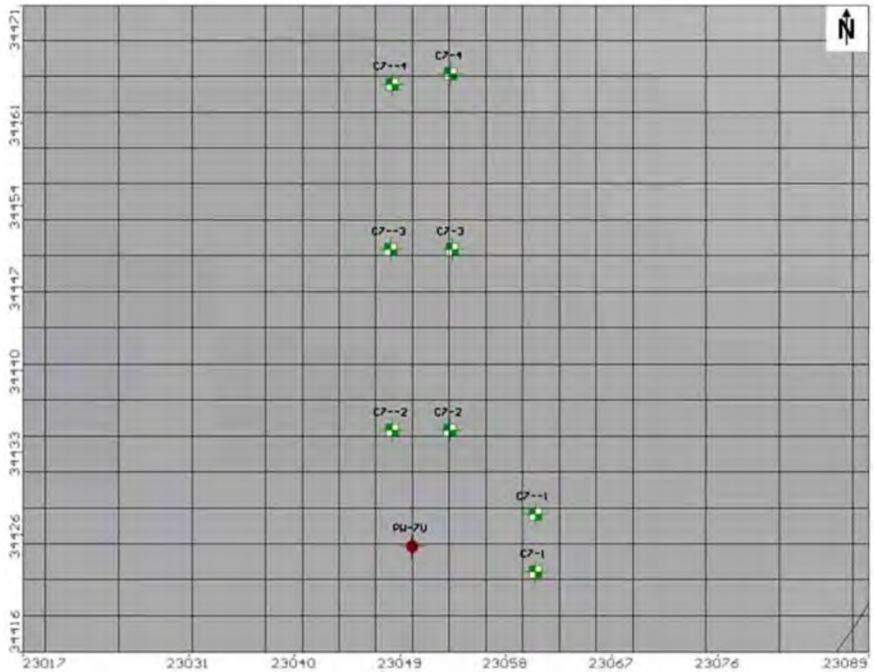


Figure 2CC-224 Model Calibration — Finite Difference Grid and Well Layout for Test PW-7U



Notes: Red symbol = pumping well. Green symbol = observation well.
Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-225 Test Well PW-7U: Observed versus Calculated Drawdowns

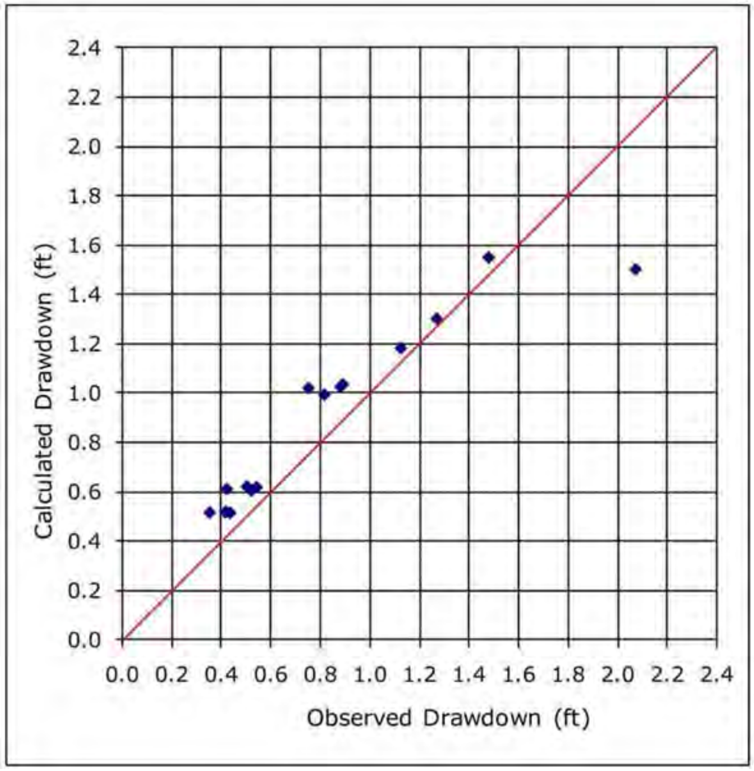
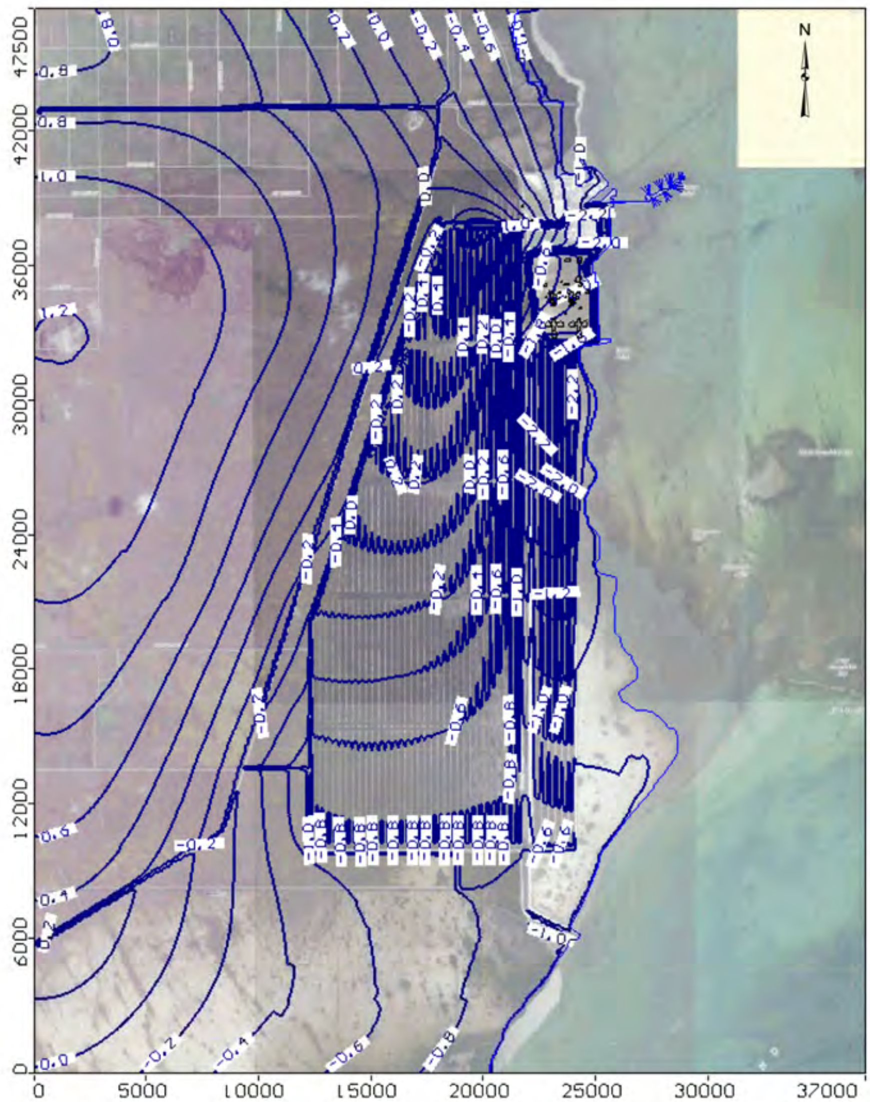


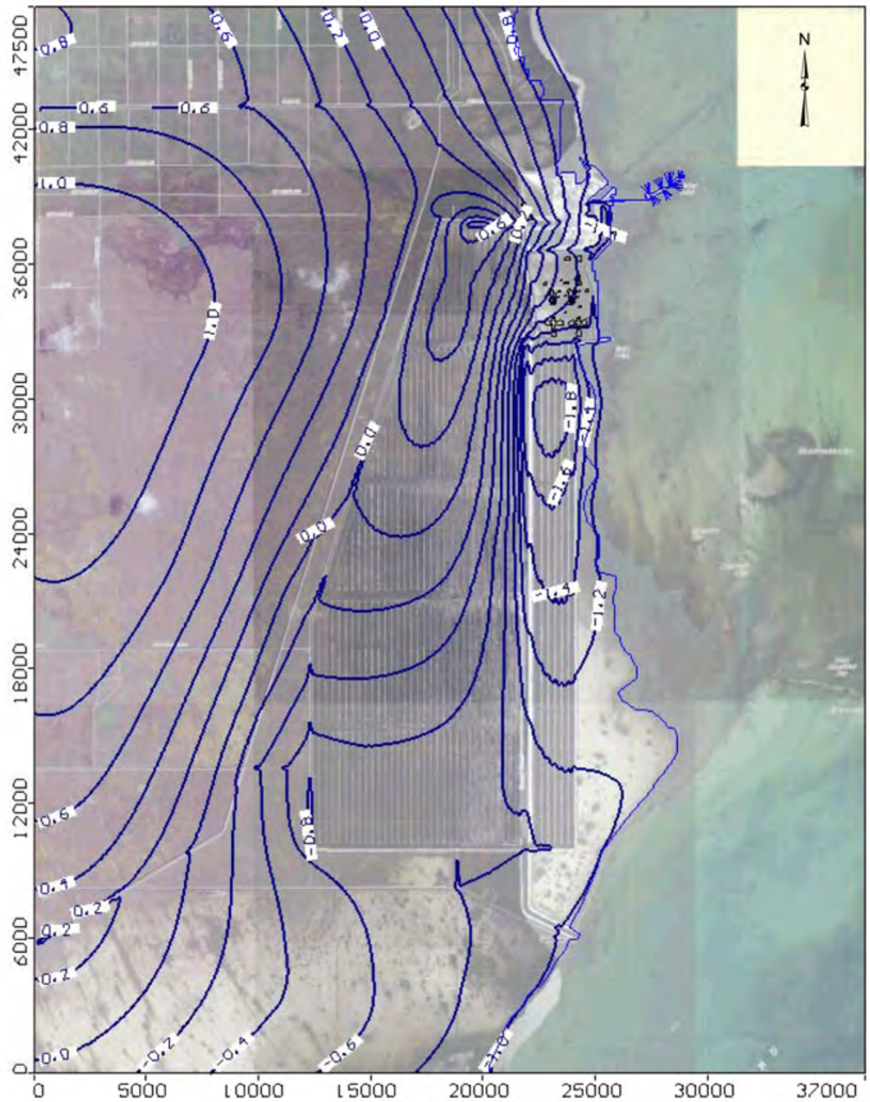
Figure 2CC-226 Simulated Groundwater Contours — Model Layer 1 — Onshore Muck and Offshore Sand/Sediments and Miami Limestone



Legend: Contour interval is 0.2 ft NAVD 88.

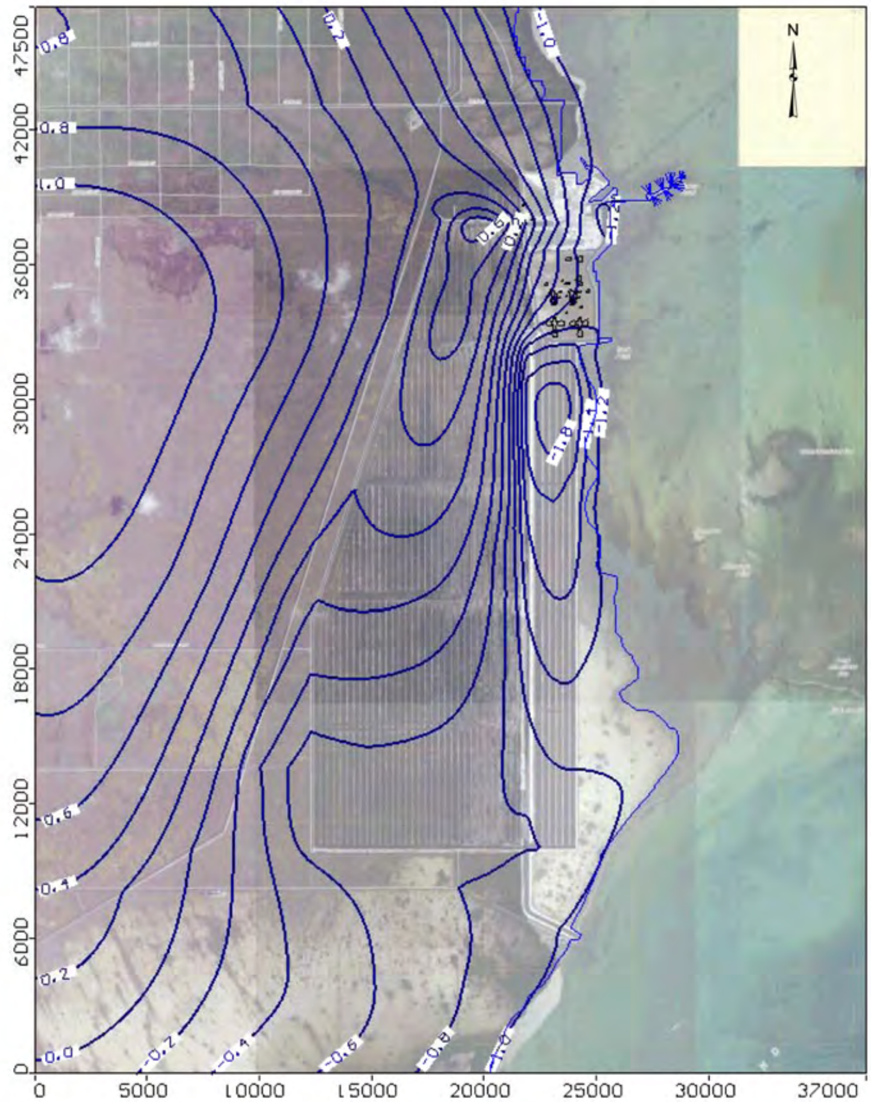
Notes: Light yellow portion in top right is where aerial imagery is not available. Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-227 Simulated Groundwater Contours — Model Layer 3 — Miami Limestone



Legend: Contour interval is 0.2 ft NAVD 88
Notes: Light yellow portion in top right is where aerial imagery is not available. Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-228 Simulated Groundwater Contours — Model Layer 4 — Upper Higher Flow Zone

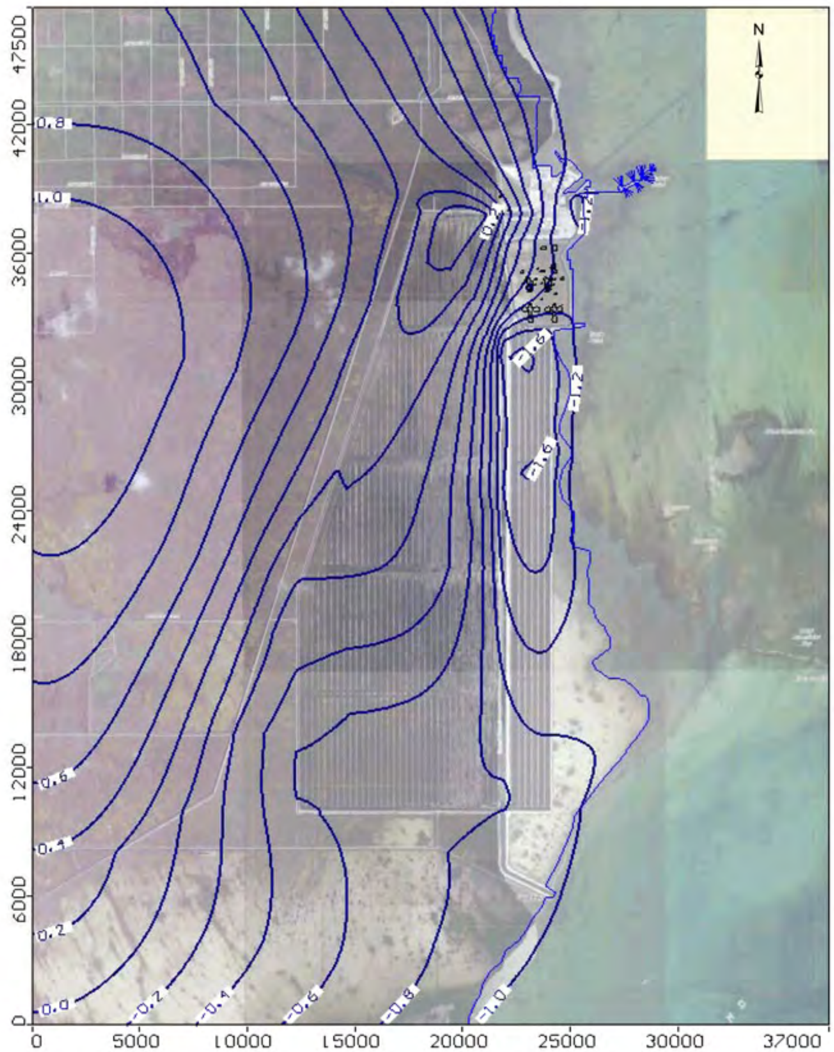


Legend: Contour interval is 0.2 ft NAVD 88
Notes: Light yellow portion in top right is where aerial imagery is not available. Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-229 Simulated Groundwater Contours — Model Layer 5 — Key Largo Limestone

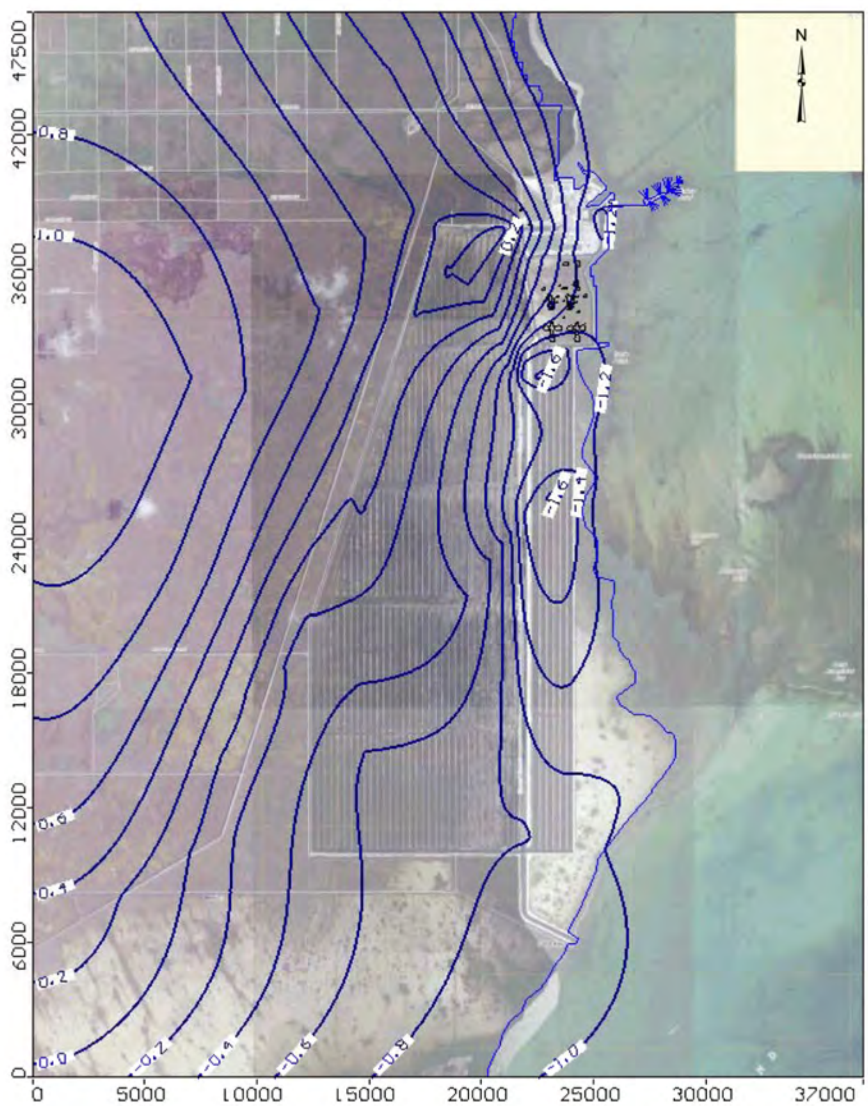
Legend: Contour interval is 0.2 ft NAVD 88
Notes: Light yellow portion in top right is where aerial imagery is not available. Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-230 Simulated Groundwater Contours — Model Layer 7 — Freshwater Limestone



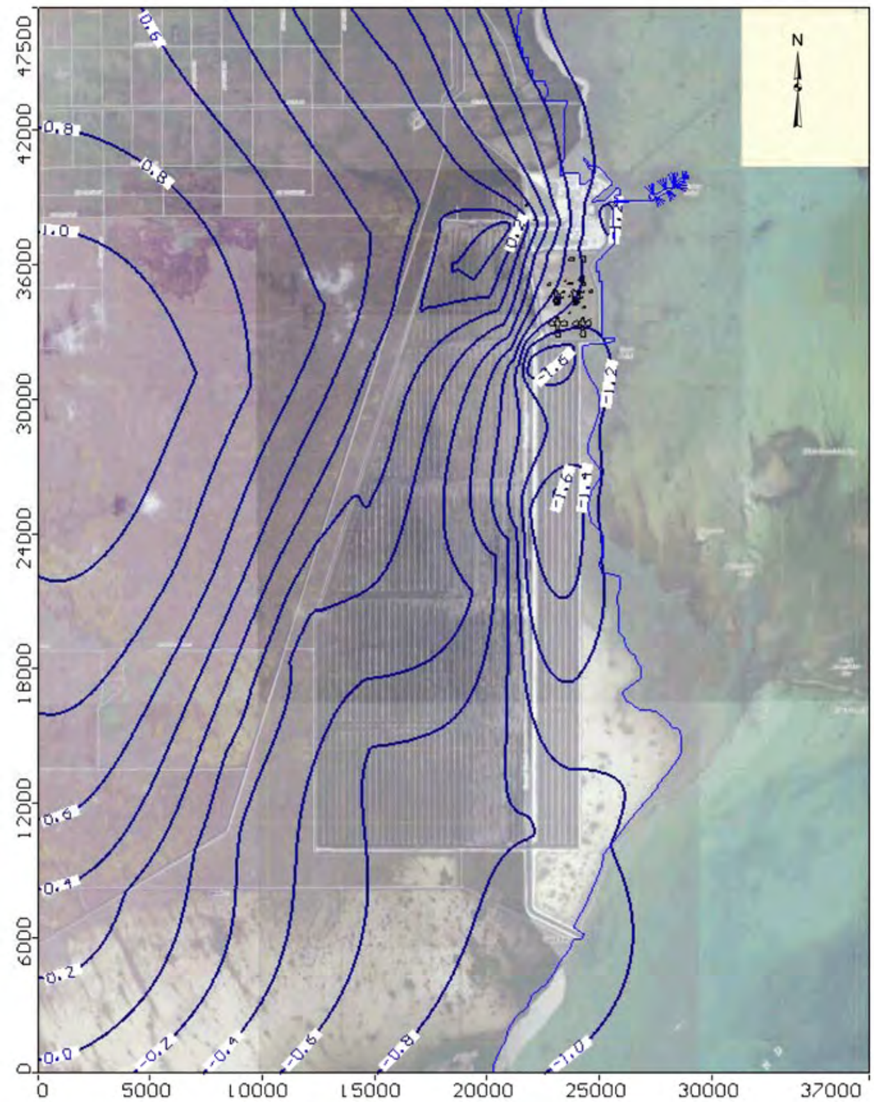
Legend: Contour interval is 0.2 ft NAVD 88
Notes: Light yellow portion in top right is where aerial imagery is not available. Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-231 Simulated Groundwater Contours — Model Layer 9 — Fort Thompson Formation



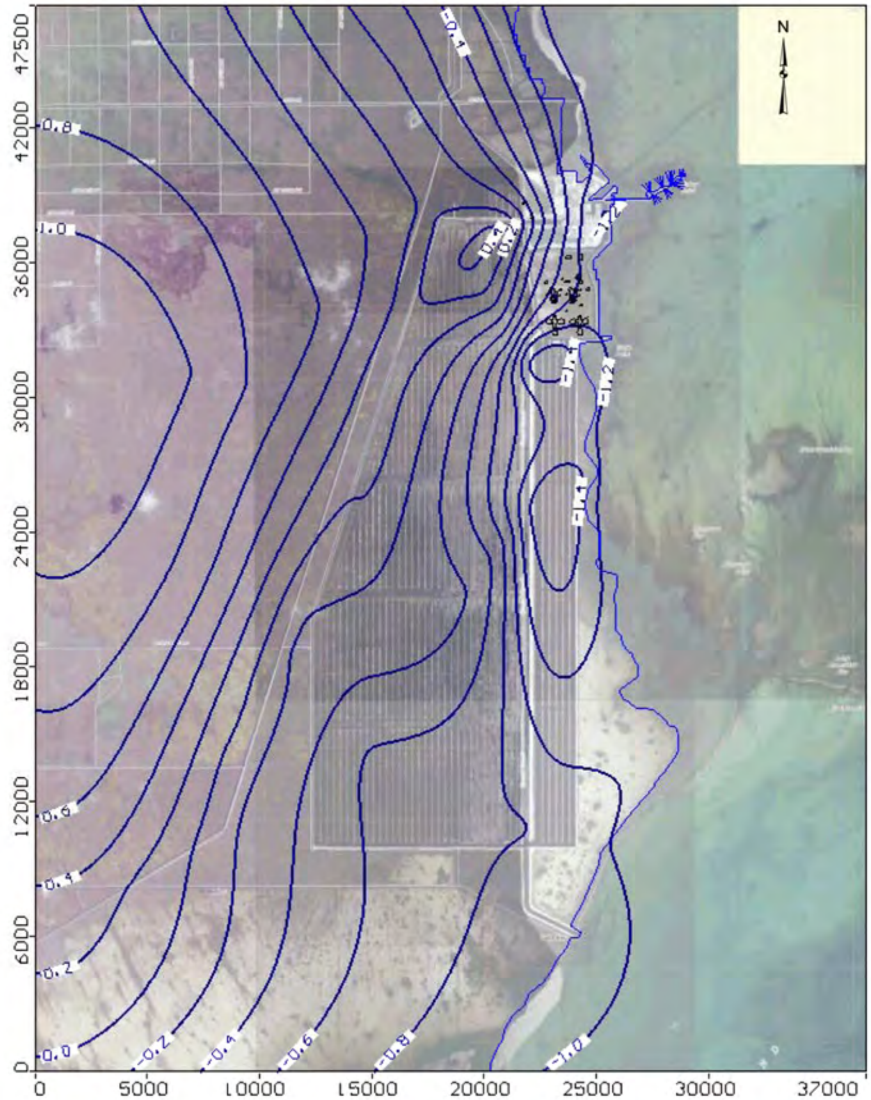
Legend: Contour interval is 0.2 ft NAVD 88
Notes: Light yellow portion in top right is where aerial imagery is not available. Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-232 Simulated Groundwater Contours — Model Layer 10 — Lower Higher Flow Zone



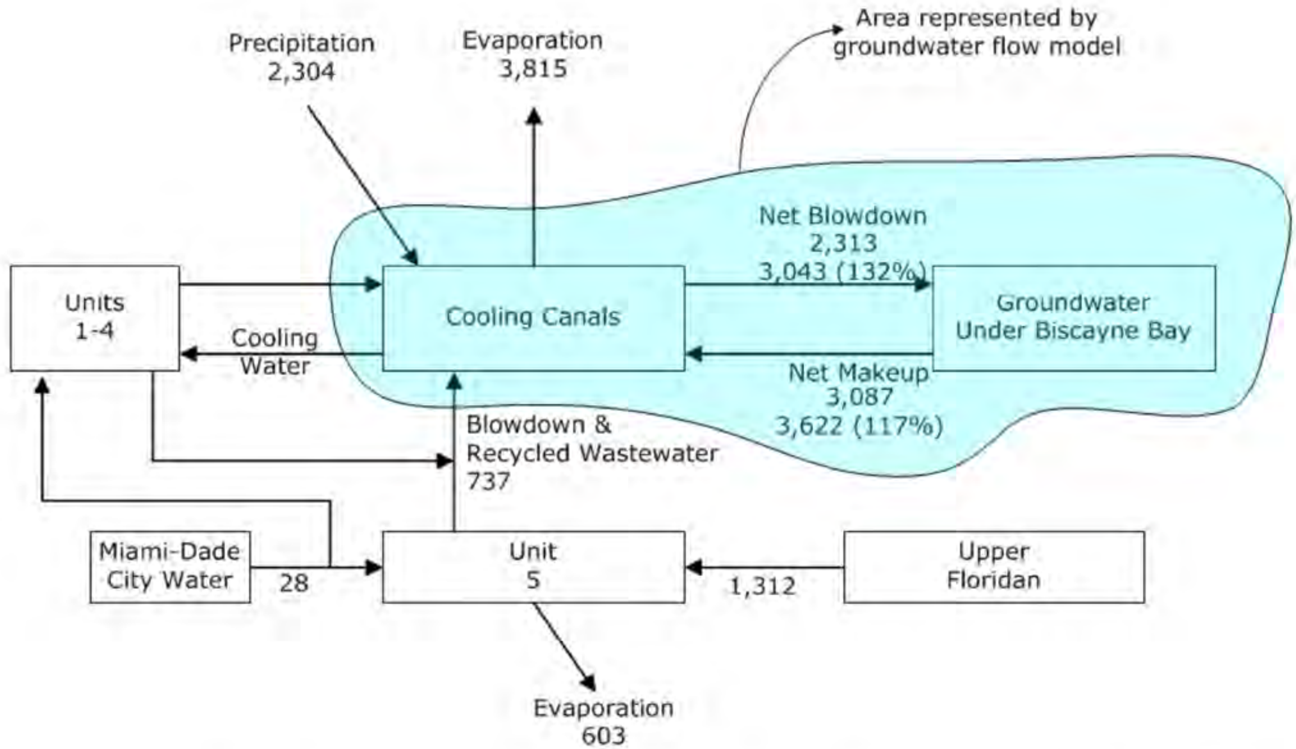
Legend: Contour interval is 0.2 ft NAVD 88
Notes: Light yellow portion in top right is where aerial imagery is not available. Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-233 Simulated Groundwater Contours — Model Layer 14 — Tamiami Formation



Legend: Contour interval is 0.2 ft NAVD 88
Note: Light yellow portion in top right is where aerial imagery is not available. Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-234 Existing Cooling Canals Water Balance — Comparison with Groundwater Model



Top value is plant at full capacity from surface water model; lower value is from groundwater model at average plant conditions. Value in parentheses is percentage difference between surface water model and groundwater model.

Note: Units in acre-ft/month.

Figure 2CC-235 Model Validation — Layout of Pumping and Observation Wells for Pumping Test PW-6U

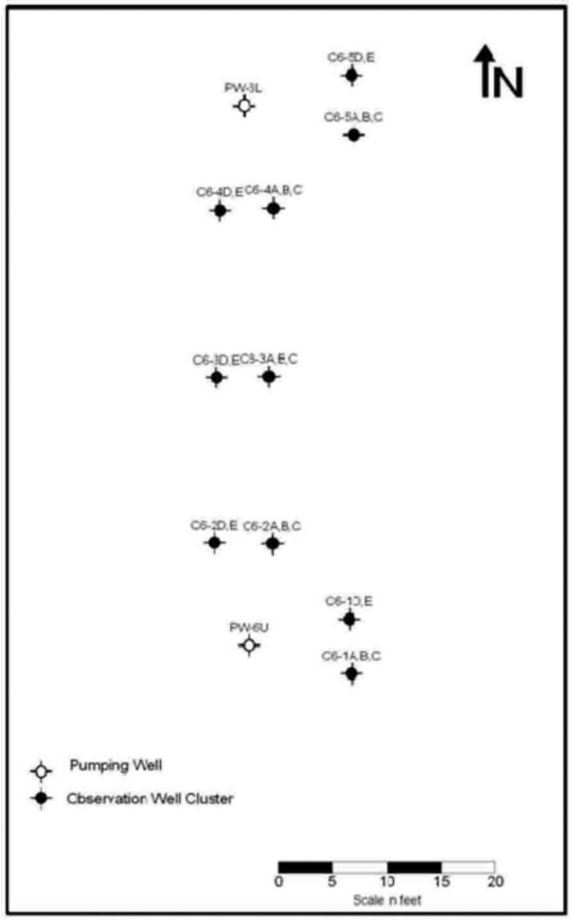


Figure 2CC-236 Test Well PW-6U: Observed versus Calculated Drawdowns

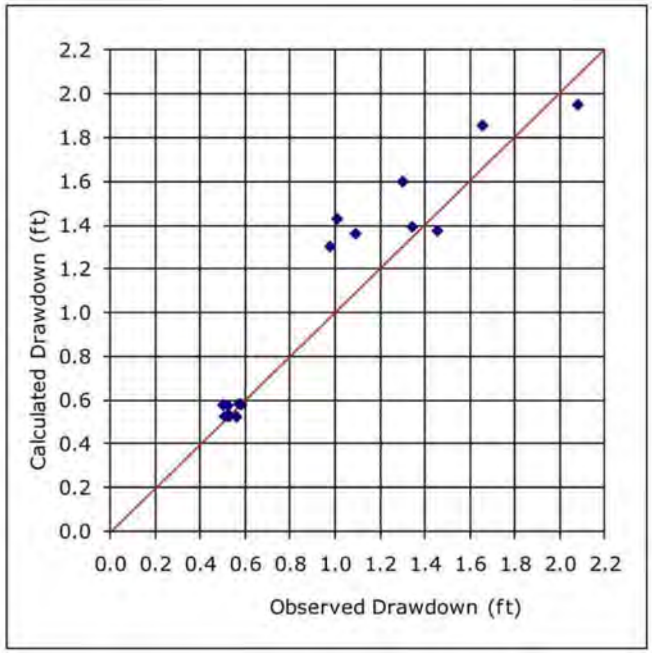
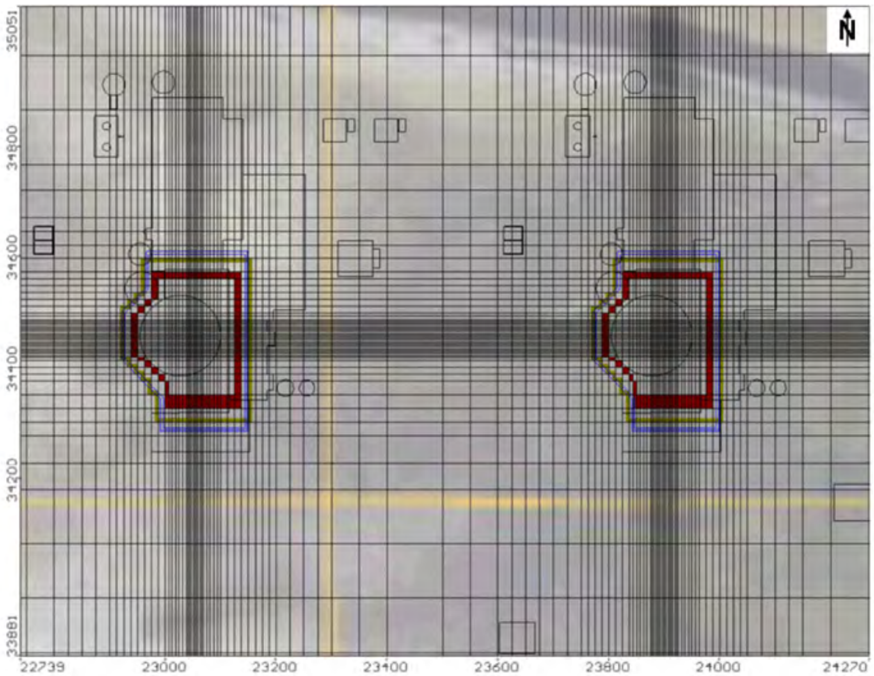


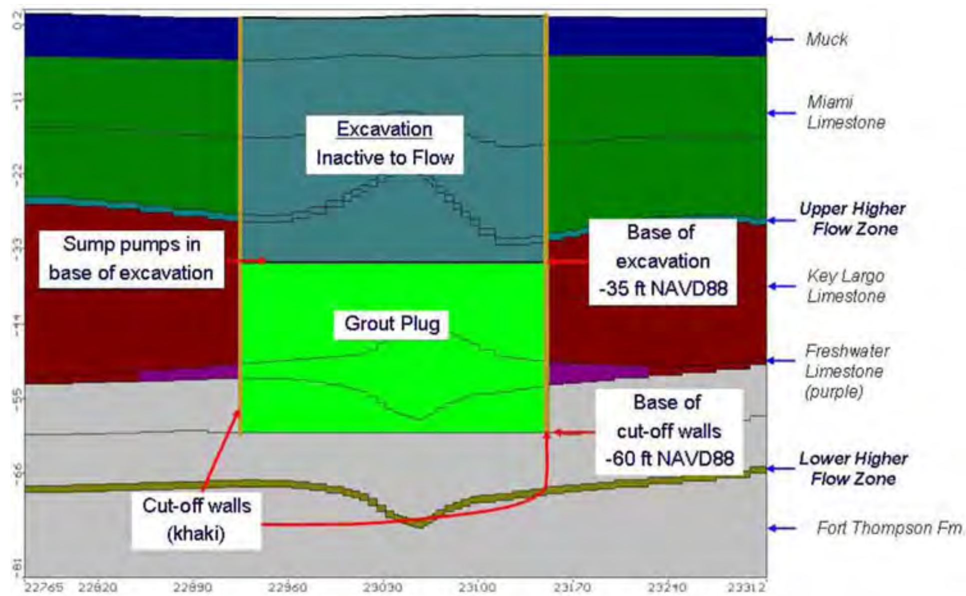
Figure 2CC-237 Location of Units 6 & 7 Construction Cut-Off Walls, Simulated Sump Pumps, and Gridlines



Legend: Blue lines represent reactor building and associated structures. Khaki (green) cells represent implementation of MODFLOW's HFB flow package in model to represent cut-off walls. Red cells represent sump pumps (inside cut-off walls).

Note: Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-238 Cross Section of Model Setup for Unit 7 Excavation



Notes: Cut-off walls extended to top of model domain for illustration only
Section Across Row 218. Vertical Exaggeration 5:1. Excavation for Unit 6 has similar configuration.
Vertical axis represents elevation in ft NAVD 88. Horizontal axis represents model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/ Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-239 Grouting Holes Spacing and Frequency during Proposed Grouting Method

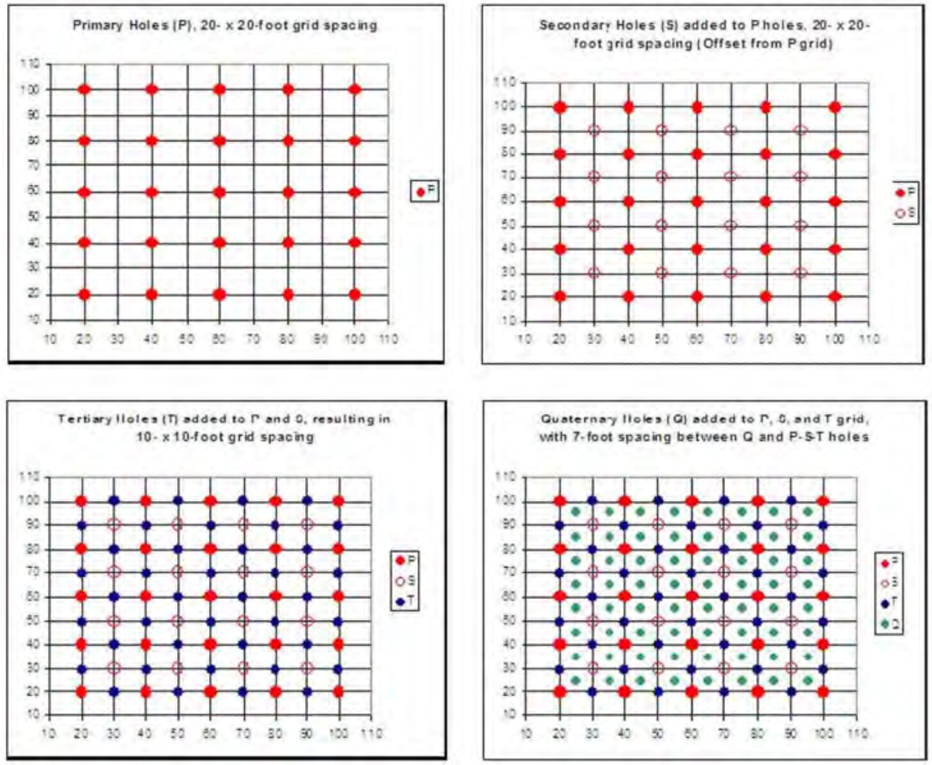


Figure 2CC-240 Comparison of Pumping Rates under Different Grouting Scenarios

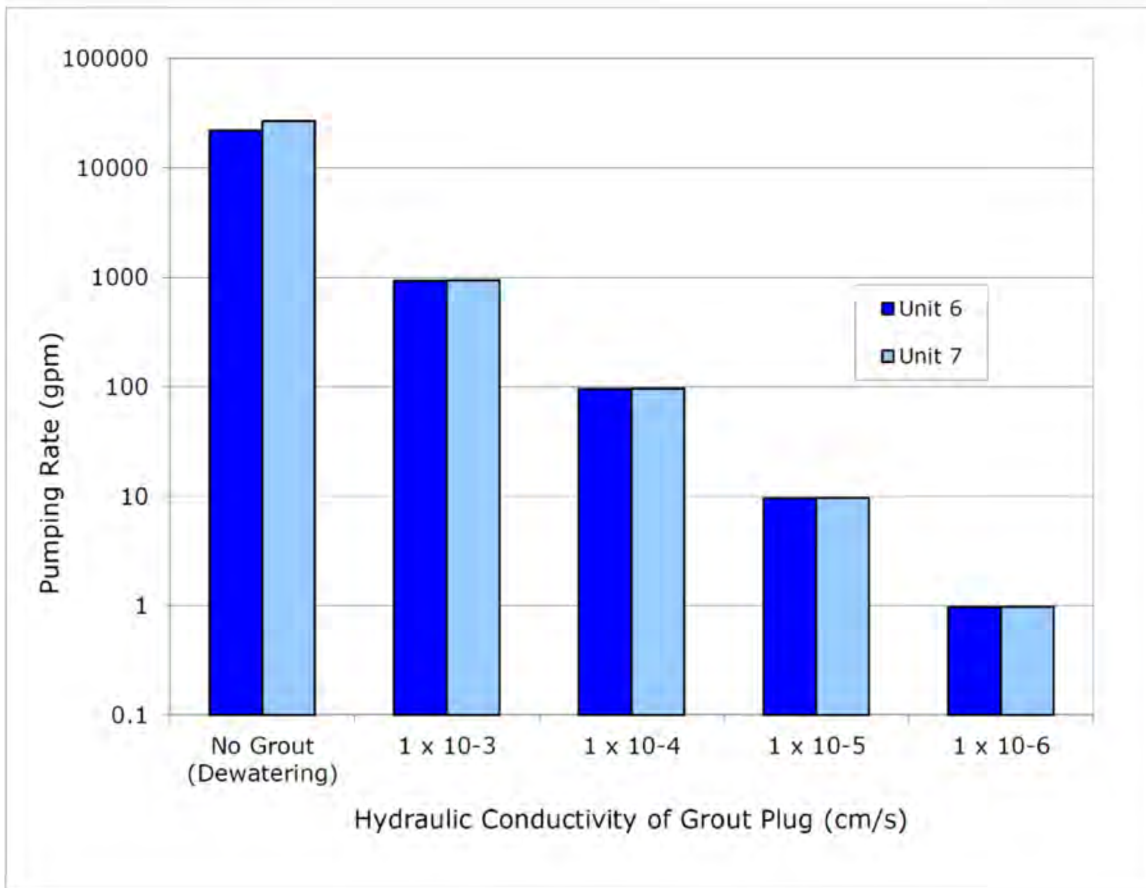
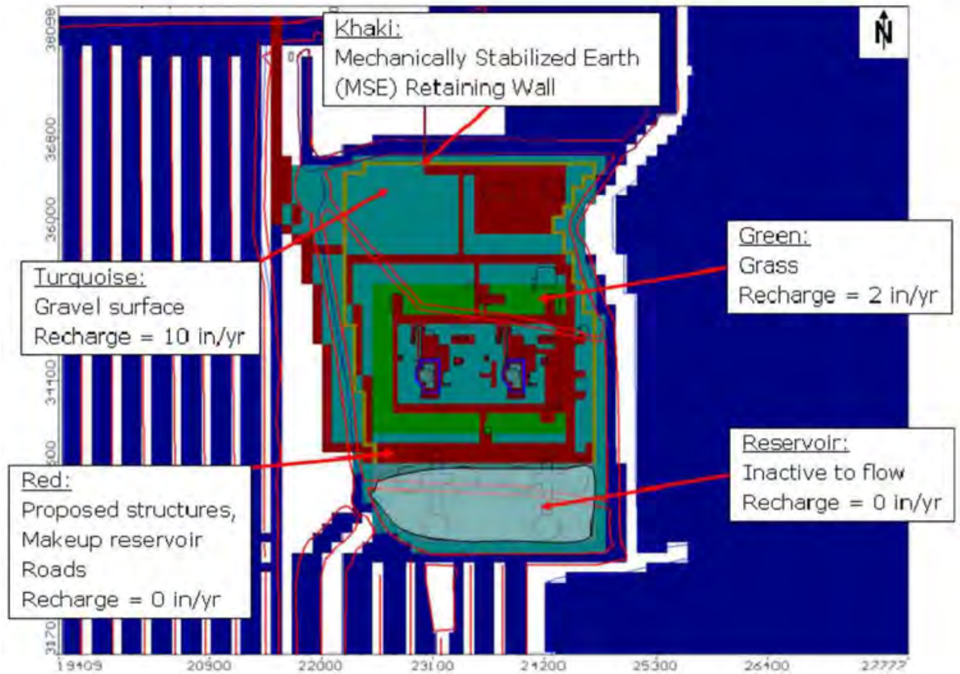
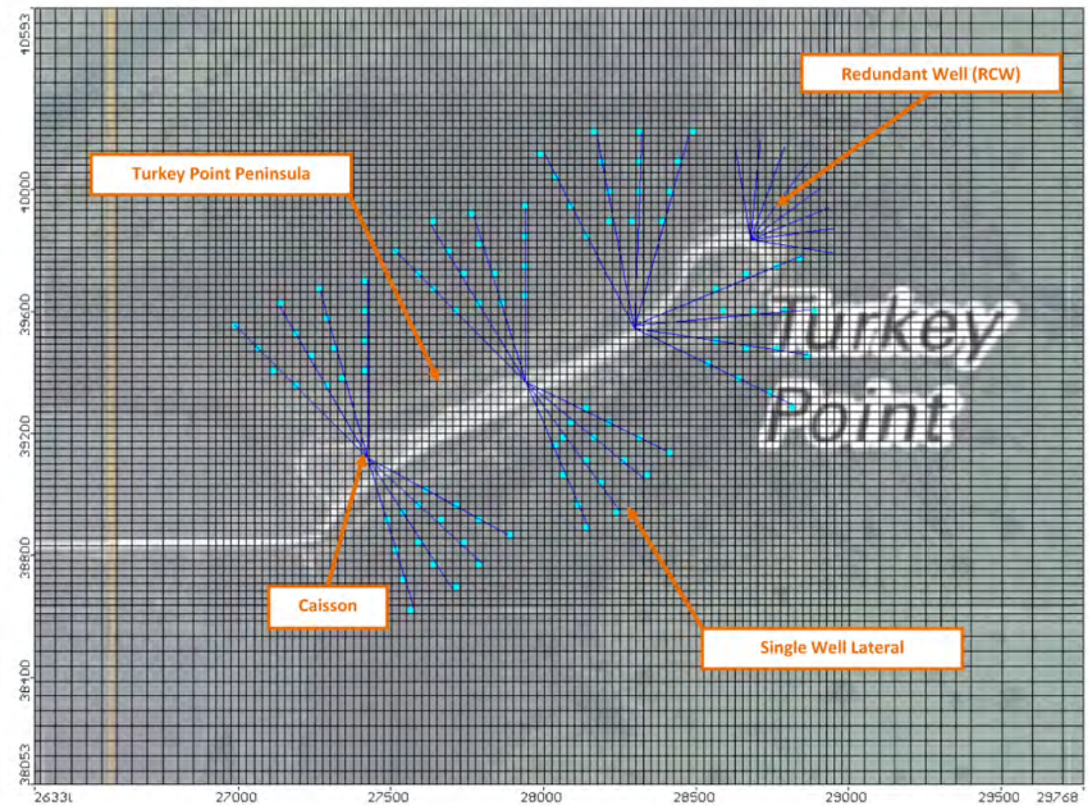


Figure 2CC-241 Phase 1 Post-Construction Recharge Zones for Units 6 & 7



Note: Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-242 Location of Radial Collector Wells and Laterals, with Finite-Difference Grid and Pumping Well Locations



Note: Dark blue lines = radial collector well arms. Light blue symbol = pumping well node.

Figure 2CC-243 Potentiometric Surface within the Upper Higher Flow Zone during Radial Collector Well Simulations

Legend: Blue lines are equipotentials in 0.5 ft increments.
Notes: The Upper Higher Flow Zone is above the Key Largo Limestone and is the zone from which the RCW system is pumped. Light yellow portion in top right is where aerial imagery is not available. Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

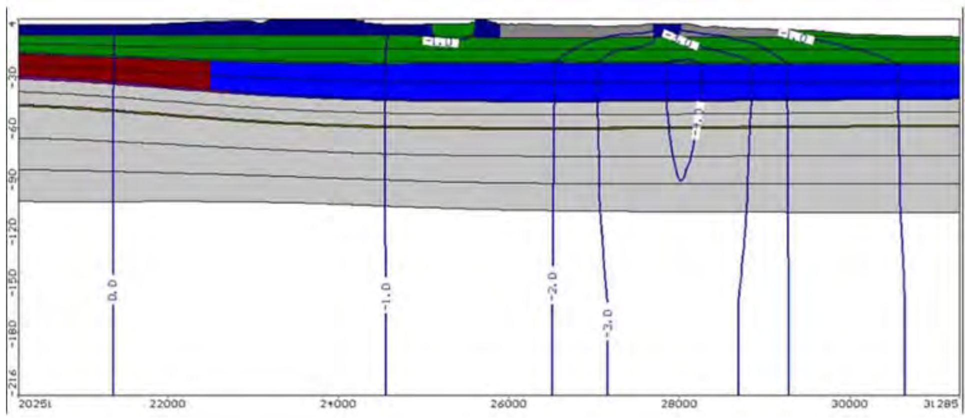
Figure 2CC-244 Head Contours in Layer 1 during Radial Collector Well Simulations

Legend: Blue lines are equipotentials in 1 foot increments.

Notes: Light yellow portion in top right is where aerial imagery is not available.

Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-245 Cross Section through Turkey Point Peninsula Showing Groundwater Contours Resulting from Operation of the RCW System



Legend: Blue lines are equipotentials in 1 foot increments.

Notes: Section Across Row 120, Vertical Exaggeration = 20:1
Vertical axis represents elevation in ft NAVD 88. Horizontal axis represents model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-246 RCW Drawdown within the Top Layer

Notes: Thin red line = 0.1, 0.5, 1.0, and 2.0 foot drawdown contours. Light yellow portion in top right is where aerial imagery is not available.

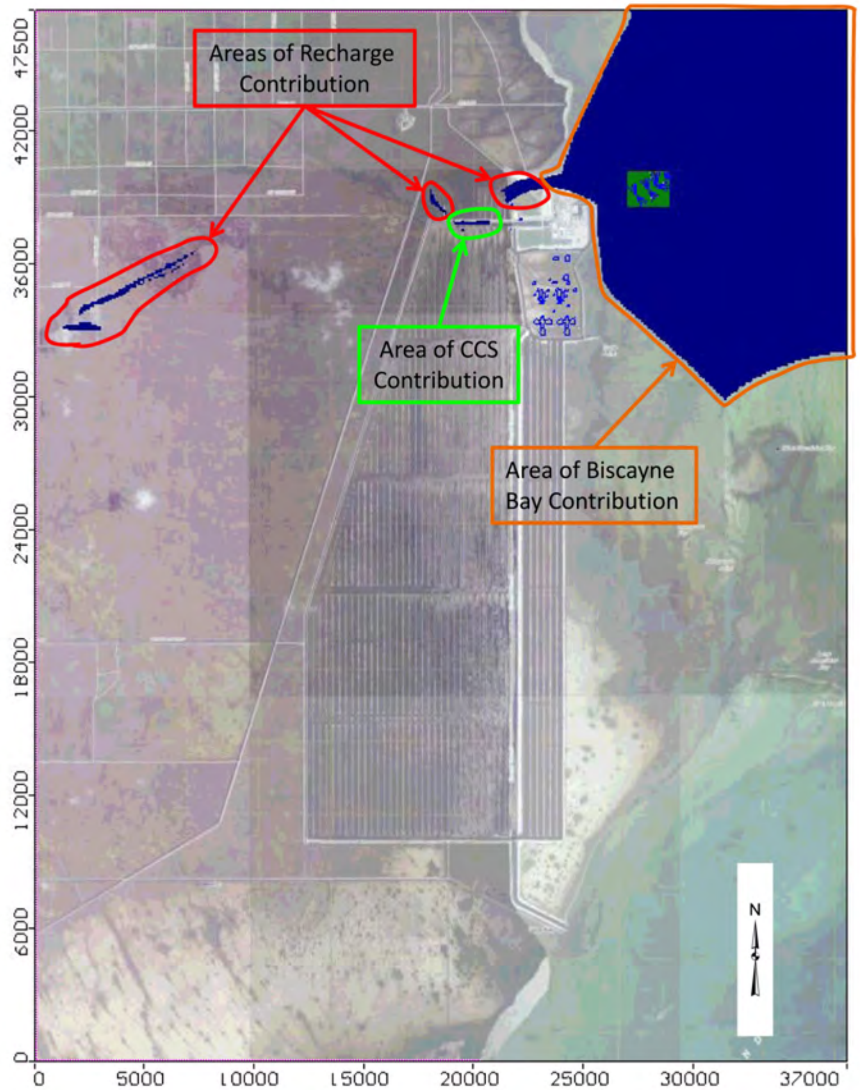
Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-247 RCW Drawdown within the Pumped Layer (Upper Higher Flow Zone)

Notes: Thin red line = 0.1, 0.5, 1.0, 2.0, and 3.0 foot drawdown contours. Light yellow portion in top right is where aerial imagery is not available. Approximate elevation of Upper Higher Flow Zone underneath Turkey Point Peninsula is -22 ft NAVD 88.

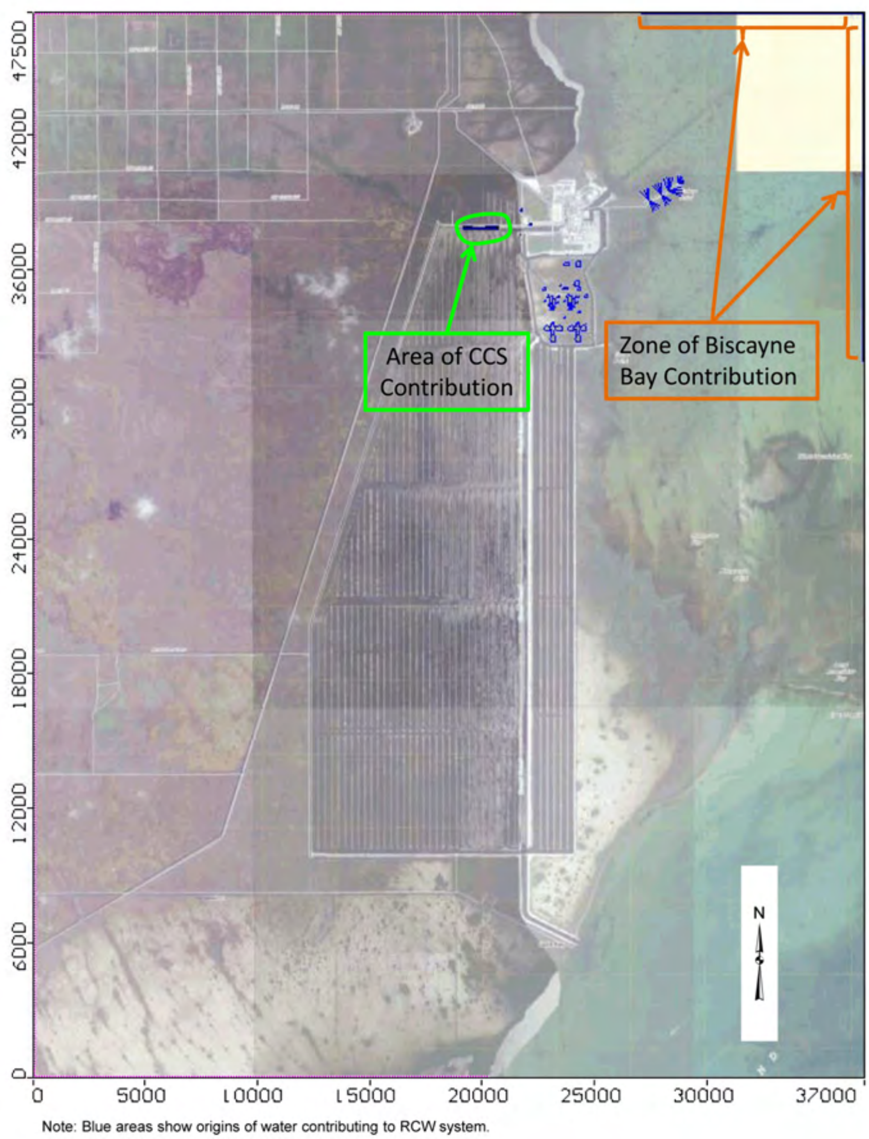
Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-248 Origin of Flow to the RCW System (Layer 1)



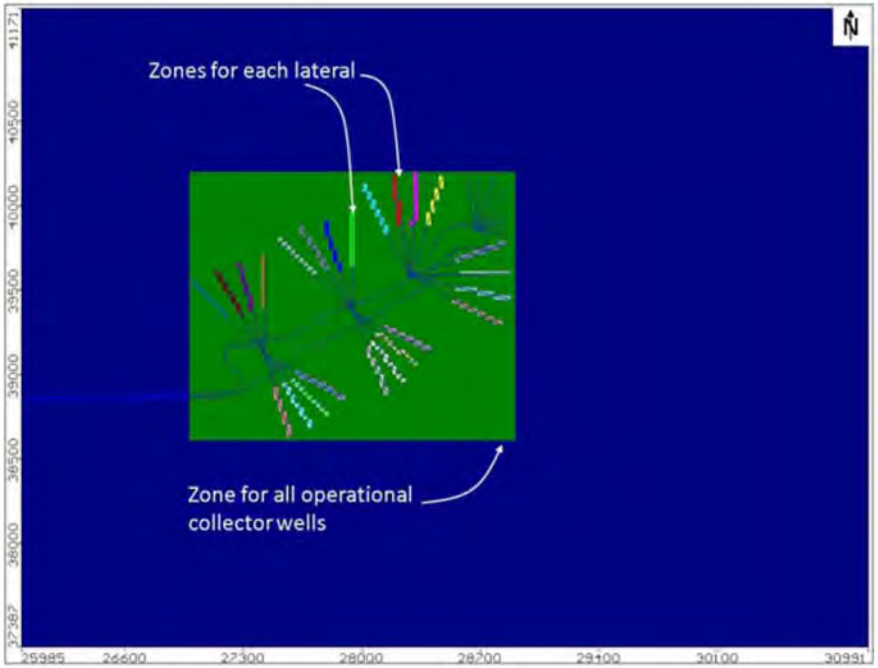
Note: Blue areas show origins of water contributing to RCW system.

Figure 2CC-249 Origin of Flow to the RCW System (Layer 2)



Notes:
1. Blue areas show origins of water contr buting to RCS system.
2. Light yellow portion in top right is where aerial imagery is not available.

Figure 2CC-250 Additional Areas for RCW Approach Velocity Calculation



Note: Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft)

Figure 2CC-251 Calculated Flux of Water between Layers 1 and 2 (Darcy Velocity)

Notes: Units in ft/day. Light yellow portion in top right is where aerial imagery is not available.
Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-252 RCW Drawdown within the Top Layer — Seasonal High and Low Water Level Biscayne Bay

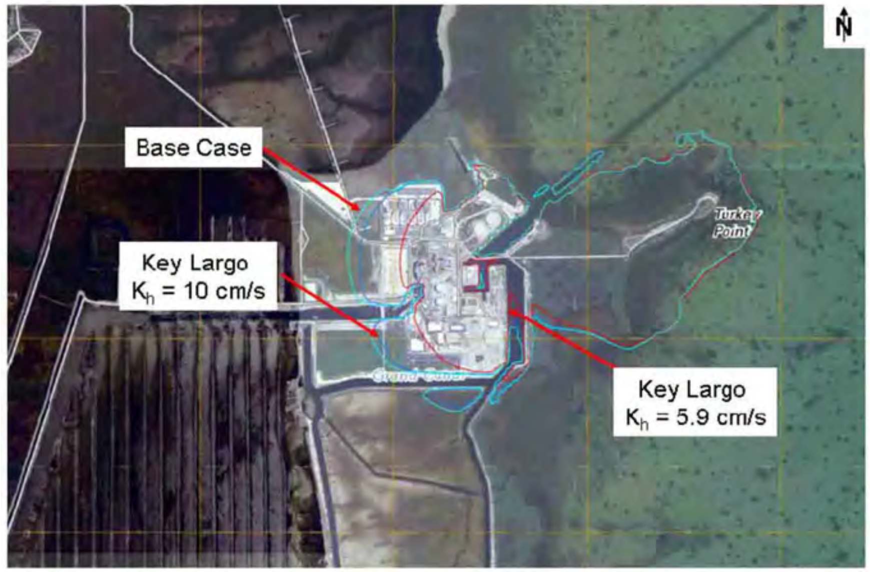
Notes:

1. 0.1 ft drawdown contour.
2. Divergence of drawdown lines is seen to the west and northwest of the existing Turkey Point plant where the drawdown contour for the seasonal high water level is to the east of the base case contour and the seasonal low water level contour is to the west of the base case contour where distinguishable.

Figure 2CC-253 RCW Drawdown within the Top Layer — Sensitivity Case Biscayne Bay Vertical Hydraulic Conductivity

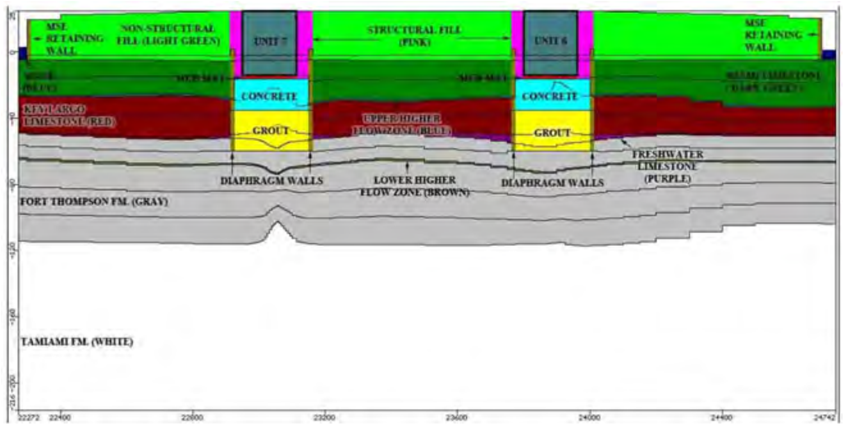
Note: 0.1 ft drawdown contour.

Figure 2CC-254 RCW Drawdown within the Top Layer — Hydraulic Conductivity of Key Largo Limestone



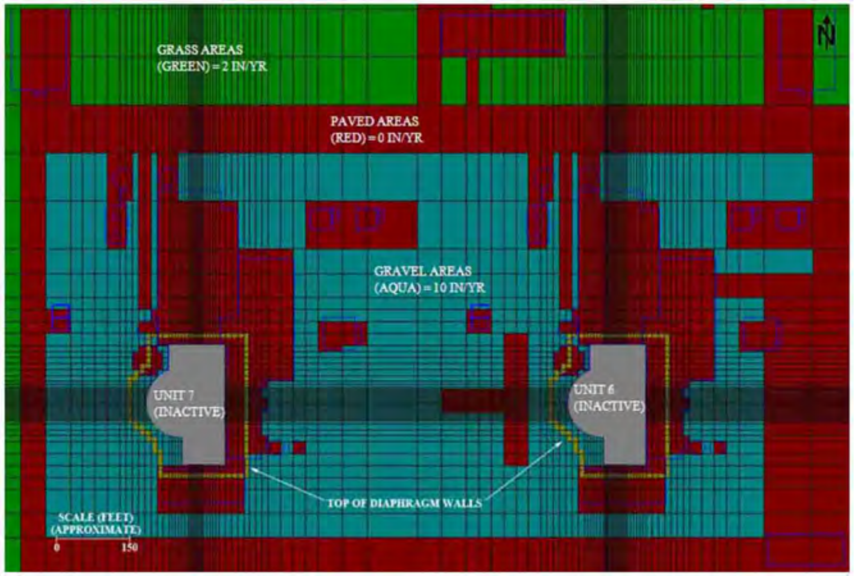
Note: 0.1 ft drawdown contour.

Figure 2CC-255 Hydrostratigraphic Units and Location of Diaphragm Walls (Row 219)



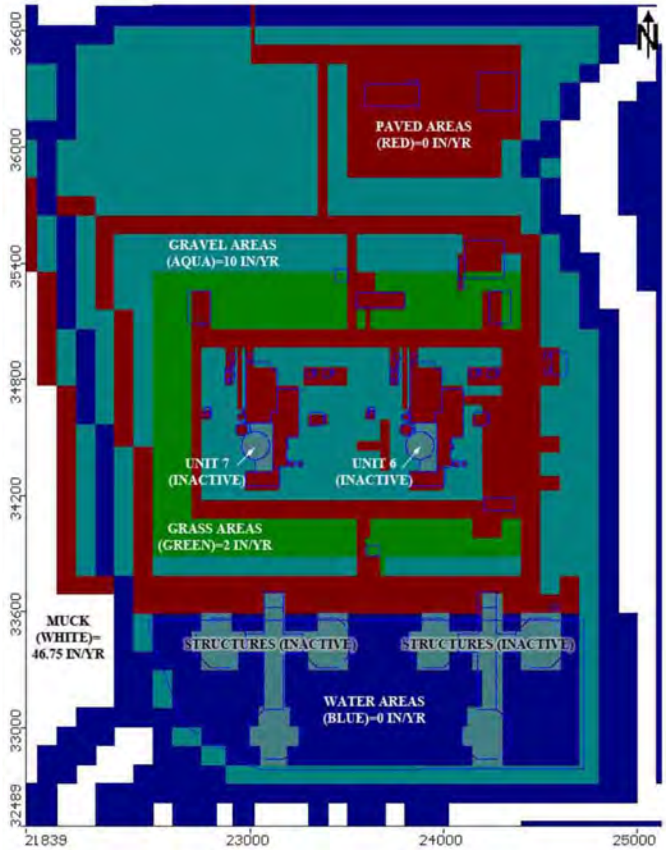
Note: Vertical axis represents elevation in ft NAVD 88. Horizontal axis represents model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-256 Layer 2 Diaphragm Walls Relative to Layer 1 Recharge Zones



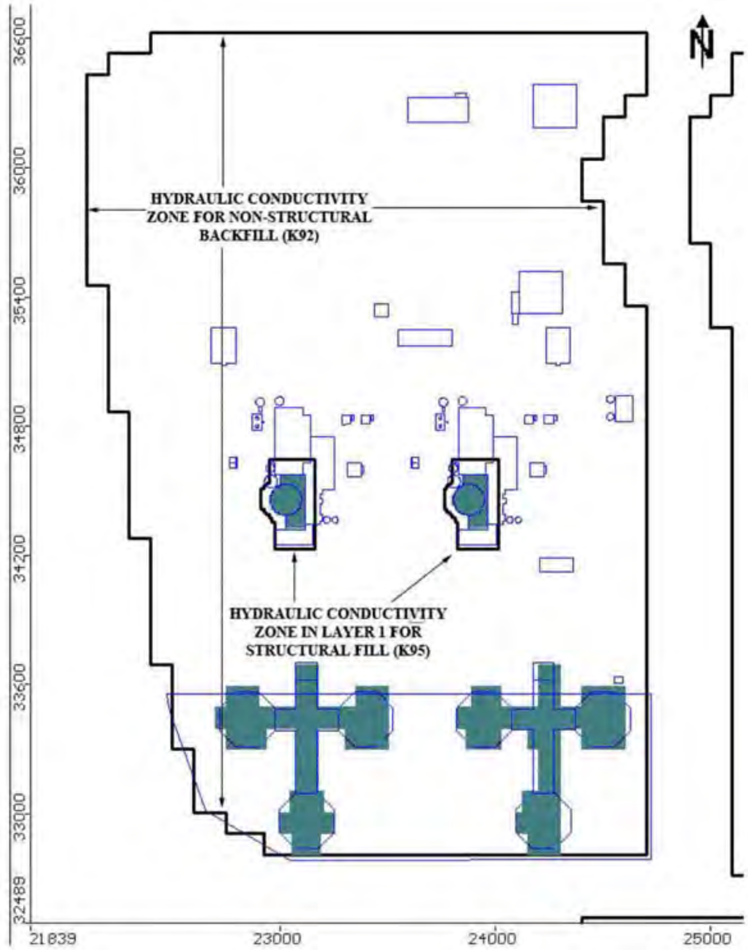
Notes: Diaphragm walls are shown in brown; gravel recharge zones are shown in aqua; paved recharge zones are shown in red; and grass recharge zones are shown in green.

Figure 2CC-257 Phase 2 Post-Construction Recharge Zones for Units 6 & 7



Note: Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

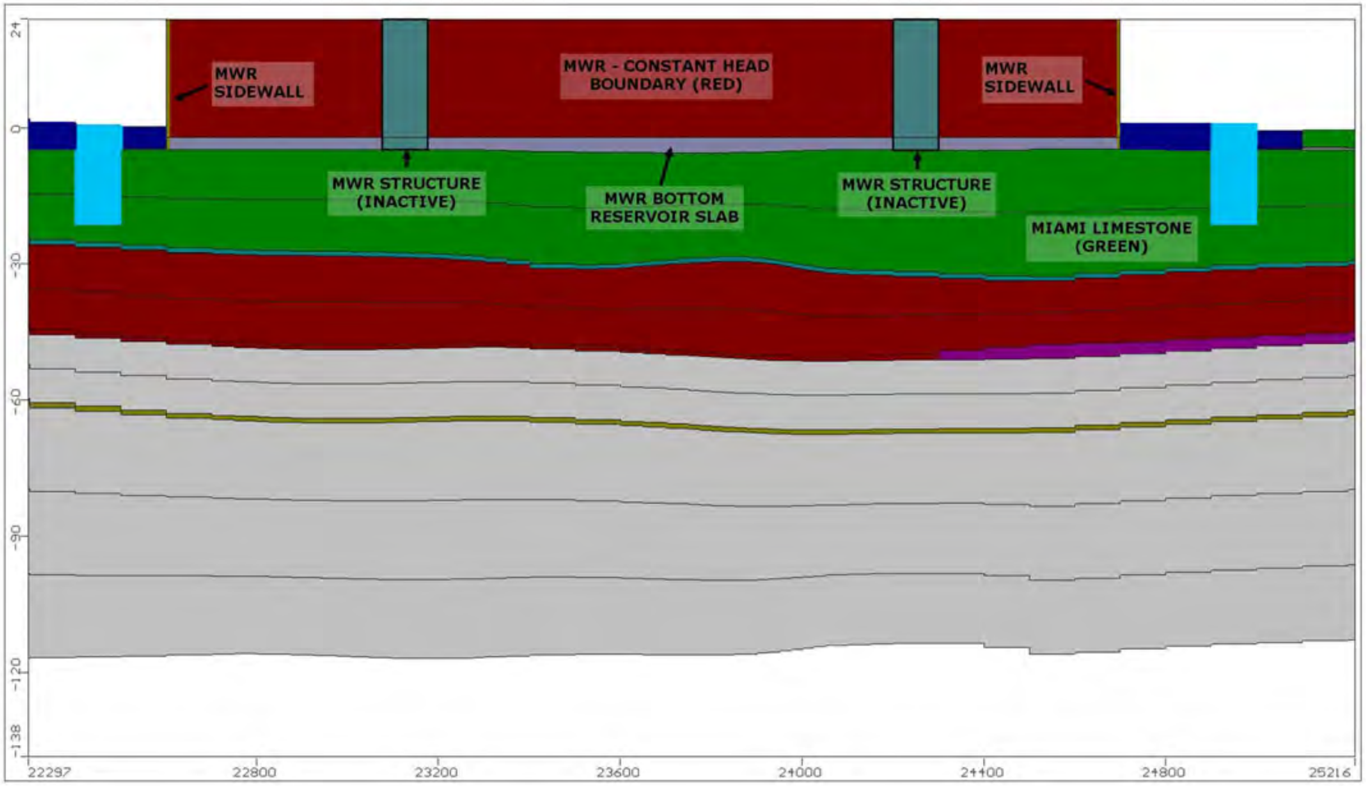
Figure 2CC-258 K95 and K92 Hydraulic Conductivity Zones



Notes: The Units 6 & 7 plant area is shown by the outer ring (shown as a black line). The inner ring near Units 6 & 7 (also shown as a black line) represents structural backfill (K_{95}).

Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-259 MWR Model Configuration (Row 251)



Note: Vertical axis represents elevation in ft NAVD 88. Horizontal axis represents model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-260 Phase 2 — Observation Point Locations Near Unit 6 and Unit 7

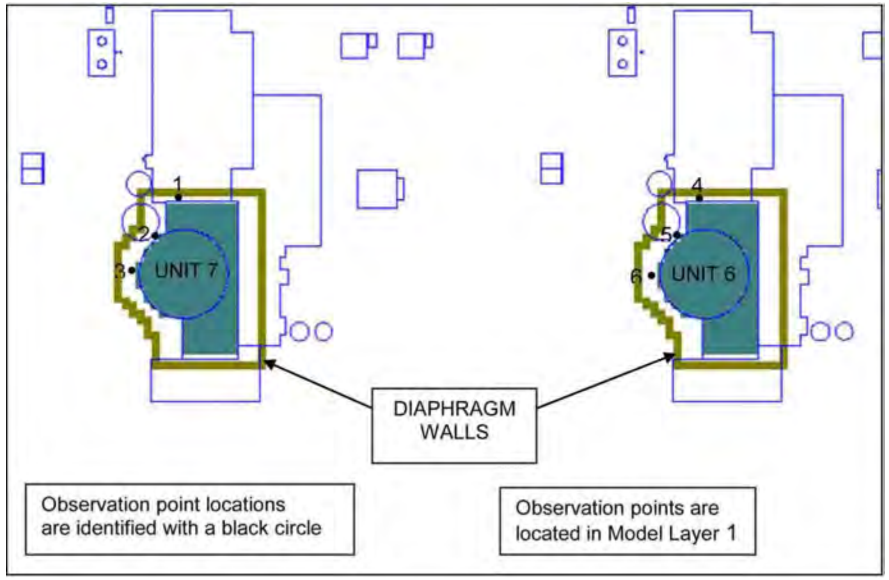
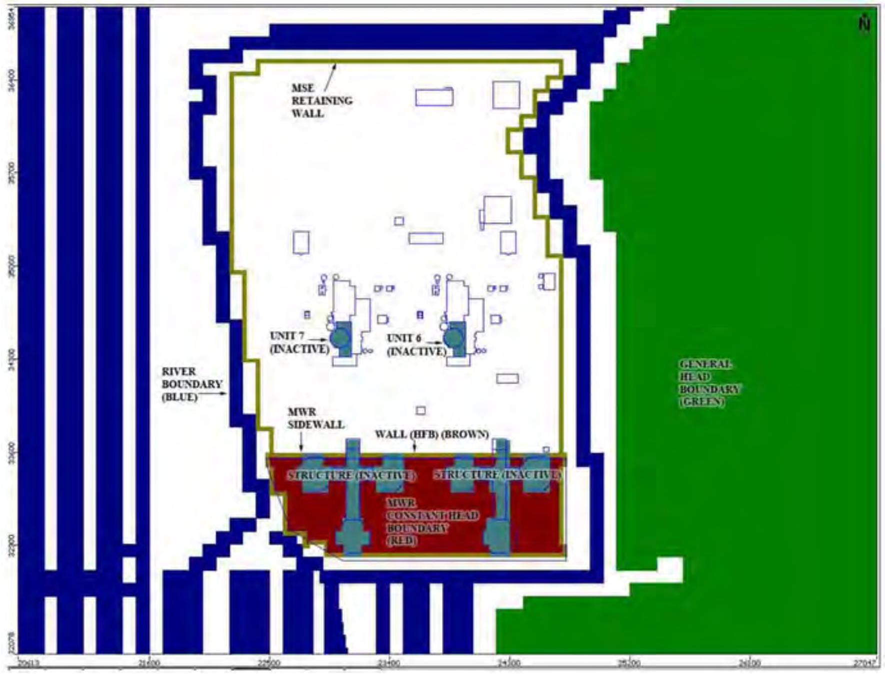
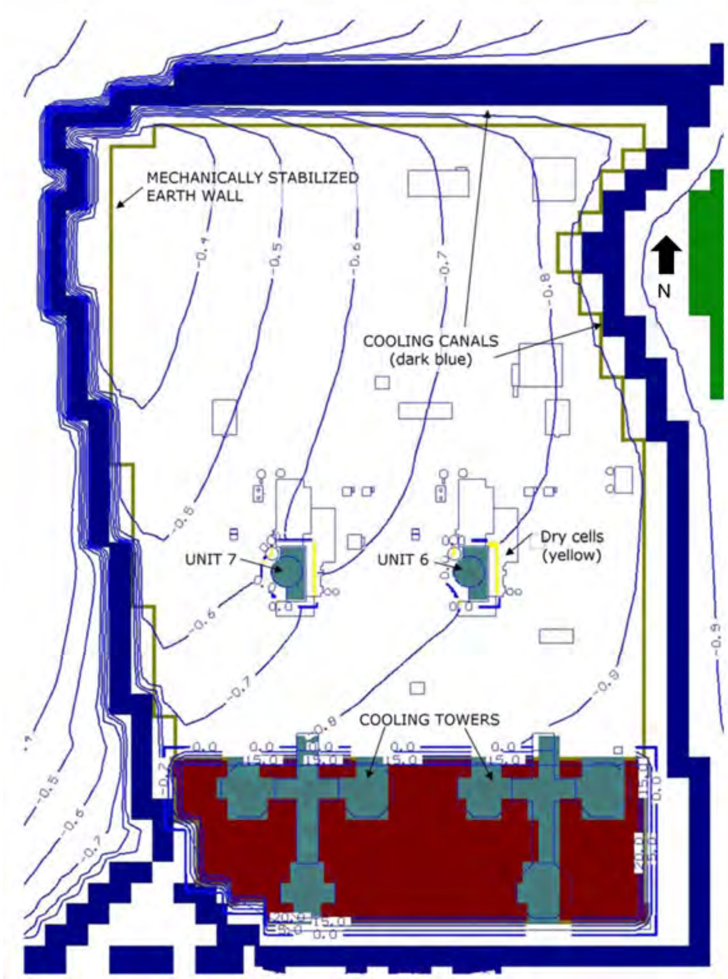


Figure 2CC-261 Phase 2 — Boundary Conditions in Model Layer 1



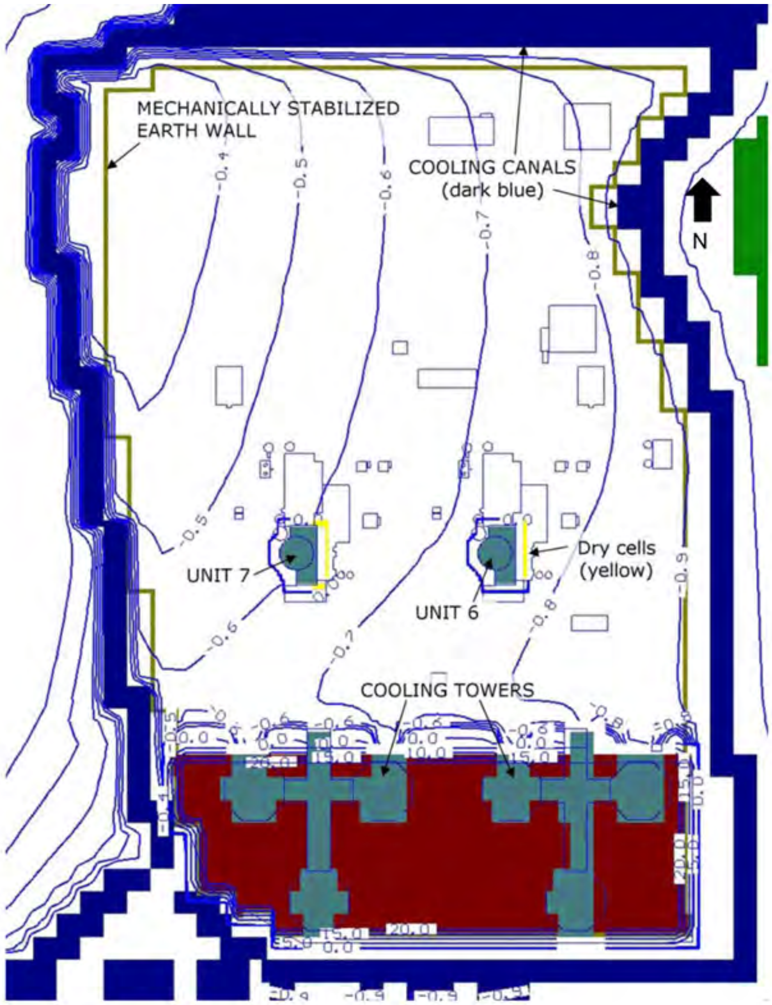
Note: Vertical and horizontal axes represent model coordinates in ft. Model origin at easting 852766, northing 362512 (in State Plane Coordinates, North American Datum of 1983/Adjustment of 1990, Florida East, Zone 0901, US ft).

Figure 2CC-262 Phase 2 Case 1 Simulated Groundwater Contours — Model Layer 1 Under Base-Case MWR Conditions



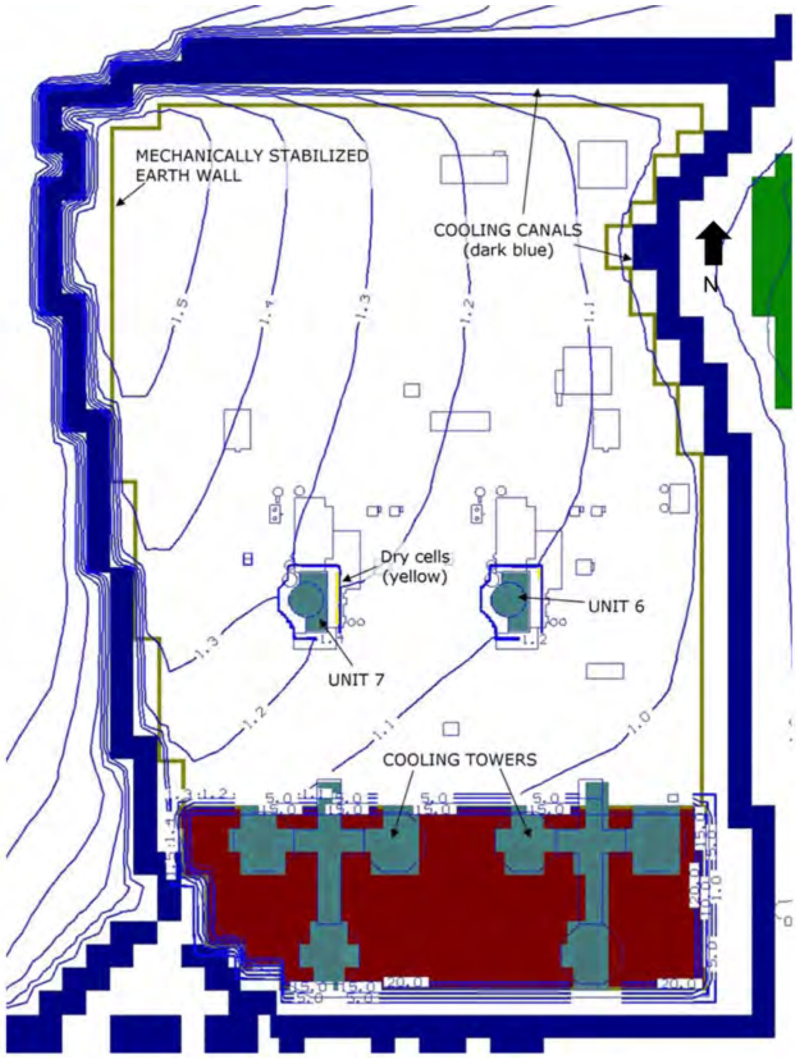
Note: Groundwater level contours in ft NAVD 88.

Figure 2CC-263 Phase 2 Case 3 Simulated Groundwater Contours — Model Layer 1 Under MWR Failure



Note: Groundwater level contours in ft NAVD 88.

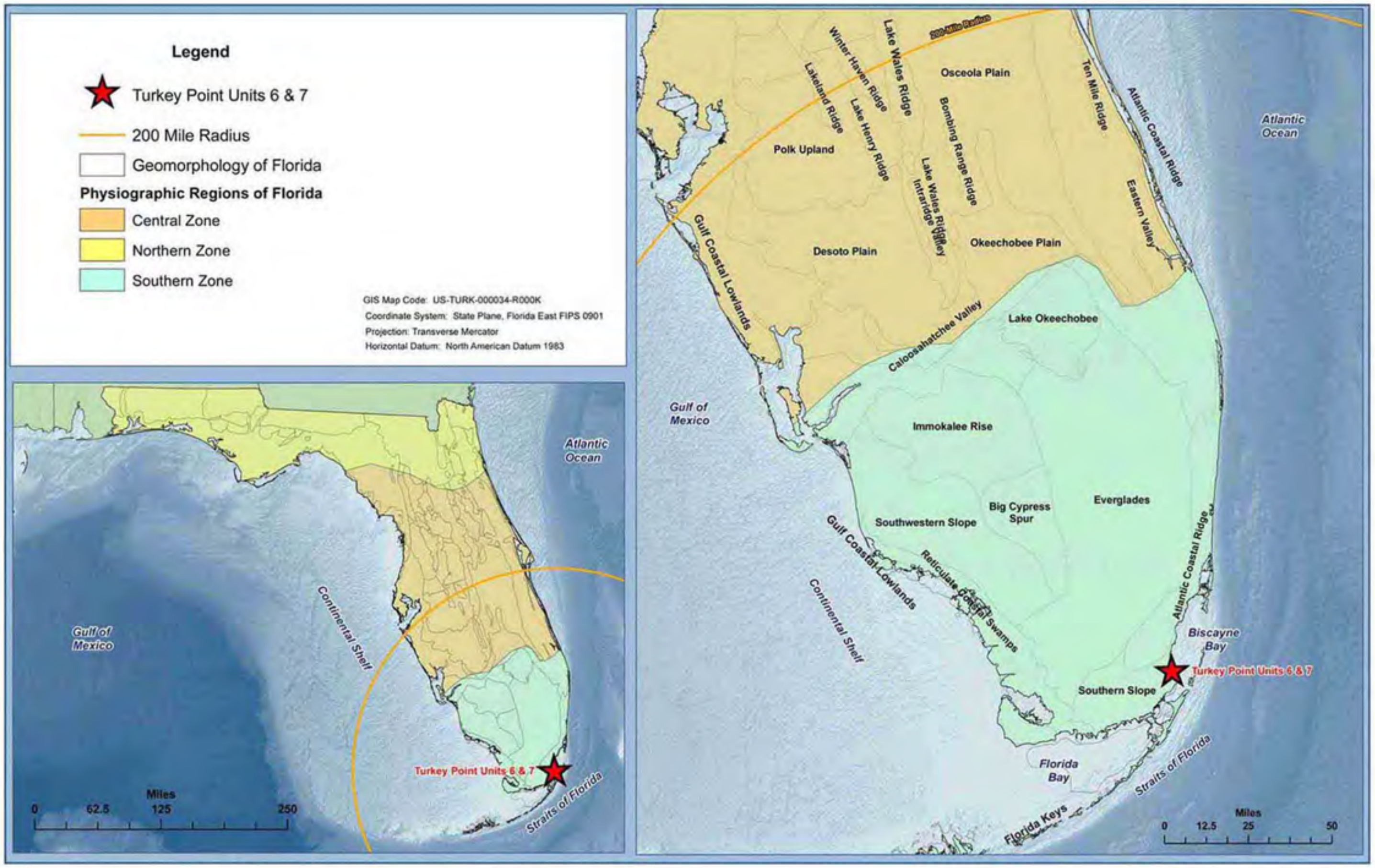
Figure 2CC-264 Phase 2 Case 4 Simulated Groundwater Contours — Model Layer 1 Under Sea-Level Rise Conditions



Note: Groundwater level contours in ft NAVD 88.

PTN COL 2.4-4

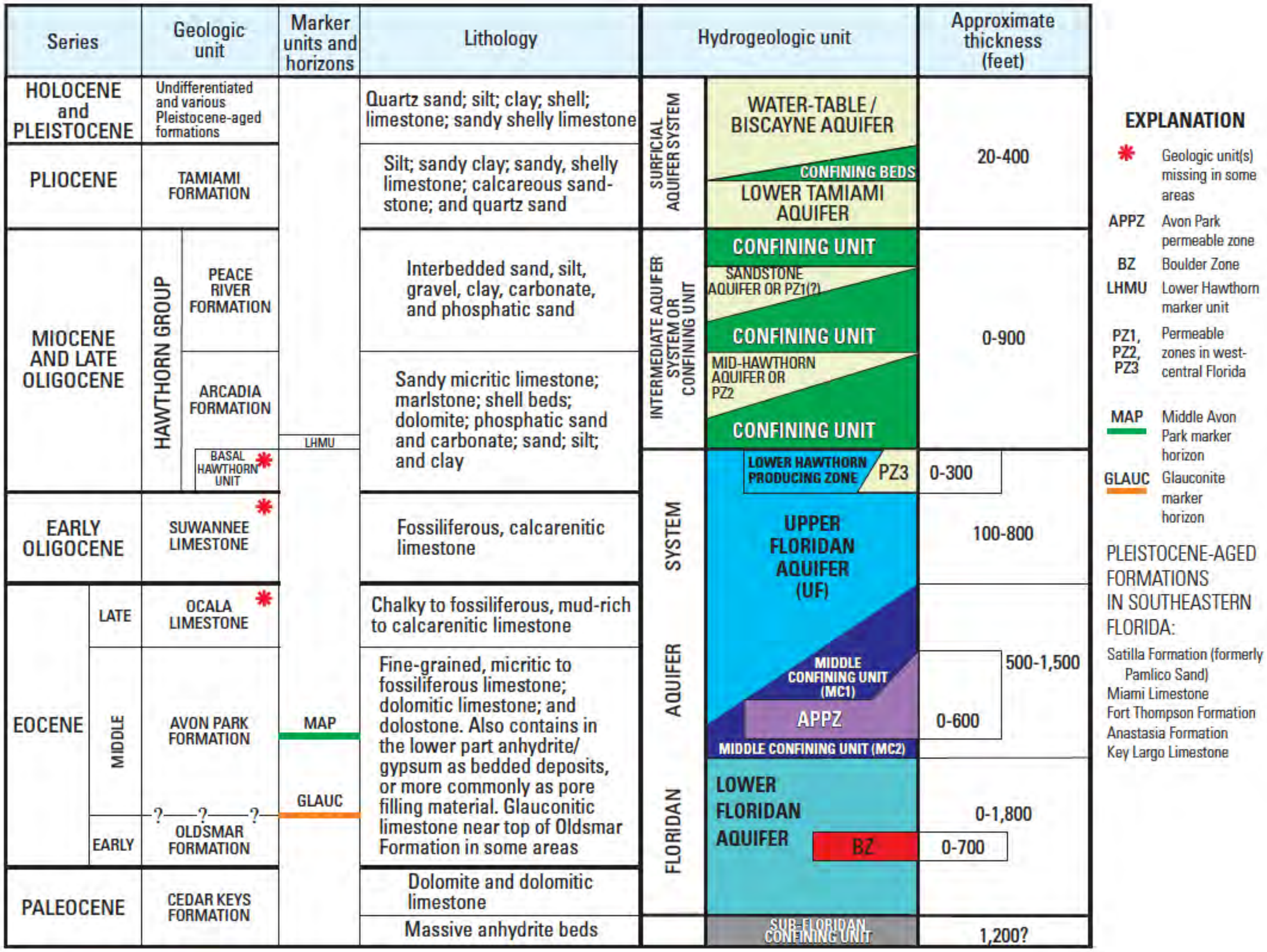
Figure 2.4.12-201 Physiographic Features



Modified from References 201 and 202
Note: Florida is within the Atlantic Coastal Plan physiographic province.

PTN COL 2.4-4

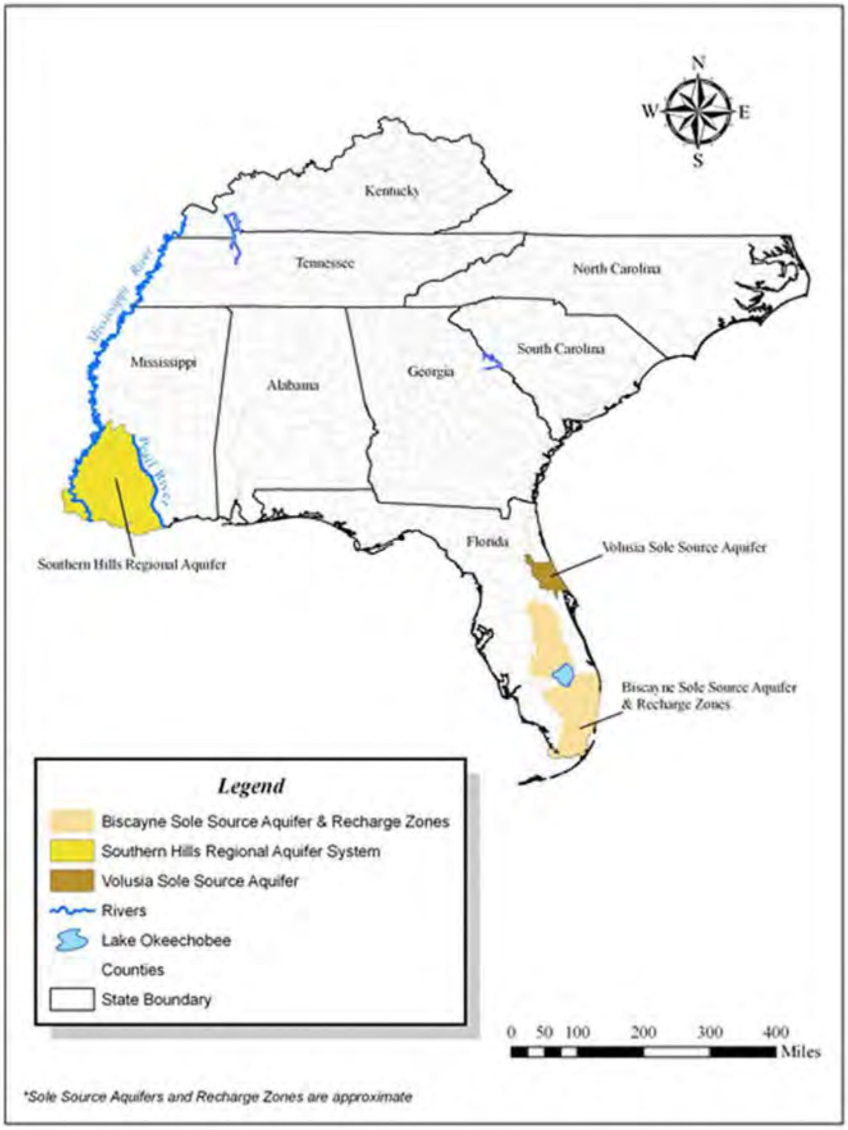
Figure 2.4.12-202 Regional Generalized Hydrostatigraphic Column



Source: Reference 206

PTN COL 2.4-4

Figure 2.4.12-203 Approximate Boundaries of EPA Region 4 Sole Source Aquifers



Source: Reference 205

PTN COL 2.4-4

Figure 2.4.12-204 Site Hydrostatigraphic Column

ERATHEM	SYSTEM	SERIES	HYDRO-GEOLOGIC UNIT		STRATIGRAPHIC UNIT		LITHOLOGY	APPROXIMATE TOP ELEVATION (ft NAVD 88)	APPROXIMATE THICKNESS (ft)
CENEZO C	QUATERNARY	HOLOCENE			organic muck		organic soil and silt	0	3
		PLE STOCENE	Surf c a aqu fer system	Biscayne aquifer	Miami Limestone		sandy, oolitic limestone	3	25
					Key Largo Limestone		well indurated, vuggy, coralline limestone	28	22
					Fort Thompson Formation		poor/well indurated fossiliferous limestone	50	65
	TERT ARY	PL OCENE		Semi confining unit	Tamiami Formation		sand and silt with calcarenitic limestone	115	105
		M OCENE	ntermed ate conf n ng un t		Hawthorn Group	Peace River Formation	silty calcareous sand and silt	220	235
						Arcadia Formation	calcareous wackestone with indurated limestones, sandstone, and sand	455	>160

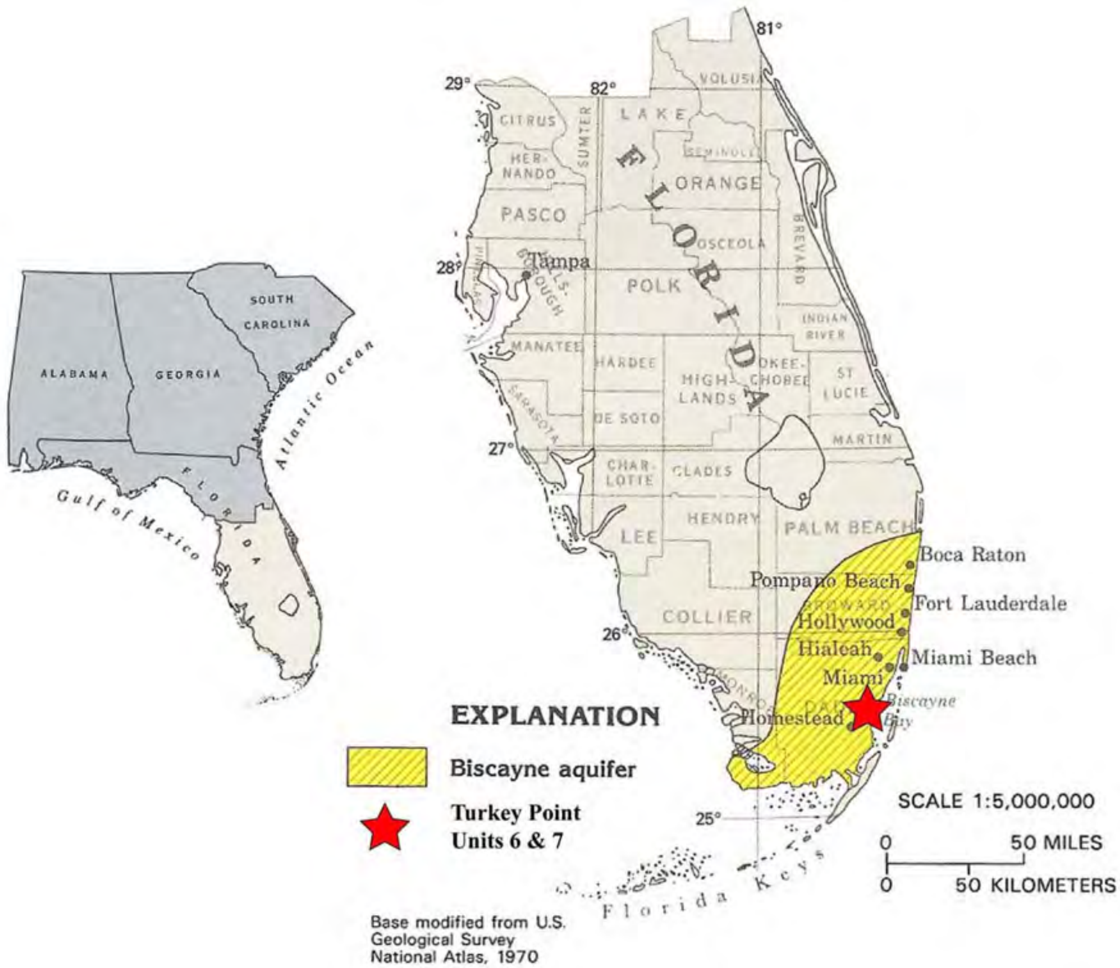
formation contact based on natural gamma signature

drilling ended at 616.5 ft NAVD 88

Color represents similar composition (carbonate, clastics, and organics).

PTN COL 2.4-4

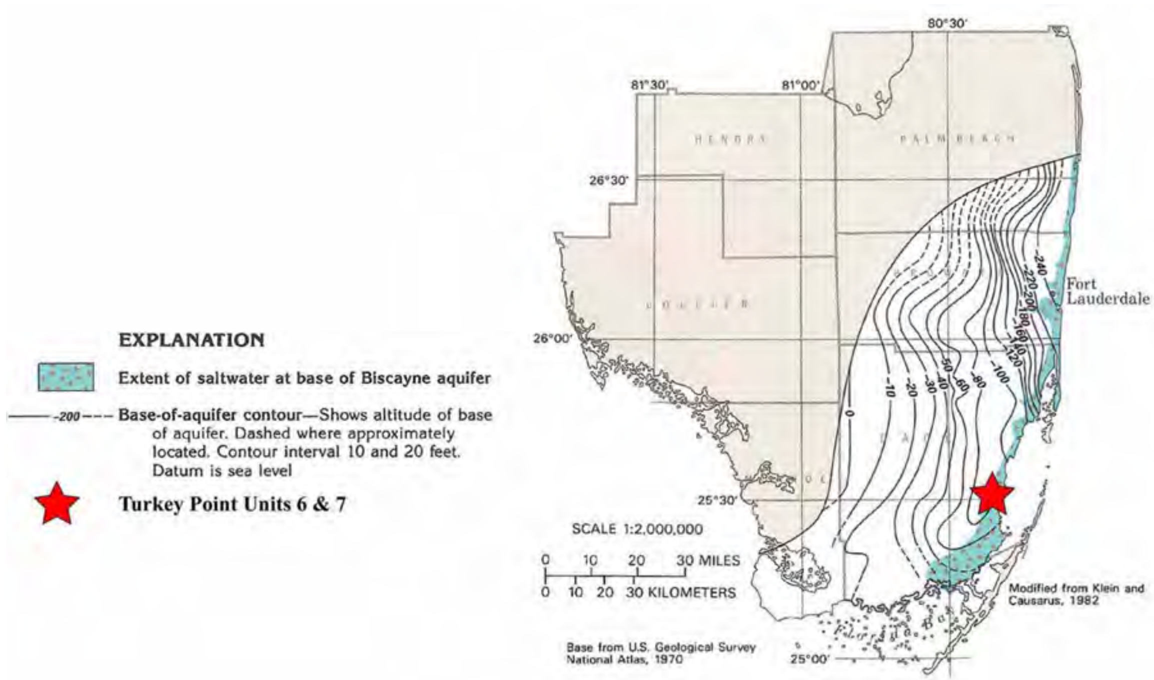
Figure 2.4.12-205 Location of the Biscayne Aquifer in Southeast Florida



Modified from Reference 210

PTN COL 2.4-4

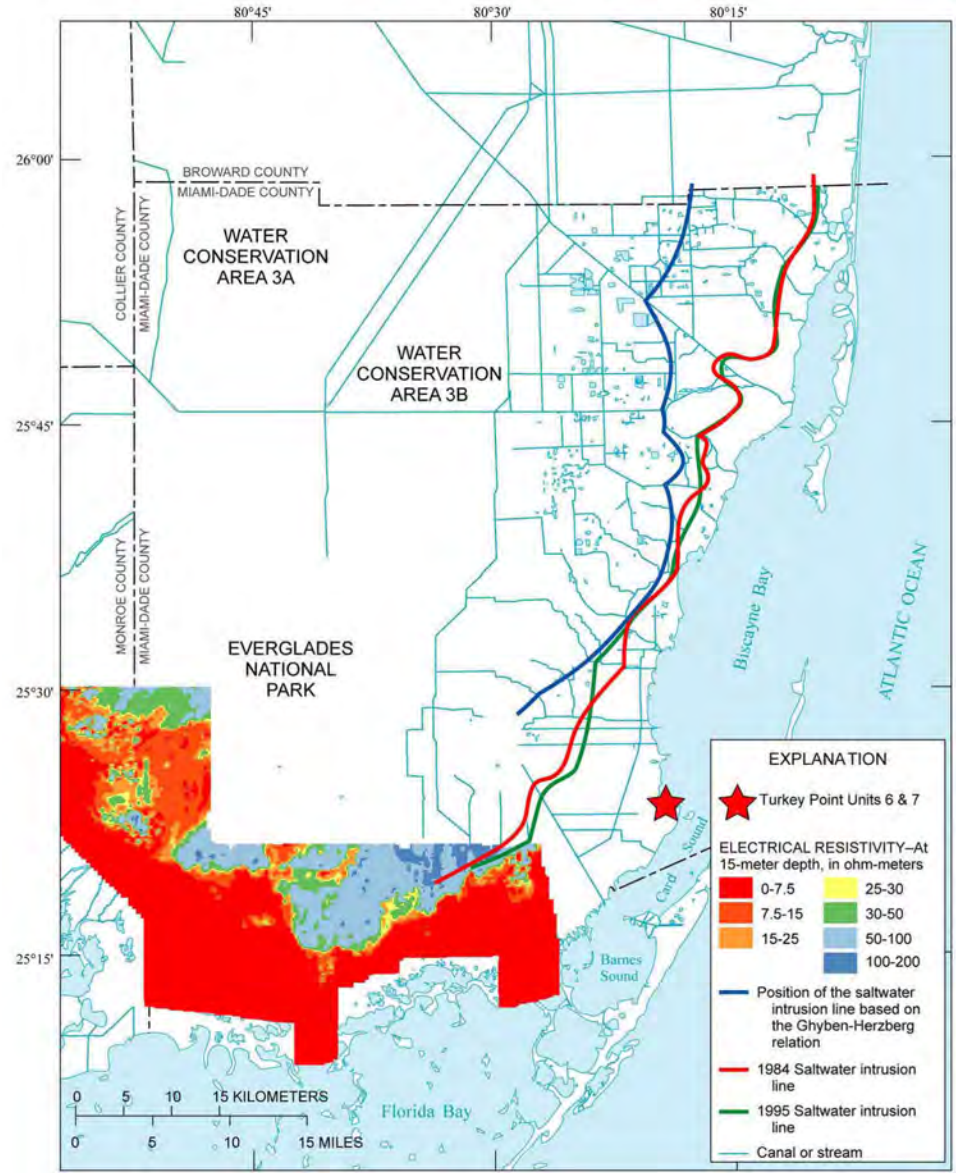
Figure 2.4.12-206 Base of the Biscayne Aquifer



Modified from Reference 210

PTN COL 2.4-4

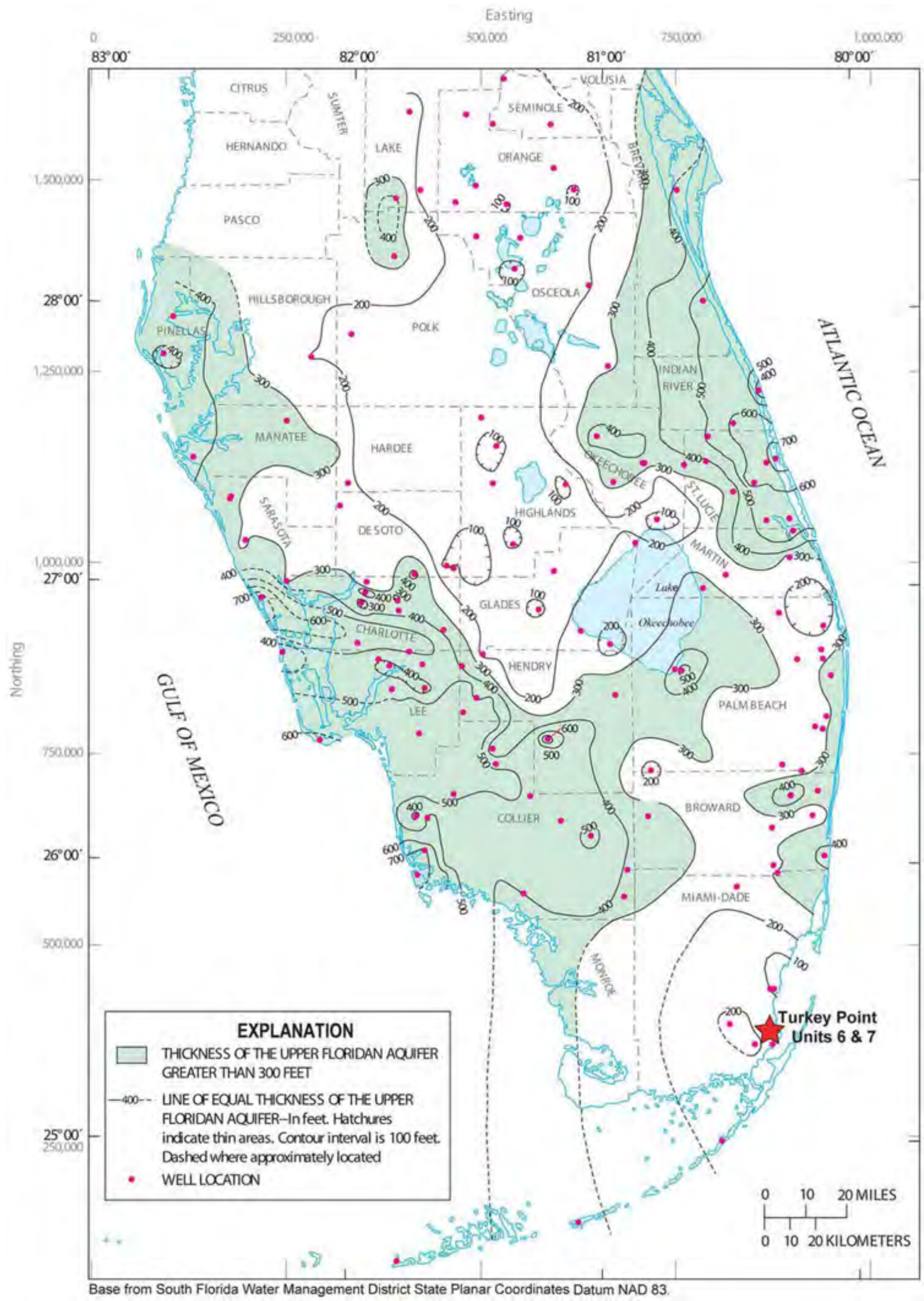
Figure 2.4.12-207 Location of the Freshwater-Saltwater Interface



Modified from Reference 212

PTN COL 2.4-4

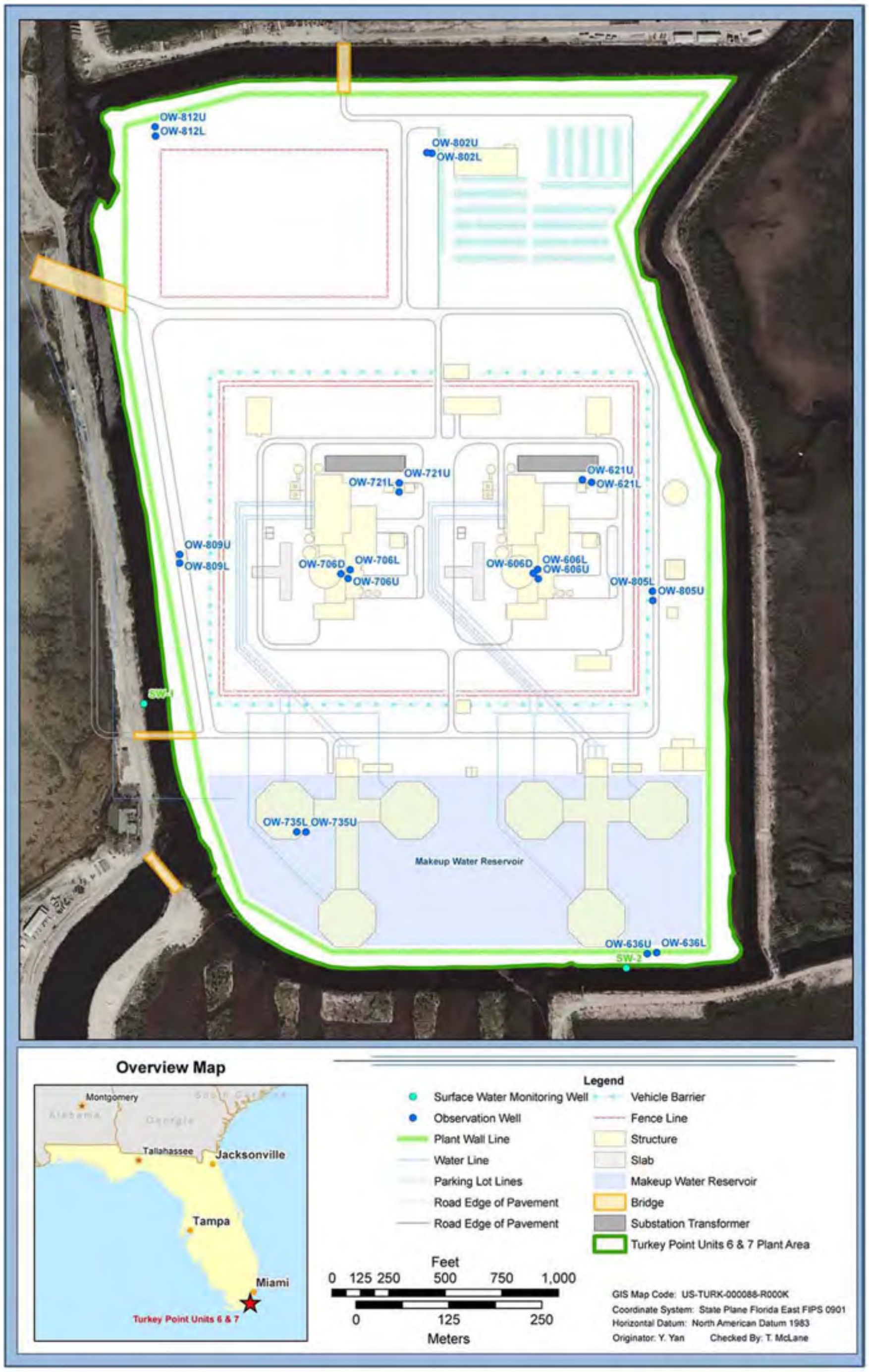
Figure 2.4.12-208 Thickness of the Upper Floridan Aquifer



Modified from Reference 206

PTN COL 2.4-4

Figure 2.4.12-209 Units 6 & 7 Observation Well Locations



PTN COL 2.4-4

Figure 2.4.12-210 Industrial Wastewater Facility

PTN COL 2.4-4

Figure 2.4.12-211 Upper Floridan Aquifer Production Wells for Unit 5