Salt Deposition and Impact Monitoring Plan for
The Palo Verde Nuclear Generation Stations
Units 1, 2, and 3

(Rev. 6)

Prepared For
Arizona Nuclear Power Project

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Note: Changes to this document are noted in the margins on each page with identifying numbers representing the revision. The original issue was in February 1983; a Revision 1 was prepared but never issued, being superseded by Revision 2, dated April 1983.

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1.0 INTRODUCTION

This document presents the modified design of an environmental monitoring program to determine the environmental impact, if any, due to salt drift from operation of the PVNGS mechanical draft cooling towers. It is designed to meet the commitment for a monitoring program contained in the Environmental Report, Construction Phase and the requirements of the Environmental Protection Plan (Appendix B to the PVNGS-OL) for a Terrestrial Ecology Monitoring Program. Table 1-1 is a summary of this commitment, and is based on experience with the program since its inception in 1983.

Table 1-1. Salt Monitoring Program for PVNGS[a]

Plant System Inducing Change	Predicted Physical Change	Physical Parameter to be Monitored	Biotic Indicator to be Monitored	Duration and Periodicity of Study: Preoperation Period	Duration and Periodicity of Study: Operation Period
Drift from cooling tower salt	Foliar deposition of salt	Airborne salt	Salt sensitive plant species	Baseline seasonal data one year prior to operation	Seasonal data until level of impact determined

[a]Environmental Report - Construction Permit Stage, Section 6.2.5.

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The monitoring program (1) determines levels of airborne salt deposition, (2) defines physical and chemical properties of surficial soils, (3) estimates species richness and cover and measures salt loading of the indigenous natural plant communities, and (4) measures salt loading and yield of cotton.

Comparisons of these parameters are made at sampling locations between the
period prior to operation and the period during operation of one, two, and
three units. There are also three control sites (42-44), which are used as 6
background locations not affected by operation of the cooling towers, that
give an indication of any long term changes.

2.0 MONITORING PROGRAM DESIGN

This section presents a description of the program design and includes a discussion of the selection of monitoring locations, sampling methods and 3 equipment, laboratory sample analyses, data review and report preparation, and quality assurance.

2.1 Selection of Monitoring Locations

The monitoring program is conducted both onsite and offsite out to approximately 15 miles from the cooling towers. With the exception of the 6 three control sites (42-44), all of the sampling locations are at distances of less than five miles from the cooling towers. This 5-mile distance corresponds to twice the maximum distance at which salt deposition has been measured during the first four years of cooling tower operation. The two salt deposition control sites (42, 43) are included in the monitoring program to measure levels of salt deposition at distances unlikely to be significantly affected by PVNGS emissions. Site 44 is a native vegetation contol site for creosote-bush. 2

Factors considered for the selection of these control site areas included an examination of the potential influences from any of the surrounding topography and their proximity to significant sources of fugitive dust or particulate emissions such as industry. The salt deposition control sites 6 (42, 43) are located approximately 15 miles to the southeast of the cooling towers. One control site (43) is an agricultural area and the other site (42) is in native desert environment. The native vegetation control site (44) is 6.6 miles northwest of the cooling towers.

At the onset of the monitoring program, a total of 44 sampling locations were 2 selected to meet the following objectives:

- Measure site-originated deposition via dustfall collection, and any changes in vegetation and/or soil chemistry at all nearby agricultural fields. 3

- Establish background data on salt conditions.

- Provide salt deposition data that could possibly be correlated with ongoing radiological and natural vegetation studies.

- Demonstrate that the monitoring program can detect site-originated salt deposition and determine the geographical limit of detection.

- Provide long-term control plots (at 15 to 20-mile distances and in 3 2 directions that are least frequently downwind of the cooling towers) for determining background variations in salt levels in the vicinity of PVNGS.

The sampling locations were reduced to 31 beginning in 1991 to focus sampling 6 on those sites likely to provide useful data. Sites beyond 2.5 miles have shown no increase in deposition from preoperational levels; however, only sites beyond 5 miles were eliminated.

6
Figure 2-1 shows the approximate locations of the 31 sites for the monitoring
of salt deposition and soil sampling, including the 3 control locations (42-
44) used to determine background changes, if any, in salt levels. Table 2-1
presents a summary of the types of sampling to be performed at each sampling
location. At nine locations within 5 miles of the site (see Figure 2-2), the
agricultural crops under cultivation are sampled.

At five onsite locations (1, 2, 3, 4 and 6), representative indigenous plant 4
communities of the site, which have been identified and monitored since 1976,
have been sampled semiannually (spring and fall). During June 1983, the
native vegetation communities at site number 5 were destroyed by fire. Site
number 5 was then and is currently maintained as a sampling site for dustfall 6
and soils only. Semi-annual sampling of the remaining locations has severely
reduced these native vegetation prompting a reduction in sampling frequency
to annually (Spring). The locations of these five communities, shown in
Figure 2-2, provide continuity with an ongoing baseline study of native
vegetation (see Section 2.2.2.1). Soil and dustfall monitoring are also
conducted at these locations.

Additional criteria used as a basis for selection of the monitoring sites 3
included the specification of their location at a distance from roads
adequate to minimize the collection of traffic-generated dust.

2.2 Sampling Methods

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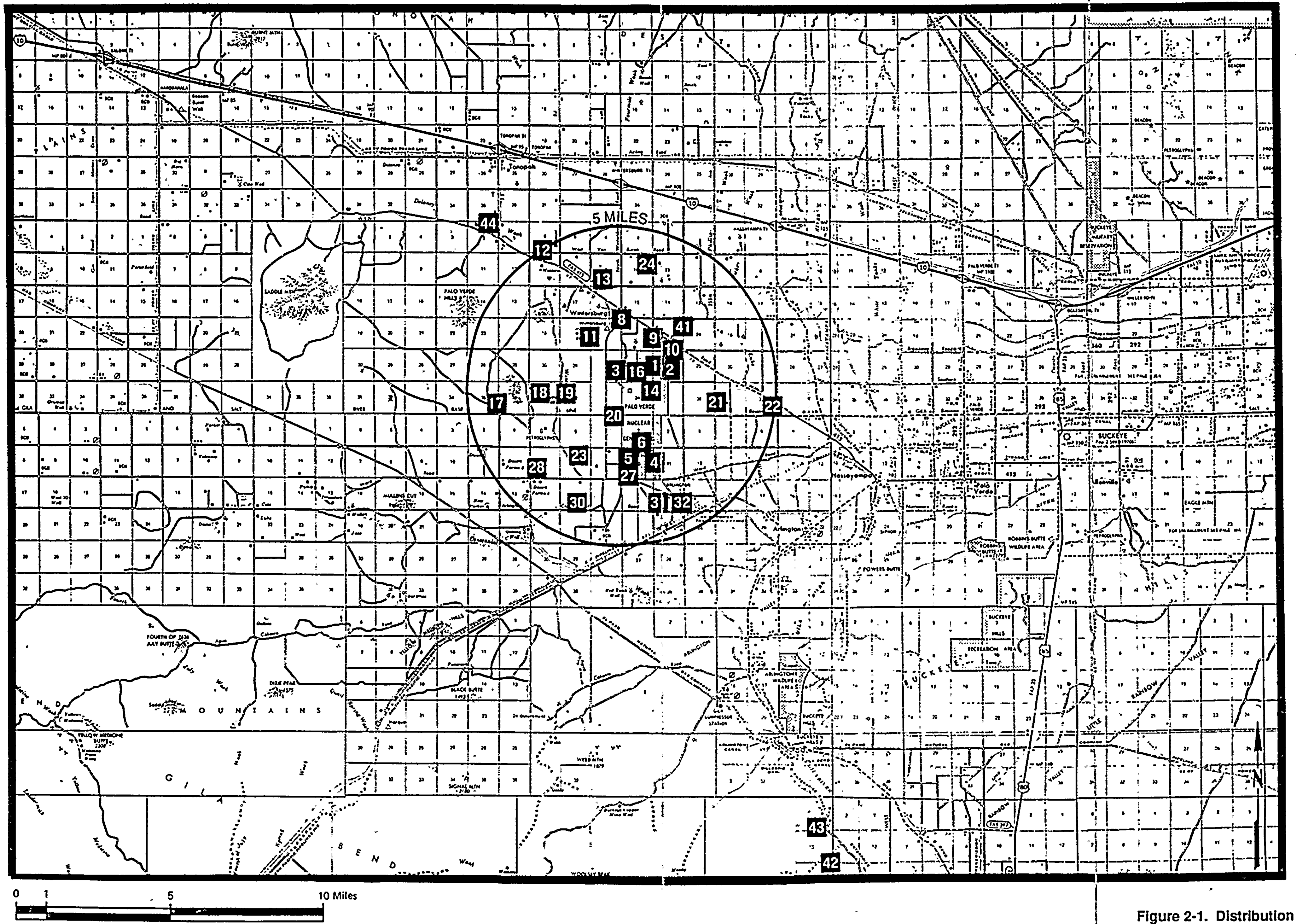
The sampling methodologies presented below and described in further detail in
the applicable work instructions are designed to assure valid data acqui-
sition. Four separate sampling methodologies are described; one for soils, 6
two for vegetation (indigenous and agricultural), and one for airborne salt.

2.2.1 Soil Sampling

At each of the 31 monitoring locations, composite soil samples (based on 6
5 cores from each of 2 transects) are collected at the end of the dry season
(July-August), and at the end of the wet season (normally March/April);
an additional sampling is conducted at all 10 agricultural sites after
cotton defoliation. The sampling procedure (Reference Work Instruction
GO 5.2.12.49) follows the DOE Environmental Measurements Laboratory's HASL-
300 Method for soil sampling[1], and uses a soil auger to collect 3-inch
diameter core samples in depth increments to 30 cm, which are divided into
upper and lower segments. The depth to the break between upper and lower
segments is determined in the field for uncultivated soils based on the depth 4
to a textural change. Cores in cultivated areas are divided into equal upper
and lower segments. All upper segments and all lower segments for each
transect are separately combined to form 4 composites (2 depth increments for
each of 2 transects) from each of which 2 samples are taken and labelled.
One sample of each composite is shipped to the analytical laboratory for
analysis and the other retained in storage.

1 Department of Energy, Environmental Measurements Laboratory, EML Procedures Manual, HASL-300, New York, NY, undated.



Revision 5, Jan. 1, 1991

Figure 2-1. Distribution of dustfall and soil sampling locations

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Table 2-1

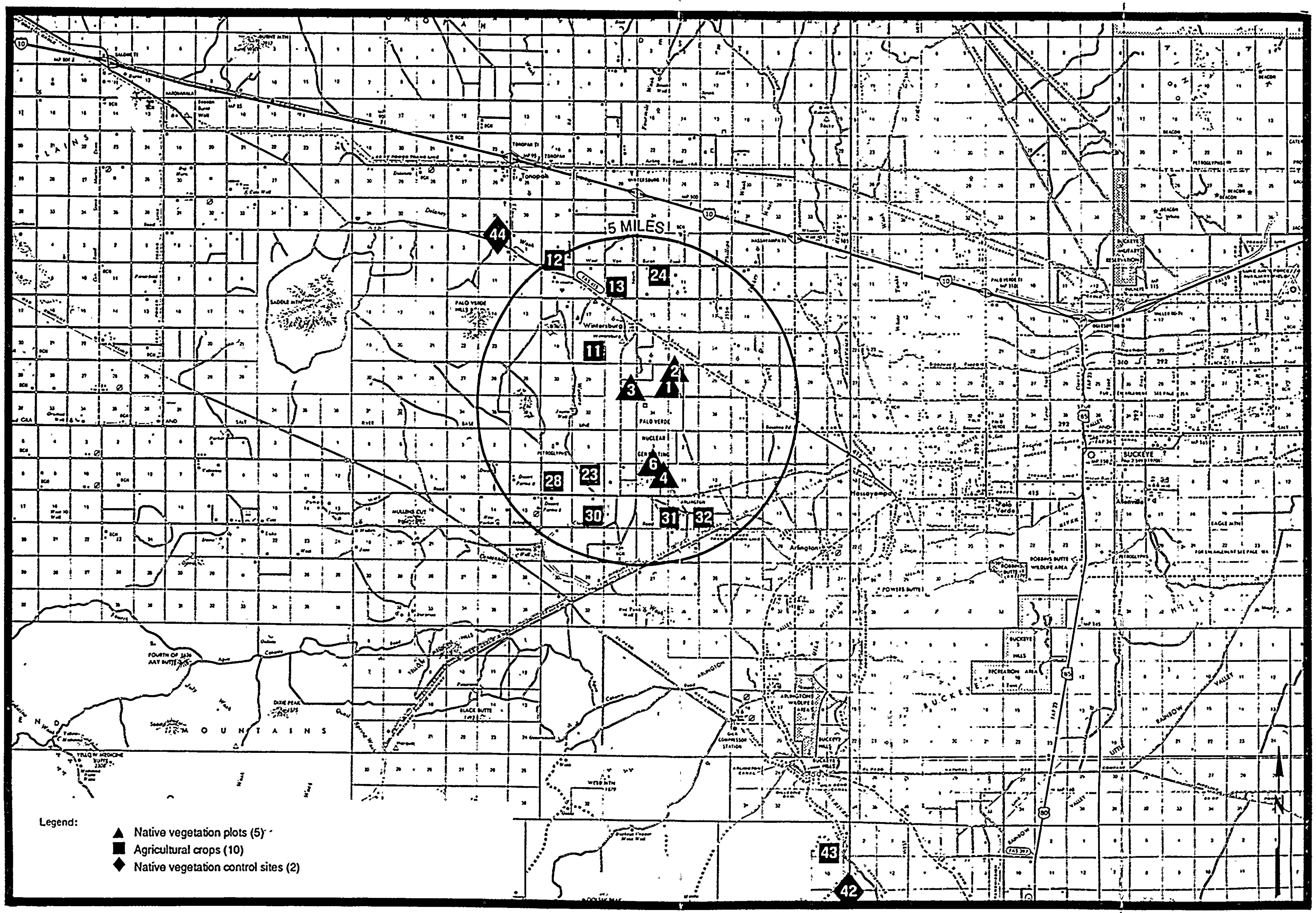
Summary of the Types of Sampling to be Performed at Each Sampling Location

Airborne Sampling Location No.	Salts Via Dustfall Collection	Native Soils	Vegetation	Agricultural
1	X	X	X	
2	X	X	X	
3	X	X	X	
4	X	X	X	
5[a]	X	X		
6	X	X	X	
8	X	X		
9	X	X		
10	X	X		
11	X	X		X
12	X	X		X
13	X	X		X
14	X	X		
16	X	X		
17	X	X		
18	X	X		
19	X	X		
20	X	X		
21	X	X		
22	X	X		
23	X	X		X
24	X	X		X
27	X	X		
28	X	X		X
30	X	X		X
31	X	X		X
32	X	X		X
41	X	X		
42	X	X	X	
43	X	X		X
44[b]	X	X	X	
Total	31	31	7	10

6

[a]Native vegetation communities destroyed by fire in June 1983.

[b]Established as a native vegetation control site for salt bush in May 1984. The salt bush plant community at site Number 42 was tilled and the land was converted to agricultural use sometime prior to May 1984. However, site 44 has been maintained as a creosote-bush control site.



0 1 5 10 Miles

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Figure 2-2. Distribution of vegetation sampling locations

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2.2.2 Indigenous and Agricultural Vegetation Sampling

2.2.2.1 Native Vegetation

Representative native plant communities, which have been identified and monitored since 1976 to determine baseline conditions, are sampled semi-annually
(March/April). Seven native vegetation study areas are sampled as depicted. 6
in Figure 2-2.

The native plant communities identified around the PVNGS are dominated by creosote and salt bush. Associated with these are mesquite and several species of cacti. The vegetation monitoring program conducted within the seven vegetation communities (Reference Work Instruction GO 5.2.12.48) includes:

3

- The measurement of species richness and relative cover. 4

- The measurement of salt loading in tissues of the dominant or co-dominant flora (other than cacti).

2.2.2.2 Crop Sampling

6

At each of the 10 agricultural monitoring locations (Figure 2-2), agricultural crops are sampled (Reference Work Instruction GO 5.2.12.43) twice each growing season (e.g., June and September for cotton) prior to defoliation(or
harvest) to determine the amount of plant tissue salt loading. Additionally, 4
cotton yield is obtained by collecting the seed and fiber (boll) from selected cotton plots (Reference Work Instruction GO 5.2.12.43) as well as from the Agricultural Stabilization Conservation Service.

2.2.2.3 Infrared Photography

In addition to the quantitative vegetative analyses, both native vegetation 2
and agricultural crops are monitored using infrared photography (Reference
Work Instruction SRO 5.2.32.3). Aerial photography (false color infrared) is 4
performed to coincide with peak vegetation crop productivity for the principal crops grown within a 5-mile radius of PVNGS (e.g., August/September for cotton).

This methodology permits the detection of vegetative stress, confirmed by 3
field inspection, whether due to natural or artificially induced (e.g., salt drift) conditions and provides a documented photographic record of existing environmental conditions.

2.2.3 Salt Deposition Sampling

The rate of salt deposition is measured by the collection of dustfall samples which are analyzed for salt content. The dustfall sampling (described in ASTM method D1739[2]) is accomplished by placing pairs of open jars at the selected monitoring locations. Two jars are placed at each sampling location to provide an estimate of sample precision.

The jars are elevated approximately three feet above the ground on stands, with a bird ring placed around the edge of the jar to prevent birds from perching and contaminating the sample. This height differs from the recommended minimum height of eight feet presented in the ASTM method to permit the collection of dustfall at the approximate plant crown height. A chemically inert 1 to 2 mm conical screen is hung above the maximum water level in the jars to keep out any potential contaminants such as insects.

The monthly sampling (Reference Work Instruction GO.5.2.12.40) follows the ASTM method for collection of dustfall, except for Section 9.1.2 (Preservation). This section, calling for the use of an algicide ($CuSO_4$) was determined to be inapplicable and unnecessary at PVNGS in April 1987. At the end of each month the jars are collected and replaced by a clean set of jars. The collected jars are rinsed to transfer the samples to shipping bottles which are labeled and sent to a laboratory for analysis. At least one inch of water is maintained in the jars to prevent collected dust from being blown out. An 18-inch deep ASTM jar used for dustfall collection is the most suitable collection jar for sampling in a desert environment; it requires less frequent checking and replenishment of the water level than other, shallower jars.

2.2.4 Sampling Schedule

The monitoring program frequency for salt deposition samples is generally on a monthly basis. Exceptions include: native vegetation, sampled each year in March/April; agricultural sampling in June/July and again with aerial photography in August/September; and soils sampled at the end of the rainy (normally March/April), and the dry seasons (July/August) and post-defoliation (November/December). The dustfall samples are analyzed on a regular monthly schedule. Cooling tower basin water is sampled at least quarterly to provide the chemical composition data used as a basis for comparison with the analyses of deposited material. Table 2-2 summarizes the sampling schedule for components of the program.

2.3 Sample Analysis

Samples collected during this program are sent to selected laboratories for the indicated analyses. The laboratory procedures adopted for analysis of soils, vegetation, water, and dustfall are documented. The procedures include the documentation of quality control checks on the instrumentation and the analyses.

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2 American Society of Testing and Materials (ASTM), Standard Method for Collection and Analysis of Dustfall (Settleable Particulates) D1739-70, Annual Book of ASTM Standards, Part 26, Philadelphia, PA., 1970.

Table 2-2. Program Sampling Schedule

COMPONENT	MONTH												
	J	F	M	A	M	J	J	A	S	O	N	D	
Particulate Dustfall	X	X	X	X	X	X	X	X	X	X	X	X	
Soils		X /	X				X /	X			X		4
Native Vegetation			X /	X									6
Crops						X /	X	X /	X				4
Aerial Infrared Photography								X /	X				
Cooling Tower Basin Water			X			X			X			X	

Soil samples are analyzed for the following: pH; soluble Na, Ca, K, Mg; B; exchangeable Na, Ca, K, Mg; electrical conductivity; $SO_4^=$, NO_3^-, Cl^-, F^- 4
$CO_3^=$, HCO_3^-, NH_4^+ and $PO_4^=$. Textural analysis is performed once as part of a baseline characterization for each monitoring site. Native vegetation and crop samples are analyzed for Na, Ca, K, Mg and for as $SO_4^=$, NO_3^-, Cl^- and PO_4^-. 2

The collected dustfall samples are analyzed for total suspended solids and 3
the most significant components of the cooling tower blowdown (and drift) as identified in Table 3.6-1 of the PVNGS ER-OL, Units 1-3.

Finally, cooling tower basin water is sampled and analyzed at least quarterly for the same major constituents as the dustfall samples and identified in Table 3.6-1 at the PVNGS ER-OL, Units 1-3, to confirm the composition of the drift (and blowdown). As a minimum, these include: Ca, Mg, Na, K, Cl^-, NO_3^-, $SO_4^=$, and Si. Additionally, minor constituents are quantitatively assessed to the extent possible.

Interpretation of the aerial photography is conducted by qualified personnel. Areas of apparent vegetative stress are delineated, and a field inspection conducted to identify causal effects for all areas of apparent stress. If there are any environmental changes, a map is prepared which indicates those areas.

2.4 Data Review

The reported data is examined by NUS for consistency. Suspicious data may prompt a request for a repeat analysis of the sample(s). Meteorological data are used to ascertain that the pattern of salt deposition is consistent with the prevailing winds, stability classes, and precipitation over the period of sampling. Patterns of inconsistent data, or locations with large differences in the paired samples may indicate that the locations are subject to interferences or tampering. Additional sampling or an alternate sampling location may be required for these locations. Once the individual data have been examined, timely summaries are prepared. Data are compared for discernible differences between the control samples.

Seasonal and annual summaries are prepared and the data examined for 3
correlations with meteorological conditions over the period. Methods for demonstrating differences in the annual data include changes in the chloride to sodium ratios, and isopleths of annual concentrations. The evaluation of the control and plant vicinity differences includes analyses for correlation between salt deposition, and changes in soil and/or plant chemistry. Detailed evaluation of changes in any of the three media (air, soil, plants) at one or more sampling locations are evaluated by appropriate statistical analyses.

2.5 Quality Assurance Program

A comprehensive quality assurance program is essential for the successful conduct of a good monitoring program. The quality control measures designed into the program include:

- collocated samples at each sampling location to determine sample precision;
- an observation and data record for each sample;
- sampling at a range of distances from the cooling towers to show the procedures are capable of detecting salt deposition and also for determining the limit of detection;
- detailed written procedures for all aspects of the program.

Written quality assurance procedures have been developed in accordance with 3
the quality assurance requirements of ANPP. The laboratory quality assurance programs provide the required quality assurance checks on the sample analyses at the laboratory. An independent audit and inspection will be conducted to review the sampling methods and the techniques and records of the analytical laboratory.