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ENGINEERING REPORT FOR THE CLINCH RIVER BREEDER REACTOR PLANT PROJECT EFFLUENT DISCHARGES

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March, 1982

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1.0 INTRODUCTION & GENERAL DATA

1.1 Project Description

The Clinch River Breeder Reactor Plant (CRBRP) is the demonstration plant proposed by the U.S. Department of Energy (DOE) under its Liquid Metal Fast Breeder Reactor (LMFBR) Program. The major objectives of the CRBRP are: (1) to demonstrate the technical performance, reliability, maintainability, safety, environmental acceptability, and economic feasibility of an LMFBR central station electric power plant in a utility environment; and, (2) to confirm the value of this concept for conserving important nonrenewable natural resources.

The CRBRP is designed to be an integrated electric power plant with a liquid-sodium-cooled breeder reactor supplying the thermal energy to produce steam to drive a turbine-generator. With the initial reactor core of uranium and plutonium mixed-oxide fuel, the plant is expected to produce 975 megawatts of thermal energy (MWt) and a gross output of 380 electrical megawatts (MWe). Future core designs may result in a gross power of 1121 MWt and a gross output of 439 MWe.

Water needed by the plant will be supplied by the Clinch River. For maximum power, the annual average water requirement would be about 8.8 mgd, of which 3.5 mgd would be returned to the river and 5.3 mgd would be consumed, mainly by evaporation from the mechanical-draft wet cooling tower used to cool the exhausted steam from the turbine-generator.

Two 161-kv transmission lines approximately 3.2 miles long will be constructed from the plant to an existing transmission line owned by the Tennessee Valley Authority (TVA). Nearly all of the right-of-way required will be obtained by widening existing corridors.

Electricity generated by the CRBRP will be purchased by TVA and distributed to loads on its power system. The applicants' plans call for a five-year demonstration period after operational testing of the plant. At the conclusion of the demonstration period, TVA may offer to purchase the plant at a price based upon its value as a power production facility; otherwise, the plant would remain under DOE ownership for continued operation or decommissioning. If the plant is operated for a total 30 years, the average capacity factor is estimated to be 68.5%.

1.2 GENERAL DESCRIPTION OF THE SITE AND ENVIRONS

The proposed CRBRP Site is located in Roane County, Tennessee, on the north side of the Clinch River, between CRM 14.5 and 18.6, and about 22 miles W of Knoxville, Figure 1.2-1. Nearby cities are Kingston, 7 miles W; Harriman, 9.5 miles WNW; and Oak Ridge, 9 miles NE. The Site is in the remote southwestern corner of the City of Oak Ridge, on undeveloped land which is federally owned and under custody of the Tennessee Valley Authority (TVA). DOE's Oak Ridge reservation meets the site's northern boundary.

The center of the reactor containment vessel would be located at 35°53'24" N latitude and 84°22'57"W longitude. Grade for principal plant structures would be 74 ft. above the mean river water level of 741 ft above MSL. The site consists of 1364 acres of which about half of the acreage is taken up by the peninsula where the plant would be located.

Steep limestone ridges, hills, and knobs are prevalent in the region. Chestnut Ridge, running through the north portion of the Site, is the dominant topographic feature, reaching an elevation of 1100 ft above MSL at the crest.

The general area within a 10-mi radius of the plant is taken up by residences, farms, recreation, industry, and woodland. Several commercial dairy farms are present in the area, although the trend over recent decades is toward beef production, with its lower labor requirement. Agricultural crops generally are grown in small plots for single family use. There are three bank fishing areas within 3 miles of the Site. A 30-unit camping and day use area is located about 2-3/4 miles SE of the Site. A 100-unit campsite, with plans for fishing, boating and swimming, is on the Caney Creek embayment about 1 mile SE of the Site boundary. There are no wildlife preserves or hunting areas within 5 miles of the Site. A waterfowl refuge is 8 miles southwest on the Tennessee River, and a wildlife preserve is at Kingston. Principal industrial activities are the Oak Ridge Gaseous Diffusion Plant, the Oak Ridge National Laboratory (ORNL), the Y-12 Area, and TVA's Melton Hill Dam (Figure 1.2-2). At the northern end of the Site, between Bear Creek Road and Grassy Creek, about 112 acres have been set aside for the Clinch River Consolidated Industrial Park. Minerals are not obtained from the Site and vicinity.

Within a 20-mi radius of the site, 8 public water systems and 16 industrial systems draw from surface water, including the Clinch River and the Emory River. The closest such withdrawal is by DOE, 1.6 miles downstream. Groundwater supplies 17 public systems and many residences within the 20-mi radius. Over 100 such residences are within 2 miles, all located south of the Clinch River. Commercial traffic through the Melton Hill Dam increased from 1000 tons in 1966 to 10,000 tons in 1973. For the same years, the numbers of recreational craft dropped from 1200 to 800.

Additional site information may be obtained by referring to Sections 2.1, 2.2, and 2.3 of the CRBRP Environmental Report.

1.2.1 SITE GEOLOGY

The CRBRP Site lies in the Valley and Ridge Tectonic Province near the western border of the former Appalachian geosyncline, which was active during most of the Paleozoic Era (more than 230 million years ago). The Site is underlain at shallow depths by sedimentary rocks (siltstone and limestone) of Ordovician age, Figure 1.2-3. The rocks were folded and faulted during the Paleozoic era and are now tilted to the SE at an angle of about 30°. Since then, weathering and erosion have been the dominant geologic processes at the Site, with sediment accumulation being restricted to terrace and flood plain deposits of the Clinch River. The area is presently characterized by rugged terrain of sub-parallel ridges with intervening valleys. In the Site vicinity, the major ridges (Chestnut Ridge to the northwest and Dug-Hood Ridge to the southeast) crest between 900 and 1,200 ft. The valley between these ridges, known locally as Poplar Springs Valley and Bethel Valley, consists of rolling hills which range between elevations of 750 and 800 ft. Within the Site boundaries, Chestnut Ridge consists of two subordinate ridges, which crest at about 900 ft. elevation. In the valley formed by these sub-ridges, a topographic saddle rises to about 800 ft. and the valley slopes from this saddle in both the northeasterly and southwesterly directions down to the Clinch River (normal summer pool 741 ft.). Flow along valleys and gullies occurs only after heavy rainfall.

The Site is situated between the traces of the Copper Creek and Whiteoak Mountain thrust faults. No evidence of any post-Paleozoic activity associated with them has been found. Eleven recorded earthquake epicenters are within a 50-mi. radius, 19 epicenters within a 100-mi. radius and 44 within a 200-mi. radius of the Site. The largest earthquake known to have occurred within the tectonic province in which the Site is located (southern part of Valley and Ridge Tectonic Province) was on May 31, 1897 in Giles County, Virginia. Detailed geologic information may be found in CRBRP Environmental Report, Section 2.4.

1.2.2 SITE TOPOGRAPHY

The Site is on a peninsula approximately between river miles 15 and 18 on the Clinch River. This region is characterized by a series of parallel ridges extending in a northeast-southwest direction. The Site lies along a rolling flank of one of these ridges which slopes gradually toward the Clinch River (also known as Watts Bar Lake). Normal summer reservoir pool elevation is 741 feet.

Figure 1.2-4 is a topographic map showing the area surrounding the Site. Topographic profile cross sections in each of the eight cardinal compass directions radiating from the Site are shown in Figure 1.2-5. Terrain to the south of the Site, approximately 3,700 feet beyond Watts Bar Lake, rises abruptly to a height of about 240 feet above plant grade which is 815 feet. This obstacle to air flow will influence the dis-

persion rate at this distance. Hills or ridges of similar height are found within two miles of the Site in practically every direction except toward the northwest. The highest point within a radius of five miles of the Site is Melton Hill, elevation 1,356 feet MSL, about 4.75 miles east-northeast of the plant. Lowest points within a radius of five miles of the Site are along the margins of Watts Bar Lake, the surface of which averages 738 feet MSL. Further topographic information may be found in CRBRP Environmental Report, Section 2.6.

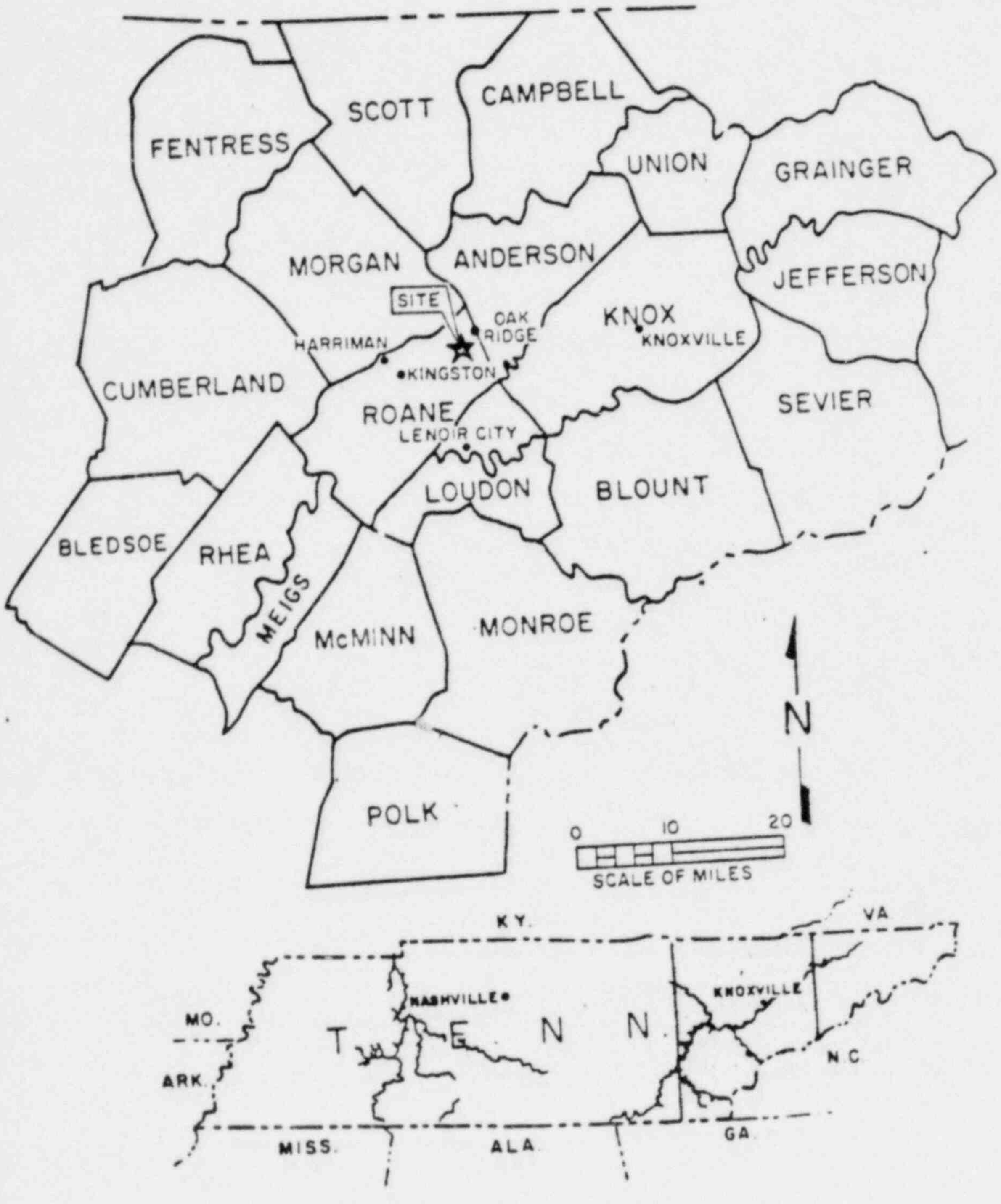


Figure 1.2-1. LOCATION OF CLINCH RIVER SITE IN RELATION TO COUNTIES AND STATE

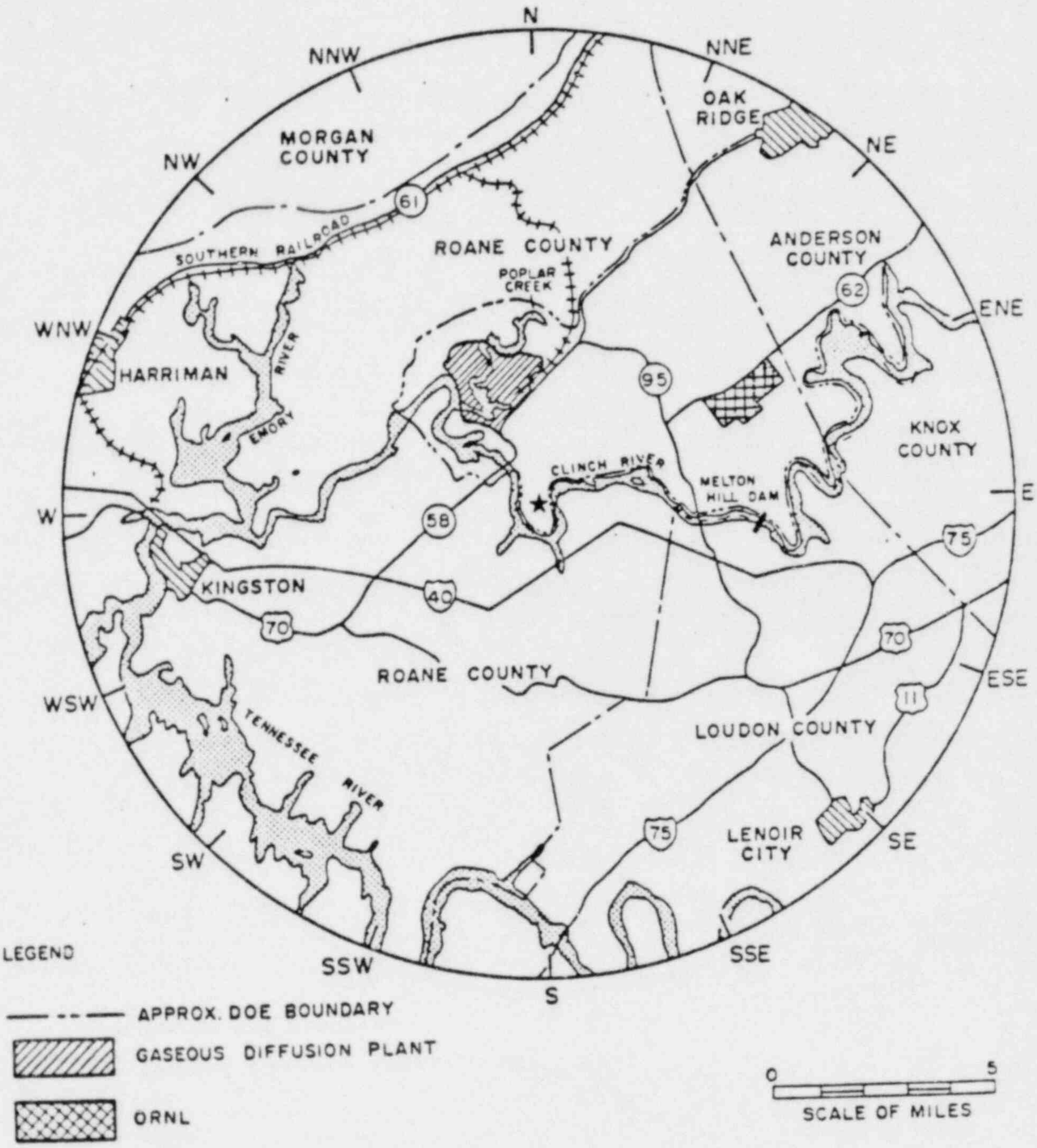


Figure 1.2-2. LOCATION OF SITE WITH RESPECT TO URBAN CENTERS, RAILROADS AND HIGHWAYS WITHIN A 10-MILE RADIUS OF THE SITE

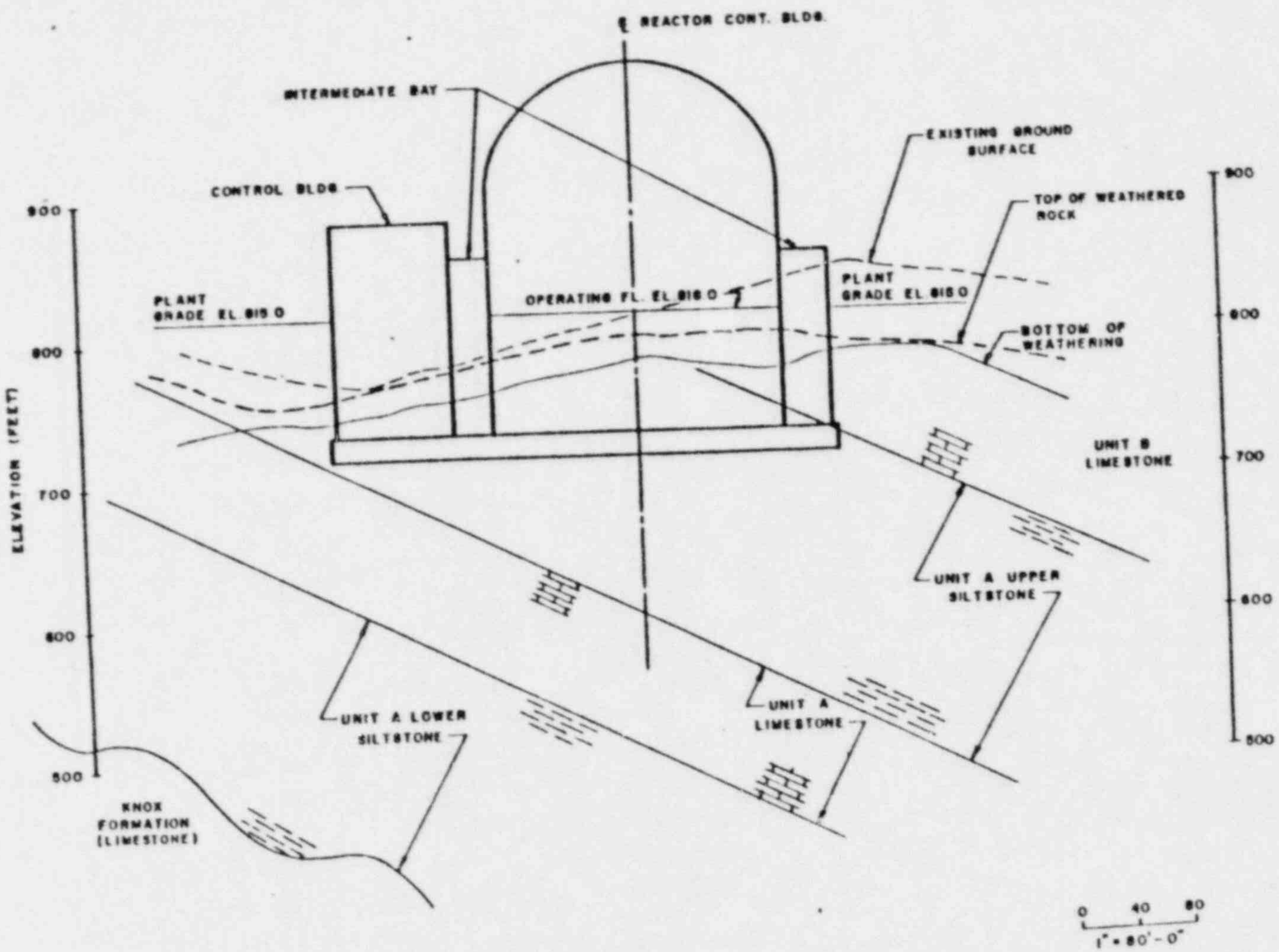


Figure 1.2-3. SECTION THROUGH CRBRP NUCLEAR ISLAND AND FOUNDATION STRATA

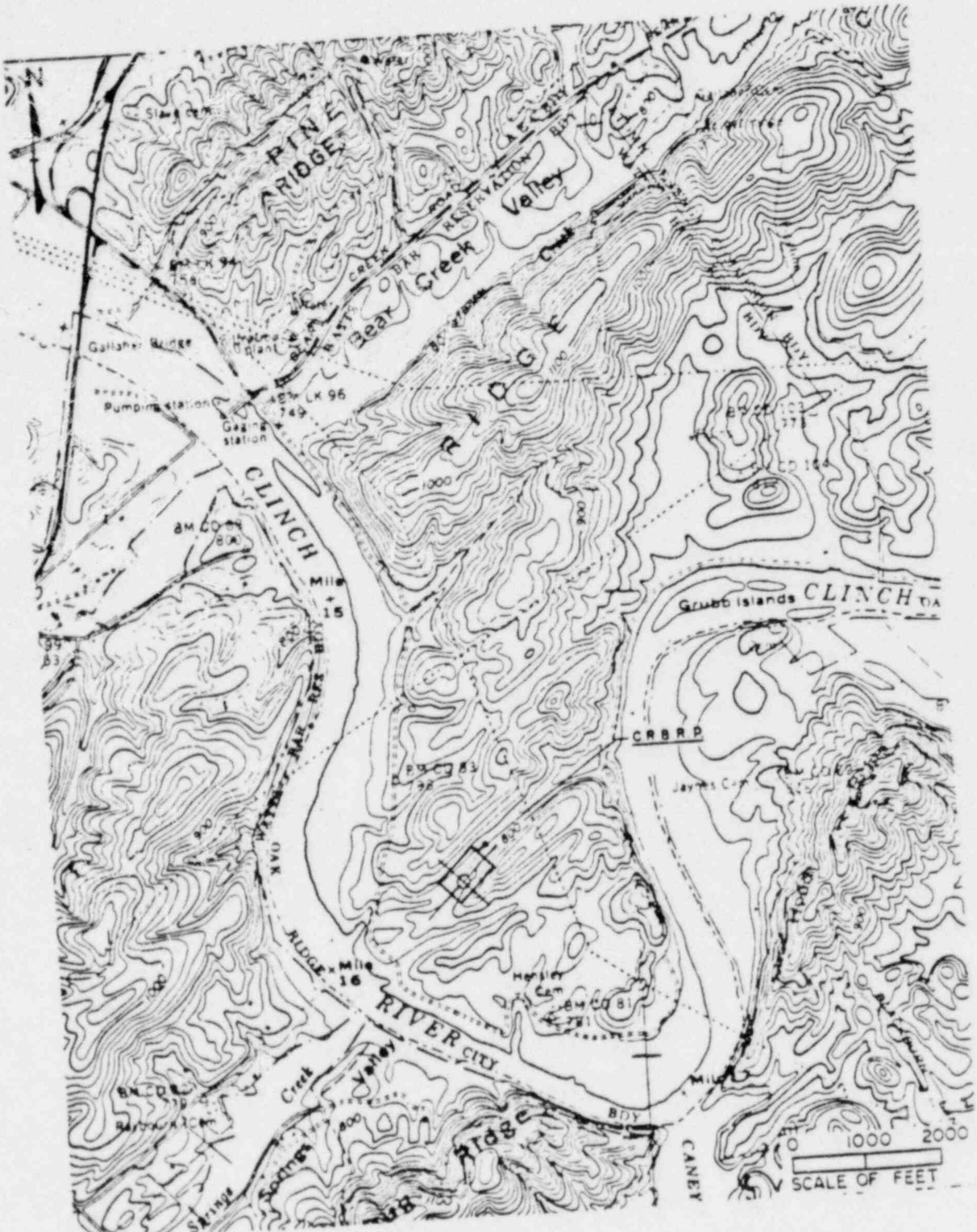


Figure 1.2-4. TOPOGRAPHY OF CLINCH RIVER SITE

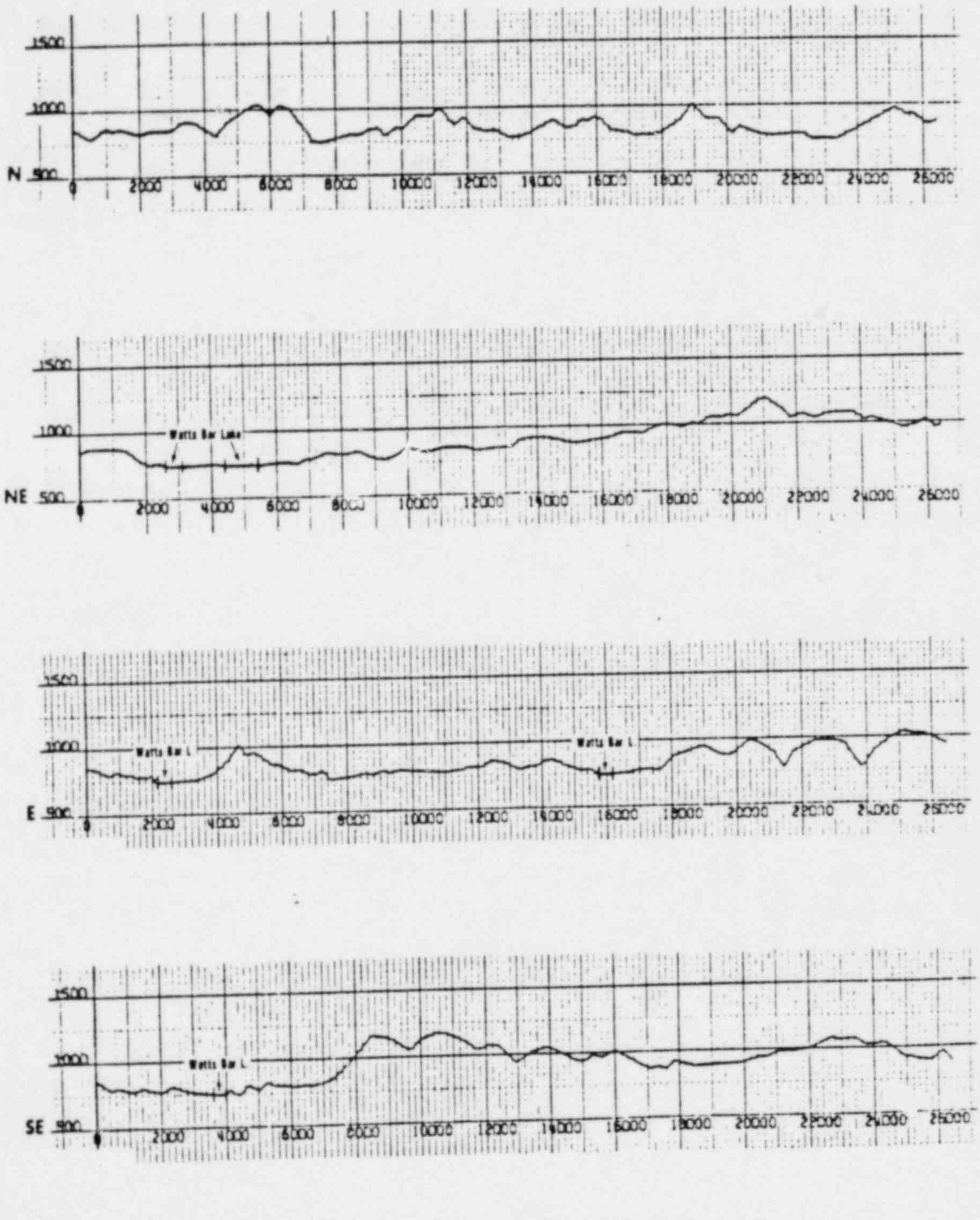


Figure 1.2-5. TOPOGRAPHIC PROFILE CROSS SECTIONS FROM SITE (sheet 1 of 2)

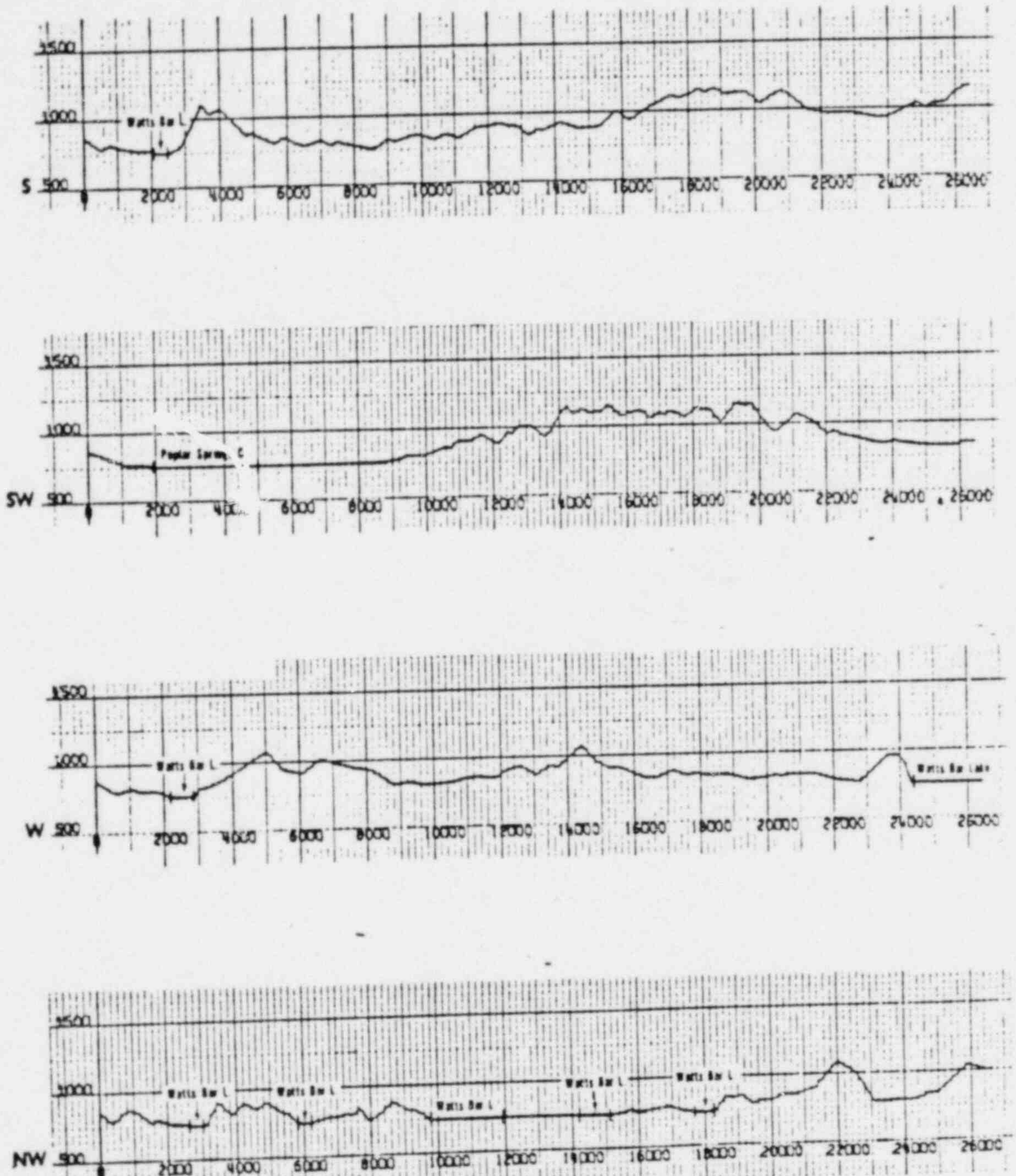


Figure 1.2-5: TOPOGRAPHIC PROFILE CROSS SECTIONS FROM SITE (sheet 2 of 2)

1.3 LOCAL METEOROLOGY

Data from the CRBRP Site, the Oak Ridge Area Station X-10, the Oak Ridge City Office and the Knoxville Airport (the closest NOAA weather bureau stations to the Site) have been used as the primary source of local meteorological data, with a few exceptions noted in the following discussion. Climatological statistics of these stations are believed to be representative of the Site area. Supplementary climatological data were obtained from TVA on relative humidities and fog frequencies. Atmospheric dispersion characteristics for the Site have been estimated from hourly data collected at the CRBRP meteorological tower during the period February 1977 through February 1978.

1.3.1 TEMPERATURE

Temperature data for the Oak Ridge Area Station X-10 show that a record high temperature of 103 degrees F occurred in July 1952 and in September 1954; a record low temperature of -8 degrees F occurred in January 1963. For comparison purposes, the temperature extremes in the Knoxville vicinity were 104 degrees F on July 12, 1930 for the highest and -16 degrees F on January 6, 1884 for the lowest. The annual average daily maximum is 69.4 degrees F and the minimum is 47.6 degrees F, with an average of the monthly mean temperature of 58.5 degrees F. Monthly climatological temperature data for Area Station X-10 and the annual mean temperature data and extremes of temperature for the Oak Ridge City Office and Knoxville vicinity for comparison purposes are presented in Table 1.3-1. It is apparent by inspection of these data that the three sites are quite similar with respect to temperature.

1.3.2 WINDS

The CRBRP meteorological information is the best data base for characterizing dispersion conditions because it is site specific and because the measuring height conforms to NRC Regulatory Guide 1.23 and the starting threshold on wind speed (0.74 miles per hour) is much improved over that at Station X-10.

Wind data obtained from the meteorological towers at the CRBRP Site show a markedly lower occurrence of calm winds with a percentage frequency of only 3.19 percent at an elevation of 33 feet above ground and 0.47 percent at a height of 200 feet above ground for the period February 17, 1977 to February 16, 1978.

Analysis of the one-year summary of on-site wind data shows an average annual wind speed of 3.5 mph at the 33-foot level and 5.6 mph at the 200-foot level. The prevailing wind is from the west-northwest at the 33-foot and west-southwest at the 200-foot levels. Analysis of the Oak Ridge Area Station X-10 data, where the wind sensor is mounted at a height of 102 feet, shows an average annual wind speed of 4.9 mph and a prevailing

wind direction of south to southwest. The Oak Ridge City Office shows a prevailing wind from the southwest with a mean speed of 4.4 mph which is consistent with the other wind data discussed above. Knoxville Airport data show that the prevailing wind is from the northeast with a mean hourly speed of 7.4 mph. These data serve to emphasize the importance of terrain on channeling the wind flow in hilly areas. A summary of these data is provided in Table 1.3-2.

1.3.3 HUMIDITY

A four-year record of relative humidity and temperature data from the Bull Run Steam Plant was used to generate frequency distribution of relative humidity according to ambient temperature. The Bull Run data are more representative of the CRBRP Site than the Knoxville data since the Bull Run sensor is located in a river valley similar to the Site. Bull Run is located approximately 15 1/2 miles NE of the Site, on the Clinch River at CRM 476. The river valley will affect wind flow and provide a moisture source that is reflected in the relative humidity data. Regardless of the location, the relative humidity varies inversely with temperature if the water content of the air is constant. Relative humidity is lowest at the time of maximum temperature and highest at the time of minimum temperature. Low relative humidities are expected to occur in mid-afternoon near the time of maximum temperature and high relative humidities are expected to occur in early morning at the time of minimum temperature.

1.3.4 FOG

Incidence of heavy fog (1/4 mile or less visibility) varies greatly around Tennessee. Typical values include 31 days at Knoxville, 34 days at Oak Ridge City Office and 36 days at Chattanooga.

Five months of the year have an average fog frequency of three days or more at all three stations. At Oak Ridge, October has the highest fog incidence with an average of eight occurrences. Supplementary fog data recorded at two sites along the Melton Hill Lake, upstream from the CRBRP Site, show that fogs which restrict the visibility to 1,100 yards or less are very common for observation points near the river or lake. The data reported are not completely comparable to that recorded at Knoxville or the Oak Ridge City Office because of the difference in definitions, but it does serve to point out that fogs are very common in the region, including the Site. Fogs which restrict the visibility to 1,100 yards or less were observed, on the average, 91 days per year at the Bull Run Creek site (about 15 miles northeast of the CRBRP Site) and 119 days per year at the Melton Hill Dam site (about 4.5 miles east of the CRBRP Site) for the period January 1964 to October 1970).

Fog which restricted visibility to less than 550 yards was recorded at the Melton Hill Dam site on an average of 106 days per year. This value is about three times that recorded at Oak Ridge.

1.3.5 PRECIPITATION

Average annual precipitation is 51.52 inches at the Oak Ridge Area Station X-10 based upon 21 years of record. Winter is the wettest season when 31 percent of the annual precipitation is recorded. February and March are the wettest months when about 5.4 inches of precipitation is normal. October is the driest month with a normal average of 2.82 inches. Maximum monthly rainfall occurred in September (12.84 inches) and the maximum observed rainfall in 24-hour period was 7.75 inches which also occurred in the month of September at Oak Ridge Area Station X-10, as shown in Table 1.3-3. Monthly precipitation from the CRBRP preconstruction monitoring program is presented in Table 1.3-4. These values are similar to those recorded for the Knoxville Airport.

Annual snowfall averages about 10 inches. Maximum annual snowfall recorded in the Oak Ridge area was 41.4 inches, more than four times the annual mean. Heavy snows, when more than six inches are recorded in 24 hours, have occurred in each month from November through March.

1.3.6 FLOOD HISTORY

Clinch River gaged stage or discharge records have been maintained at Wheat, a few miles downstream from the plant site, from 1937-63 and during the water year of 1967-68. Stage records are available downstream at Kingston, near the mouth of the Clinch River, since 1874 except for the years 1877-82. Mixed stage and discharge records are available upstream at Clinton since 1883 except for the years 1949-64. Discharge stations have also been maintained for various periods at Scarboro, Lake City, and Norris Dam, all upstream from the plant site.

Judging from these gage records and from newspaper and other historical accounts, a March 1886 flood was the greatest known on the Clinch River. It reached about elevation 764 at the upper limit of the plant site, Mile 18, and about elevation 758 at the lower limit of the site, near Mile 16. Backwater up the Clinch River from the maximum known Tennessee River flood of March 1867 approached the 1886 levels near Mile 16 but was substantially lower at Mile 18.

A record breaking flood occurred in March 1929 on the Emory River, which enters the Clinch River at Mile 4.4. In the natural state, this flood did not exceed the 1886 and 1867 flood levels upstream on the Clinch River at the plant site. Under present-day conditions, a repetition of this 1929 flood would cause the maximum known regulated level, producing elevation 751 at the plant site. The maximum Clinch River flood of 1886 would be reduced to a lower level of about elevation 748 by Norris Reservoir, including backwater from Watts Bar Dam.

The largest flood since completion of the present TVA system was in March 1973 when elevations 749.6 and 748.6 were reached at CRM 17.8 and CRM 14.5, respectively. This flood resulted from unusually intense rainfall below Norris Dam and below other TVA tributary reservoirs, resulting in high Emory River and local flows and record high Watts Bar Reservoir elevations.

There are no historic records of Clinch River flooding from dam failures or ice jams.

TABLE 1.3-1

MONTHLY CLIMATOLOGICAL TEMPERATURE DATA
OAK RIDGE AREA STATION, X-10

Month	Climatological Standard Normals 1931-1960 Mean Monthly (°F)	Daily Maximum (°F)	Daily Minimum (°F)	1945 - 1964 Highest Temp. (°F)	Lowest Temp. (°F)
December	40.4	49.4	31.3	76	-5
January	40.1	48.9	31.2	77	-8
February	41.7	51.6	31.8	77	0
Winter	40.7	50.0	31.4	77	-8
March	48.0	58.9	37.0	87	4
April	58.2	70.0	46.3	89	24
May	66.9	79.0	54.8	94	32
Spring	57.7	69.3	46.0	94	4
June	74.7	86.1	63.3	99	41
July	77.4	88.0	66.7	103	49
August	76.5	87.4	65.6	99	44
Summer	76.2	87.2	65.2	103	41
September	71.1	83.0	59.2	103	33
October	60.0	72.2	47.7	91	21
November	47.6	58.6	36.5	83	4
Fall	59.6	71.3	47.6	103	4
Annual	58.5	69.4	47.6	103	-8
Oak Ridge City Office Climatological Standard Normals 1941-1970					
Annual	57.8	68.6	47.0	105*	-9*
Knoxville Vicinity Climatological Standard Normals 1941-1970					
Annual	59.7	69.8	49.5	104**	-16**

*May 1947 - October 1974

**1874 - October 1974

TABLE 1.3-2

MONTHLY WIND DATA

Month	Oak Ridge City Office* Average Speed (mph)	Oak Ridge City Office* Prevailing Direction	Knoxville Airport** Average Speed (mph)	Knoxville Airport** Prevailing Direction	Area Station X-10+ Average Speed (mph)	Area Station X-10+ Prevailing Direction	CRBRP Meteorological Tower++ 33 Foot Level Average Speed (mph)	CRBRP Meteorological Tower++ 33 Foot Level Prevailing Direction	CRBRP Meteorological Tower++ 200 Foot Level Average Speed (mph)	CRBRP Meteorological Tower++ 200 Foot Level Prevailing Direction
January	4.8	SW	8.2	NE	5.3	SSW	4.5	WNW	7.5	WNW
February	5.0	ENE	8.7	NE	6.0	SSW	4.4	WNW	7.5	NE
March	5.3	SW	9.2	NE	6.8	WSW	4.3	SSE	7.2	WSW
April	5.7	SW	9.3	WSW	7.0	SSW	3.7	WSW	5.9	WSW
May	4.5	SW	7.4	SW	6.2	NE	2.8	ENE	4.4	NE
June	4.2	SW	6.7	SW	6.2	WSW	3.3	SW	5.3	WSW
July	3.9	SW	6.3	WSW	4.2	SSW	2.8	WSW	4.1	WSW
August	3.7	E	5.7	NE	1.5	SSW	2.6	SW	4.1	WSW
September	3.8	E	5.9	NE	2.9	NNE	2.4	E	4.1	NE
October	3.6	E	5.9	NE	2.9	NNE	3.0	WNW	4.8	WSW
November	4.1	E	7.2	NE	3.2	N	3.3	WNW	6.0	ENE
December	4.5	SW	7.6	NE	4.3	NNE	4.0	WNW	6.8	WSW
Annual	4.4	SW	7.3	NE	4.7	SSW	3.5	WNW	5.6	WSW

*16-year record on wind speed, 13-year record on prevailing direction[4]

**31-year record on wind speed, 14-year record on prevailing direction[3]

+1-year record[26] (102 feet, sensor elevation)

++1-year record, February 1[illegible], 1977 - February 16, 1978

TABLE 1.3-3

PRECIPITATION DATA

OAK RIDGE AREA STATION, X-10

1944-1964

Month	Monthly Average (inches)	Monthly Maximum (inches)	Monthly Minimum (inches)	Maximum in 24 Hours (inches)
December	5.22	10.28	1.98	4.38
January	5.24	12.37	1.11	3.96
February	5.39	10.01	1.89	3.23
Winter	15.85			
March	5.44	9.69	2.06	3.84
April	4.14	8.54	1.25	2.39
May	3.48	7.01	0.90	2.09
Spring	13.06			
June	3.38	7.55	1.18	3.08
July	5.31	10.19	2.14	3.74
August	4.02	10.31	0.50	3.31
Summer	12.71			
September	3.59	12.84	0.21	7.75
October	2.82	6.43	0.00	2.32
November	3.49	12.00	1.01	3.20
Fall	9.90			
Annual	51.52	12.84	0.00	7.75

TABLE 1.3-4

PRECIPITATION DATA FOR THE CRBRP SITE
FEBRUARY 1977 - FEBRUARY 1978

Month	Precipitation in Inches
February	1.44
March	4.81
April	6.95
May	1.36
June	3.55
July	1.01
August	4.22
September	8.96
October	4.36
November	6.55
December	3.37
January	5.21
Annual total	51.79

1.4 Water Use and Wastewater Discharge Sources

1.4.1 Clearing, Grubbing and Earthwork Activities

Clearing will consist of removing from designated areas marketable timber, brush, shrubs, standing timber, down timber, rotten wood, slashings, rubbish, other vegetation, and all other objectionable material. Grubbing will include removing from the ground stumps, roots, matted roots, stubs, brush, organic materials and debris. Roots, matted roots one inch or larger in diameter, stumps, logs, organic or metallic debris shall be excavated to a minimum depth of one foot below natural ground level and removed. Clearing and grubbing will precede earthwork operations and be generally confined to areas required for cut/fill, permanent and construction facilities, meteorological towers and runoff treatment ponds.

Required excavation/fill slopes and compaction controls are design features which assist in controlling soil erosion. The storm drainage system (catch basins, culverts, runoff treatment ponds) judicious drainage ditch locations, and early installation of these facilities serve to control surface runoff and mitigate erosion effects.

Construction provisions consisting of temporary culverts, ditching, silt traps, seeding etc. will be utilized in soil erosion control and storm runoff regulation.

While the draft NPDES permit requirements do not specify limitations associated with the effects of construction runoff, the runoff treatment pond basins and appurtenances have been designed to meet discharges effluent guidelines and standards as follows: the 10 year 24 hour rainfall event, total suspended solids (TSS) not exceeding 50 mg/l and pH within the range of 6.0 to 9.0.

The following civil/structural drawings and specifications (available at Owner's Oak Ridge Project Office) apply to land clearing and excavation activities:

Drawings

The drawings listed below generally indicate existing site contours, proposed finished grades, plant arrangement and details including roads, railroads, runoff treatment ponds, etc., major excavations/fills and storm drainage systems including appurtenances.

BC 501	BC 511	BC 542	BC 605	TSK007
502	512	543	613	045
503	515	544	620	046
504	516	545	622	047
505	526	546		052
506	527	551		053
507	528	552		075
508	535	553		082
509	536	565		
510	541	566		

Specifications

3066-19-1 Clearing & Grubbing

3066-19-2A Excavation, Filling and Backfilling

Raw water will be required for soil compaction, dust control and quarry operations. Water for soil compaction will be pumped from the Clinch River into a tank truck for spraying onto fill areas. The amount of water required for fill compaction is estimated by the constructor to average less than 10,000 gallons per day. It is also estimated by the constructor that an additional 10,000 gallons per day of raw river water will be used for dust control on construction roadways. Water for the quarry will be pumped from the river and will be recycled from settling basins; maximum use during peak crushing is estimated by the constructor to be 40,000 gallons per day. Water for the concrete batching and mixing plant will be taken from the Bear Creek Road Filtration Plant via a permanent water main.

1.4.2 Construction Period

The construction of the CRBRP is anticipated to extend over a period of approximately 5 years. DOE may be authorized by NRC through an exemption request to commence site preparation activities during the summer of 1982. However, if NRC does not grant the exemption request, the site preparation activities are expected to commence on 4/1/83. Support of construction will require water for the following purposes:

Potable Water

- Sanitary water uses such as toilets, showers, lavatories
- Fire protection system
- Concrete batching plant
- Concrete curing

Clinch River Water

- Dust control
- Fill compaction
- Quarry drilling operations
- Crushed stone production dust control

Discharges resulting from construction operations will include:

- Sewage treatment system effluents
- Storm water runoff
- Excavation dewatering operations

Use of water at the construction site and quantities of discharge are a function of the size of the construction work force, climatic conditions and the stage of construction. Major water uses and discharges have been calculated on the basis of the following assumptions:

- Sanitary wastes - 2450 person construction work force at 25 gallons per capita per day. (See Section 3.1.2 and 3.1.2.2 for additional information concerning design population to be served.)

- Stormwater runoff - 24 hour storm having a recurrence interval of 10 years and individual treatment pond inflow based upon a composite runoff coefficient ranging between 0.3 to 0.6 reflective of

contributing catchment area characteristics. A runoff coefficient of 1.0 was used to compute quarry treatment pond runoff from the immediate quarry area and 0.05 from the meadowland around the quarry.

- Excavation dewatering - based on ground water data, and on-site soil and rock conditions.

A schematic diagram of peak water use and discharge is presented in Fig. 1.4-1. Locations of the discharges are presented in Fig. 1.4-2.

1.4.3 Operating Period

Water for plant operation will be supplied by the Clinch River. The anticipated annual average water makeup requirement is 8.8 mgd. An average of 3.5 mgd will be returned to the river as blowdown (3.35 mgd) and effluent from other plant systems (0.15 mgd). Approximately 5.3 mgd would be consumed through evaporation, drift, and plant water usage.

Based on an annual average Clinch River flow rate of 3,480 mgd (5,394 cfs) the consumptive water use is less than 0.2% of river flow.

Potable water for the CRBRP will be supplied by the DOE Bear Creek Water Filtration Plant. Potable water usage includes an allowance of 7000 gpd for sanitary water uses and 30,000 gpd for a hypochlorite generating plant. The latter is a seasonal demand, anticipated to occur only during the summer months when chlorination of plant water system is required for control of slimes, algae and fresh water clams.

Figure 1.4-3 is a schematic diagram of the plant water uses and plant discharges. Discharges due to storm water runoff from the site are represented schematically in Figure 1.4-1. The location of these discharge points are shown in Figure 1.4-4.

For plant operations, the discrete discharge point sources are as follows:

- Cooling Tower Blowdown
- Wastewater Treatment System Effluent
- Sewage Treatment System Effluent
- Low Activity Level Liquid Radioactive Waste Treatment System Effluent
- Storm Water Runoff

The first four point sources are discharged to the Clinch River via a Common Plant Discharge. Storm water runoff is discharged to the river via five separate discharges from runoff treatment ponds. The quarry runoff treatment pond will be redressed following the construction period and will not be a point source discharge.

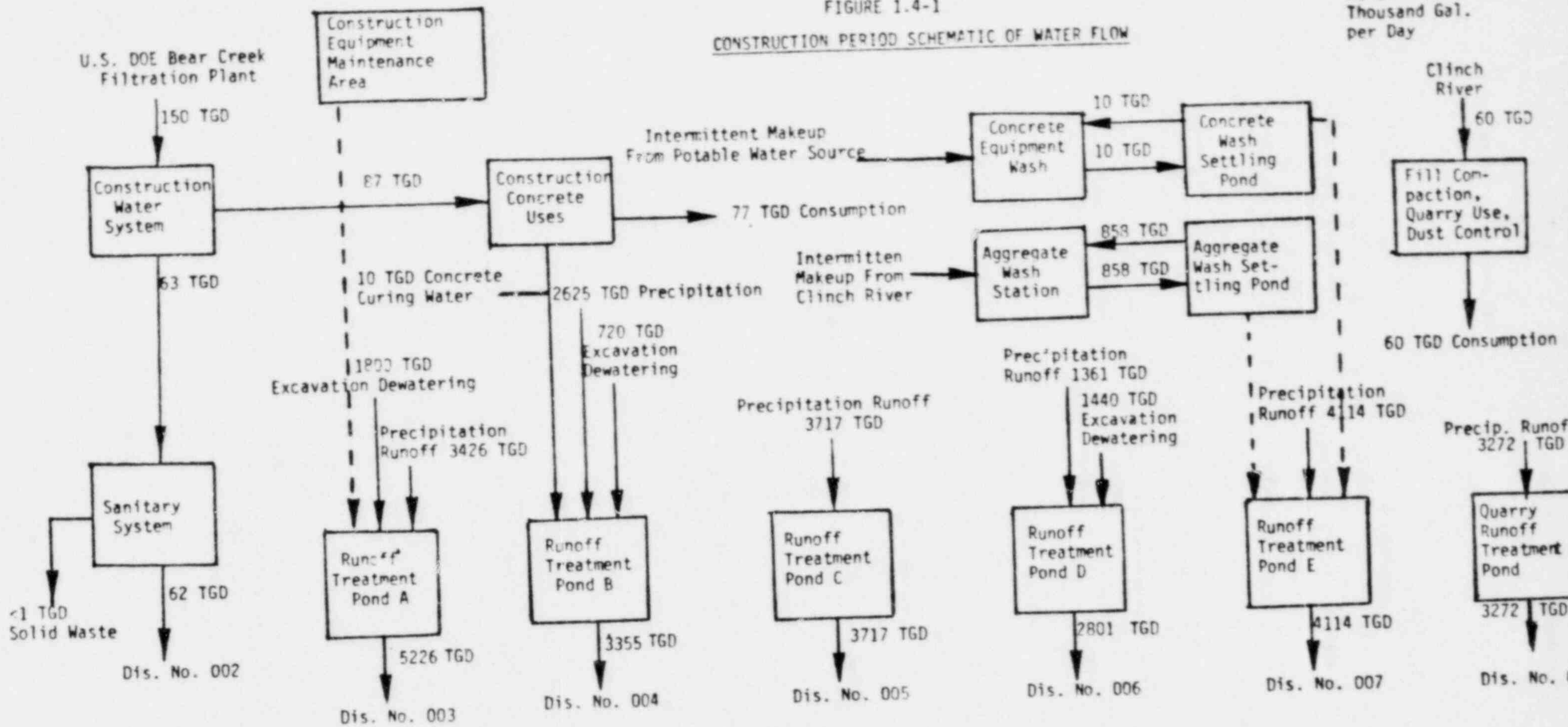
Low Activity Level Liquid Radioactive Waste (LALL) is discharged to the common plant discharge stream after processing. The system is designed to insure that the activity concentration of the discharge, after processing is As Low As Reasonably Achievable (ALARA) and a small fraction of 10 CFR 20 limits. Section 3.2.1 of this report provides additional information relative to the design of the system. Section 3.5 of the Environmental Report provides a detailed discussion of the system and summarizes the expected isotopic concentrations of both influent and effluent streams.

Present design plans for pre-operational cleaning call for treatment and disposal offsite by cleaning contractor. Should present plans change, the owner will provide facilities for treatment and disposal of these wastes onsite. Treatment processes may include, but not be limited to, physical/chemical treatment, biological treatment, incineration and evaporation. Treatment process to be used will be determined on the basis of the type and volume of cleaning wastes. Treatment facilities and appurtenant structures may include: waste holding ponds of impervious construction, chemical addition provisions, mixing provisions, aeration provisions, pumping provisions and other structures as required to suit the treatment process selected.

FIGURE 1.4-1

CONSTRUCTION PERIOD SCHEMATIC OF WATER FLOW

NOTE: TGD-Thousand Gal. per Day



DEPARTMENT OF ENERGY
CLINCH RIVER BREEDER REACTOR PROJECT
OAK RIDGE, ROANE COUNTY, TENNESSEE

March 1982

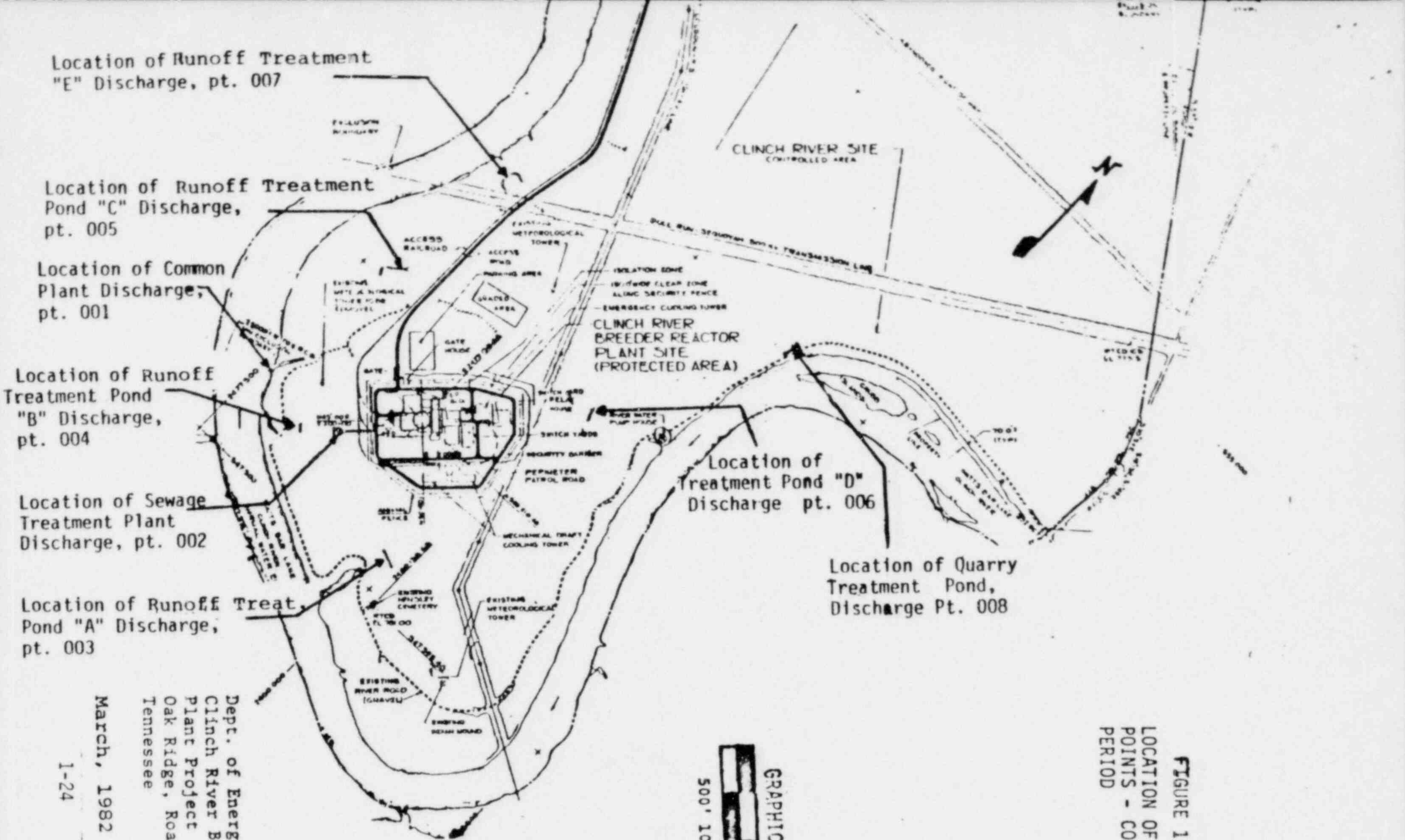


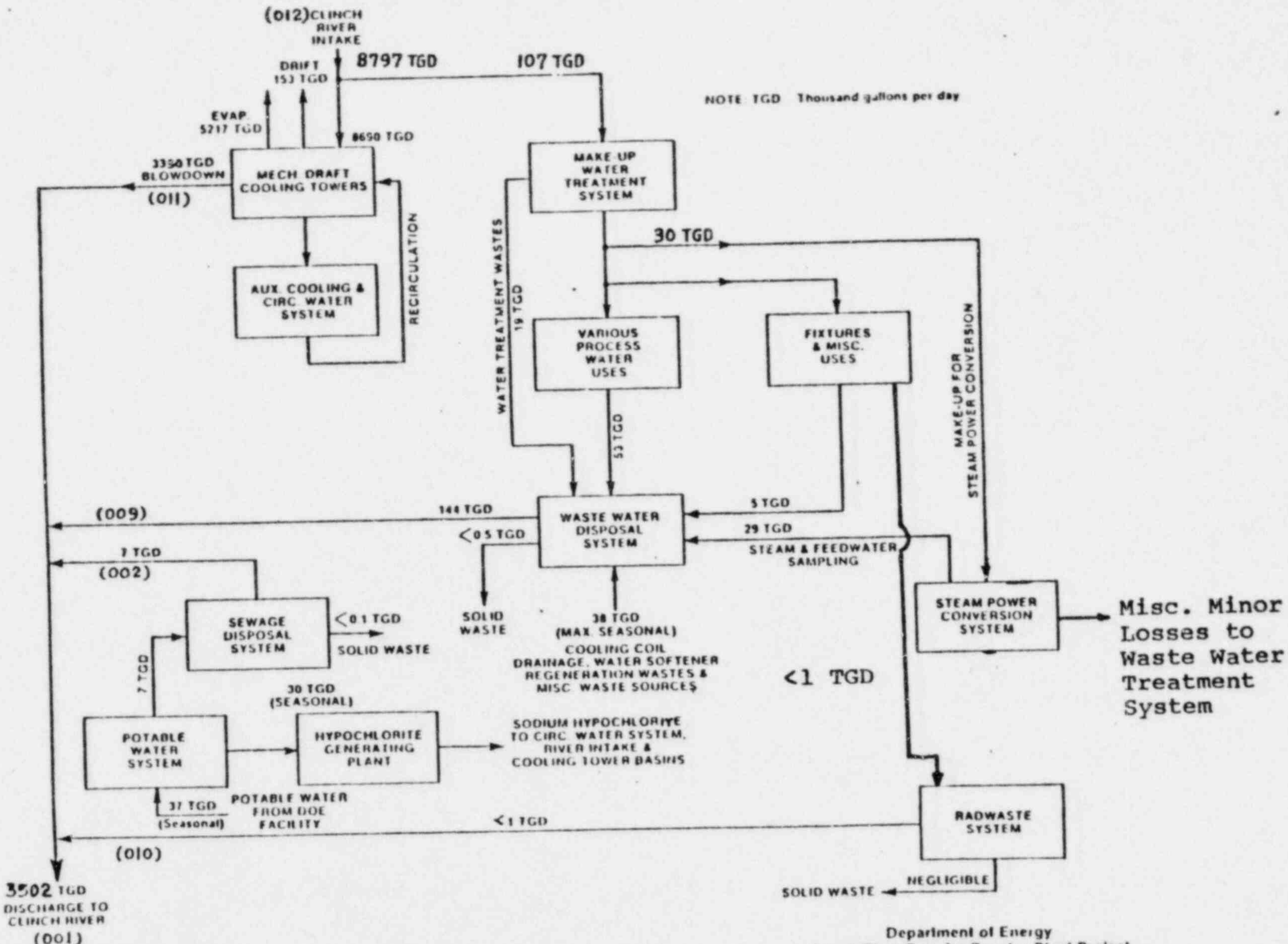
FIGURE 1.4-2
LOCATION OF DISCHARGE POINTS - CONSTRUCTION PERIOD

Dept. of Energy
Clinch River Breeder Reactor Plant Project
Oak Ridge, Roane County, Tennessee

March, 1982

FIGURE 1.4-3

SCHEMATIC OF WATER FLOW — OPERATING PERIOD



Department of Energy
Clinch River Breeder Reactor Plant Project
Oak Ridge, Roane County, Tennessee

March, 1982

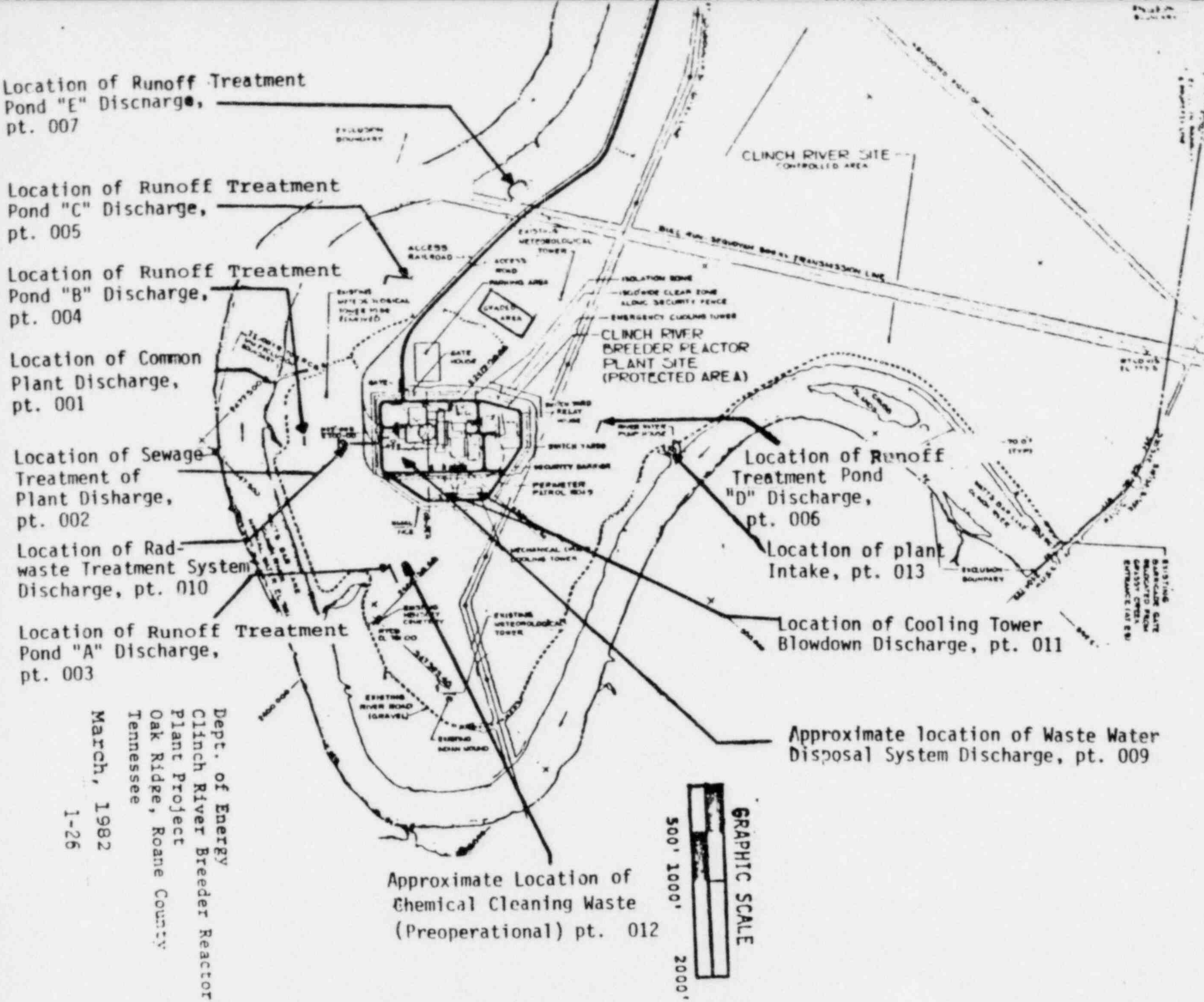


FIGURE 1.4-4
LOCATION OF DISCHARGE POINTS - OPERATING PERIOD

1.5 Basis of Design and Discharge Criteria

The design of treatment facilities and discharges for the CRBRP are based on accepted treatment technologies for the various classes of wastes that are expected at the plant. In general, these can be summarized as follows:

Discharge Source	Design Basis	Design Criteria
Cooling Tower Blowdown	Development Document for Effluent Limitation Guidelines and Standards of Performance - Steam Electric Power Plants, June 1973, Oct. 1974	Draft NPDES Permit TN0028801
Waste Water Treatment System	Development Document for Effluent Limitation Guidelines and Standards of Performance - Steam Electric Power Plants, June 1973, October 1974	Draft NPDES Permit TN0028801
Sewage Treatment System	Design Criteria Including Laws, Regulations and Policies for Water and Waste Water Systems, Tennessee Dept. of Public Health	Draft NPDES Permit TN0028801
Low Activity Level Liquid Radioactive Waste System	As low as reasonably achievable through recognized industry practice.	Draft NPDES Permit TN0028801, 10 CFR 20
Storm Water Runoff	Engineering practice for minimizing impact of overland flow, due to 10 year 24-hour storm.	Draft NPDES Permit TN0028801

2.0 WASTE WATER CHARACTERISTICS

2.1 Cooling Tower Blowdown

Evaporation in the cooling tower will cause the solids concentrations in the circulating water to increase. To preclude reductions in plant efficiency and service life, cooling water blowdown is required. The blowdown maintains the cooling water concentration of solids in a non-scaling, non-corrosive condition. Blowdown will contain primarily the same constituents as the river water concentrated by a factor of about 2 1/2. Average concentrations in the Clinch River and in the blowdown are shown in Table 2.1-1.

Normally, chemical additions will not be required to control scaling conditions. However, provisions for sulfuric acid addition are provided, if needed, to reduce circulating water alkalinity by converting calcium carbonate to stable, soluble calcium sulfate. The feed rate in this application will be determined on an as needed basis by plant operators based upon circulating water chemistry. Two, 30 gph acid feed pumps are provided for this purpose, designed to use 66° Bé sulfuric acid.

Control of biological growths (algae, slimes and bacteria) in the circulating water system and control of fresh water clams will be accomplished by use of 0.8% solution of sodium hypochlorite. Based on experience of other facilities in the area which use river water, chlorination will take place during warm-weather months only. Total residual chlorine (TRC) will not exceed 0.14 mg/l in the blowdown since chlorine residual analyzers will index as automatic blowdown control valve to close when chlorine concentration exceeds 0.14 mg/l.

Chlorine dosage rates are manually set by plant operators on the basis of demand and residual requirements.

2.2 Waste Water Treatment System Influent

The waste water treatment system receives all non-radioactive power plant liquid wastes, except cooling tower blowdown, storm water runoff and sanitary wastes. Most of the wastes are discharged to the system on an intermittent basis; both scheduled and unscheduled. The wastes vary considerably in chemical/physical characteristics and temperature, consequently, all wastes are blended prior to treatment to equalize characteristics.

Sources and estimated volumes of the various wastes processed by the waste water treatment system are given on the following page:

	SOURCE	WASTE STREAM	PRINCIPAL CHARACTERISTICS	ESTIMATED WASTE VOLUME, GPD	DISCHARGE FREQUENCY
1.	Condensate Polishers	Ion exchange regeneration wastes (sulfuric acid, sodium hydroxide), and rinses	high/low pH, high dissolved solids	40,000	once/week
2.	Make-up Water Demineralizers (anionic and cationic)	"	"	27,000	daily
3.	Make-up Water Demineralizers (mixed bed)	"	"	4,500	once/5 days
4.	Make-up Water Treatment	Gravity Filter Backwash	high suspended solids	8,750	daily
5.	Make-up Water Treatment	Clarifier Blowdown	"	2,140	daily
6.	Make-up Water Treatment	Activated Carbon Filter Backwash	"	8,400	daily
7.	Waste Water Treatment	Clarifier Blowdown	"	1,650	daily
8.	Waste Water Treatment	Gravity Filter Backwash	"	5,000	daily
9.	Feedwater and Steam Sampling	Laboratory Analysis Wastes	high/low pH, chemical reagents	28,800	daily
10.	Non-radioactive Floor Drains	Equipment drainage, floor washing, etc.	high suspended solids, oil/grease	20,000	daily
11.	Cooling Coil Drainage	-	-	0-74,000	seasonal
12.	Hypochlorite Generating Plant	Water softener regeneration wastes (brine) and rinses	high dissolved solids	800	daily seasonal

Equalized average annual characteristics of the waste water treatment system influent have been estimated on the basis of the waste water volumes given in the preceeding table and on river water characteristics, assuming CRBRP operation at 100% power on a year-round basis.

These data are presented below:

Waste Volumes

Waste Water Source	Annual Volume
1. Condensate Polishing	2.1 Million Gallons
2. Makeup Demineralizers	10.2 Million Gallons
3. Cooling Coil Drainage	13.5 Million Gallons
4. Floor Drains, Clarifier Blowdown & Filter Backwashes (Sludge Lagoon Overflow), & Miscellaneous plant wastes	27.0 Million Gallons
Total Annual Volume	52.8 Million Gallons

Waste Characteristics

1. Condensate Polisher Wastes:

Total Dissolved Solids removed	10,000 lb/yr
Sulfate discharged in regenerant waste	68,000 lb/yr
Sodium discharged in regenerant waste	30,000 lb/yr
Total impurities in Polisher Waste	108,000 lb/yr

2. Makeup Demineralizer Wastes:

Total Dissolved Solids removed from river water	46,000 lb/yr
Sulfate discharged in regenerant waste	274,000 lb/yr
Sodium discharged in regenerant waste	121,000 lb/yr
Total impurities in Demineralizer Waste	441,000 lb/yr

3. Cooling Coil Drainage:

No impurities anticipated, assume 10 ppm TDS — 1,000 lb/yr.

4. Floor Drains, Filter Backwashes & Clarifier Blowdown, and Miscellaneous wastes (a part of these wastes enter the wastewater treatment system as overflow from sludge lagoons following a quiscent settling period).

Assumed total suspended solids and total dissolved solids, 150 mg/l — 34,000 lb/yr.

5. Combined Waste (Items 1 through 4, above)

Total Dissolved Solids in combined waste	91,000 lb/yr.
Sulfate in combined waste	342,000 lb/yr.
Sodium in combined waste	151,000 lb/yr.
Total impurities in combined waste	584,000 lb/yr.
Combined waste TDS, Sulfate, Sodium concentration	1350 ppm

<u>Sludge Lagoon Influent</u>

(Note: Lagoon overflow enters the waste water treatment system and is accounted for above.)

Total volume of clarifier blowdowns, gravity filter backwashes, activated carbon filter backwashes, is estimated to be 26,000 gallons per day. Combined suspended solids concentration is estimated to be 2,000 mg/l. Based on above estimates, daily sludge production on a dry solids basis is estimated to be 450 lb/day.

2.3 Low Activity Level Liquid (LALL) Radioactive Waste System Influent

Low activity level liquids (LALL) are defined as radioactive liquids having an activity concentration less than 10^{-4} µCi/cc. This category of radioactive liquids consists of low purity wastes, chemical wastes and detergent wastes. The LALL influents emanate from floor and equipment drains, laboratory drains, decontamination station and personnel shower drains from the various buildings of the CRBRP as well as from the Reactor Service Building (RSB) Decontamination Facility and The Maintenance Shop and Warehouse (MS&W) Regulated Maintenance Shop. Influent to the system is periodic and the total average influent varies due to operations being performed within the plant. The maximum daily LALL influent is estimated to be 850 gallons per day.

2.4 Sewage Treatment Plant Influent

Sewage treatment influent during the construction and operating periods for the CRBRP will be similar to typical domestic sewage, except that kitchen and laundry wastes are not anticipated. Non-radioactive laundry will be processed offsite; kitchen facilities are not provided except for small kitchenette units in employee lunch areas.

Influent hydraulic and biological loadings are anticipated to be in the range of values contained in Chapter 5 of Section V "Design Criteria for All Waste Water" of Design Criteria; Including Laws, Regulations and Policies for Water and Waste Water Systems, published by the Tennessee Department of Public Health.

These values are as follows:

	Construction Period	Operating Period
Hydraulic loading, gallons/ capita per day	25	35
Biological Loading, lb/day per capita of BOD_5	0.06	0.06

2.5 Storm Water Runoff and Construction Dewatering

Storm water runoff will contain particulates and suspended solids that are picked up by the water during overland flow. The quantity of these materials is a function of rainfall intensity and the surface over which the water flows. During construction, ground surface will be disturbed, resulting in more solids in the runoff. During the operating period, surfaces will be paved or planted with ground cover resulting in reduced quantities of solids in the runoff. During the construction and operating period, some quantities of oil and grease can be expected in the storm water, although positive control will be exercised to minimize the quantity discharged to the runoff treatment ponds. Positive control includes: allocation of specific areas for fueling and oiling operations; isolation of these areas from the stormwater system during handling of hydrocarbons; and housekeeping practices which include use of oil absorbing materials and sweeping compounds for clean up of minor spills.

Construction dewatering flow is expected to contain fewer suspended solids than storm water runoff since the water will emanate primarily from fractured or solutioned zones in the rock which are relatively free of soil. Further, it is expected that water from excavations will be conveyed to the storm drainage system by means of hoses and pipes, rather than traveling overland.

TABLE 2.1-1

CHEMICAL CONCENTRATIONS IN CLINCH RIVER AND COOLING TOWER BLOWDOWN

Parameter	Avg. River Water Concentration (1)	Avg. Cooling Tower Blowdown Concentration (2)
Alkalinity (total as $CaCO_3$), mg/l	87	218
Aluminum, μg/l	NR (3)	-
Ammonia Nitrogen, mg/l	0.04	0.10
Arsenic, μg/l	NR	-
Cadmium, μg/l	<1.0	<2.5
Calcium, mg/l	29	72
Chloride, mg/l	3.0	7.5
Chromium, mg/l	<6.0	<15
Copper, μg/l	36	90
Hardness (as $CaCO_3$), mg/l	103	258
Iron (Total) μg/l	530	1325
Iron (dissolved), μg/l	50	125
Iron (ferrous), μg/l	64	160
Lead, μg/l	<11	<28
Magnesium, mg/l	7.7	19.2
Manganese (total), μg/l	55	138
Mercury, μg/l	<0.2	<0.5
Nickel, μg/l	<50	<125
Selenium, μg/l	NR	-
Silver, μg/l	NR	-
Sodium, mg/l	3.3	8.2
Sulfate, mg/l	16	40
Total Dissolved Solids, mg/l	125	312
Total Suspended Solids, mg/l	7.0	17.5
Zinc, μg/l	36	90

(1) Data based on samples at proposed river water intake structure Clinch River Mile 17.9. (See Environmental Report, Amend. IX, Table 2.5-14a.)

(2) Blowdown concentration based on concentration factor of 2.5 x river water concentration.

(3) NR - Not Reported.

3.0 WASTEWATER TREATMENT PROCESSES AND EFFLUENT DISCHARGES

3.1 Construction Period-General

Construction period discharges include sewage treatment system effluent and stormwater/excavation dewatering discharges via runoff treatment ponds. The locations of these discrete point sources are shown in Figure 1.4-2. Anticipated volumes are shown on Figure 1.4-1.

Areas of the plant site not served by the construction period stormwater system and treatment ponds will result in discharge directly to existing drainage ways. These areas include the access road, railroad embankment and spoil deposit areas. The consequences of runoff from these areas during the early construction period are expected to be minor, and will be mitigated by the installation of silt trenches across drainage ways, erection of hay bale barricades, and possibly pumping to nearby retention ponds.

3.1.1 Runoff Treatment Ponds-Design Features

Five runoff treatment ponds (also referred to as impounding ponds in referenced documents) and a quarry pond serve the construction and operating period. The ponds are designed to process water from a 24 hour storm having a recurrence interval of 10 years in addition to anticipated dewatering flows. Rainfall runoff from storms greater than the design event will be discharged by means of the riser overflow pipe.

Design data for the ponds is given in Table 3.1-1.

Construction features of the ponds are shown in Figures 3.1-1, 3.1-2, and 3.1-3.

The primary function of the ponds is to provide a quiescent settling environment and filtration system so that stormwater discharged to the Clinch River contains acceptable total suspended solids. Consequently, the pond configurations have been developed on the principles of sedimentation/filtration theory and current operating practice.

The pond retention dike features are indicated in Figure 3.1-1. Suspended solids are removed by processing the collected stormwater through the sand/aggregate filter set forth in Figure 3.1-3. This filtration system is generally representative of the actual system to be employed. Individual pond filters will vary in total filter area and number of perforated risers.

As shown in Figure 3.1-2, the pond outlets are provided with an energy dissipation structure to minimize potential erosion caused by the discharge to the river.

When settled solids reach a predetermined thickness, the individual pond and filter medium will be physically cleaned. Maintenance frequency will vary during construction and plant operational phases between several weeks to upwards of four to six months, respectively. In the event total suspended solids concentration in the effluent exceeds 50 mg/l, treatment pond system performance will be evaluated. Appropriate corrective action will be taken as required.

On-site activities during the construction period include unloading and handling of petroleum products (diesel oil, turbine lube oil, etc.) and various chemicals (sulfuric acid, caustic, etc.) and periodic maintenance of various construction equipment. To prevent the discharge of these materials to the stormwater system, the CRBRP has included design features and administrative controls in all areas where these activities take place.

The construction equipment maintenance area will be located at plant coordinates N43 + 53, E210 + 00. All equipment maintenance will be done on a concrete pad enclosed by a gravel and sand apron. The pad will be sloped to allow any spills/leaks to drain into a dry sump collection point for disposal offsite by a licensed contractor. The fuel storage area will be located in the same general area as the equipment maintenance area. All above ground storage tanks will be located on concrete pads, enclosed by a gravel and sand apron to locally contain any spills/leaks that may occur. These pads will also be sloped to allow any leakage to drain to a dry sump for collection and ultimate disposal offsite by a licensed contractor. All overflow which may occur during upset conditions will flow into runoff treatment pond "E". Oil booms and skimming equipment will be available to prevent the leakage from reaching the river.

3.1.2 Sewage Treatment System - Design Features

There will be two periods of sanitary waste water generation: construction and normal plant operation. During both of these periods, the sanitary waste water may be characterized as normal domestic sanitary waste water, except that no kitchen or laundry wastes are expected for the CRBRP. The sanitary system for the construction period is designed for accommodating 2,450 persons. Average daily sanitary waste water design flow will be 61,250 gallons or 25 gal/person/day. The average daily sanitary waste water flow during normal operation will be 7,000 gallons. This is based upon 200 plant personnel or 35 gal/person/day for normal plant operation. Present projected number of plant personnel is 179 persons with a peak manning of 300 persons anticipated for annual shutdown. Annual shutdown duration will be approximately 1 month. The permanent plant design flow of 13,000 gal/day will be adequate for this peak loading.

The treatment plants during the construction period are designed to accommodate a projected work force of 2,450. The actual peak construction work force and the served population may be higher than the design population of the plants for a relatively short period of time during the peak construction period. Construction scheduling and manpower requirements are not finalized at this time, however, the plant design population and capacities identified herein are sufficient to serve the construction work force for most of the time during the construction period. Increases in served population will be evaluated to determine their impact on the sewage treatment plants: changes in population

may necessitate modification of the biological treatment process to accommodate additional loading, or may require the addition of temporary treatment units. Any changes to treatment processes or the number of treatment units at the CRBRP site will be reported in advance to the appropriate permitting agencies.

Sanitary waste water generated during the construction period will be treated by two package sewage treatment plants. The package plants, installed in parallel will have treatment capacities of 13,000 gpd and 52,000 gpd. Upon completion of CRBRP construction, the smaller plant will continue operation for the life of the project, and the larger plant will be either abandoned or removed.

During the construction period, sewage flow will be proportionally split between the two treatment plants to avoid underloading or overloading either plant. To accomplish the flow splitting, a junction manhole will be constructed upstream of the plants. The manhole bottom will have a "Y" form channeled bottom. The leg of the "Y" leading to the smaller plant will include an adjustable sliding deflector board that will regulate the quantity of flow diverted to either facility. The collector board will have to be adjusted on a trial and error basis to achieve the proper flow split.

Treatment will be by the extended aeration variation of the activated sludge process, with chlorination of the effluent prior to discharge into the Clinch River. Pretreatment is provided by means of a screening basket and an influent comminutor. Prior to installation of the sewage treatment plants, portable toilets will be used by construction personnel. Portable toilets may be used after operation of the sewage treatment facilities to serve remote areas during the construction period. Wastes from the portable toilets will be removed from the site and disposed of in an environmentally acceptable manner by licensed contractors. The treatment plants include aerated surge tanks for equalization of flow and post aeration tanks to assure that effluent discharged to the Clinch River is not septic.

The sewage treatment plants will be located approximately 850 feet south of the Reactor Containment Building centerline. (See Figure 3.2-3.)

The 13,000 gal/day capacity treatment plant, as described above, will remain for the plant operating period. The extended aeration process is expected to effect a 90 percent removal of suspended solids and biochemical oxygen demand. Sludge generated by the sewage treatment systems will be trucked offsite for ultimate disposal.

The sewage treatment system is designed in accordance with applicable State of Tennessee Design Criteria.

The sewage collection system is designed in accordance with Chapter 2 ("Design of Waste Water Collection Lines and Pumping Stations") of Section V "Design Criteria; Including Laws, Regulations and Policies for Water and Waste Water Systems, published by the Tennessee Department of Public Health. All collection lines are 8-inch ductile iron pipe, installed at a minimum slope of 0.4%. Manholes are spaced at 350 feet, maximum. Building sewers

are 4-inch C.I. soil pipe and conform to the requirements of the Southern Building Code Council Plumbing Code. Minimum depth of cover for piping is 3 1/2 feet.

3.1.2.1 Component Design Description

The permanent and construction period plant and component design requirements have been included in Technical Specification 3066-76-2, "Sanitary Waste Treatment Equipment". The contract for this equipment has been awarded to Clow Corporation of Florence, Kentucky. Specific design data and dimensional data are not available at this time. The component descriptions provided below reflect specification requirements imposed on the equipment manufacturer.

Pre-Treatment Facility

A removable welded ANSI Type 304 stainless steel screening basket is provided, along with an influent comminutor. The pre-treatment facility is arranged so that raw waste can be sampled after comminution, before raw waste enters the aeration tank.

Aeration Tank

The tank volume is determined by the F/M ratio (Food-to-Microorganism) for the design condition: F/M ratio of 0.1 of MLSS (Mixed-Liquor Suspended Solids) = 2,500 mg/l or 0.05 at MLSS = 5,000 mg/l (same as 15.6 lb BOD per 1,000 cubic ft of tank volume). Therefore, the volume for the construction sewage treatment plant is 8,000 cubic ft and the permanent plant volume is 1,200 cubic ft. Froth sprays are provided in the aeration tank.

Air Blowers

Aeration equipment supplies at least 2,100 cubic feet of air per pound of BOD or 3 cubic feet per minute per foot of length of aeration tank, whichever is larger. Additional air is provided for the sludge holding tank and air lift for pumping return sludge from the settling tank, and for the aerated surge tank and post aeration tank. Two air blowers are provided, each blower having a capacity to supply the air necessary for plant operation. Blowers are rotary positive displacement type. Each blower is complete with electric motor and V-belt drive, air relief valve, gas type check valve, and filter silencer, all mounted on a common base. Additional sheaves are included for each blower to provide blower output of approximately 50 percent or 75 percent of output capacity. The blowers and motors are mounted in a ventilated weather proof enclosure, lined with fiber glass insulation for noise control.

Air Diffusers

The diffusers installed in the aeration tank are designed for the maximum quantity of air required to assure uniform small bubble distribution of air over the entire length of the tank. The oxygen transfer efficiency of the assemblies is such that an adequate supply of oxygen is maintained in the aeration compartment to meet the treatment requirements of the biological loading for which the plant is designed.

The air diffuser assemblies are of corrosion-resistant construction, individually mounted from an air distribution header. The complete air diffuser and drop-pipe assemblies are factory mounted on the air header and adequately supported by structural framing. Each drop-pipe is equipped with an air regulating valve to permit adjustment of the air flow or complete shutoff of each individual diffuser assembly. The drop-pipe is so connected to the air header as to permit the air diffuser assembly to be removed quickly and easily without disturbing the air flow to, and the operation of, any other diffuser assembly and without dewatering the tank.

Clarifier

The clarifier is sized for a surface loading at peak flow rate of 360 gpd/ft^2 based on effective surface area. The maximum allowable weir loading rate is 10,000 gpd/lin ft.

The clarifier has a hopper bottom with side walls sloped at a minimum of 60 degrees to insure effective removal of solids from the clarifier to the aeration tank. The clarifier is properly baffled, including scum baffles and an adjustable V-notch overflow trough. An adjustable air lift type surface skimmer is provided to remove the skimmings from the surface of the clarifier and return them to the aeration tank.

Sludge Return Air Lift

The settled sludge is pumped from the bottom of the clarifier by a sludge air lift to the inlet of the aeration tank, and is arranged so that a sample of the return sludge can be collected. The air lift has a minimum capacity equal to 100 percent of the daily design flow. Valves are provided for regulating return sludge flow and for blowing down the air lift to prevent clogging. A valved tee connection and piping are provided for removing excess sludge to the waste sludge holding tank.

The air blowers provide air for the operation of the air lift, and the air supply line includes a needle valve for control and adjustment of air flow. The air lift is installed in a manner to permit convenient removal from the clarifier without dewatering the tank.

Waste Sludge Holding Tank

The waste sludge holding tank volume is at least 10% of the aeration tank volume and is aerated. Provision is made for effective liquid/solid separation and decantation of supernatant. Arrangement of the tank is such that supernatant flows by gravity to the inlet of the aeration compartment. The waste sludge holding tank has an outlet provided near the bottom for removal of waste sludge from the outside of the tank. Aeration at 2 cfm per 100 ft^3 of holding tank volume is provided.

Chlorination System

The chlorination system includes a chlorine contact chamber, complete with a hypochlorite solution feed pump, polyethylene solution tank, required piping or tubing, electrical controls, and weatherproof enclosure.

The chlorine contact tank is designed to provide a contact time of 45 minutes, based on the peak flow rate. Air lift piping (1-inch) and valves are provided to allow for periodic discharge of sludge accumulation to the head of the plant.

The hypochlorinator is a positive displacement type feeder, designed for feeding a solution of sodium or calcium hypochlorite. The unit provides for manual adjustment of feed rate and is acid and alkali resistant. All parts and surfaces which come in contact with the hypochlorite solution are chemically resistant plastic or rubber. The hypochlorinator unit is complete with electric motor and drive, relief valve, plastic fittings and tubing, foot valve, injection check valve or antisiphon valve, essential spare parts and special tools and polyethylene solution crock to provide a minimum of thirty-six hours storage capacity.

The hypochlorinator housing is a ventilated weatherproof enclosure and is complete with bottom plate, hinged lid, and mounting brackets. An electrical unit space heater of adequate capacity to maintain temperature above freezing and a manual pushbutton operated blower provides forced ventilation.

Surge Tank and Post Aeration Tank

A surge tank is provided to assure a uniform and continuous flow to the aeration tanks. The surge tank is aerated to prevent septicity.

A post aeration tank is provided to assure that effluent discharged to the Clinch River is not septic.

Flow Measurement and Monitoring

Sewage treatment plant effluent flow is measured and continuously recorded by means of a V-notch weir and a float activated flow indicator/recorder provided with 7-day circular chart. The weir is located at the outlet of the chlorine contact chamber.

Influent, effluent and process unit monitoring for regulatory purposes and process control will be by means of grab samples taken at locations which reflect representative conditions for the parameters being measured. Analytical techniques for fulfilling regulatory monitoring requirement will be EPA approved methods.

3.1.2.2 Treatment Capacity vs. Variable Loadings

During the life of both treatment plants, the population served will vary, the primary concern being that the facilities may be underloaded. To allow for variation in served population, physical plant modifications and process adjustments may have to be made. Specific changes will be worked out between the owner and the plant manufacturer (Clow Corporation) so as to maintain treatment efficiencies.

The changes and modifications may include, but not be limited to the following:

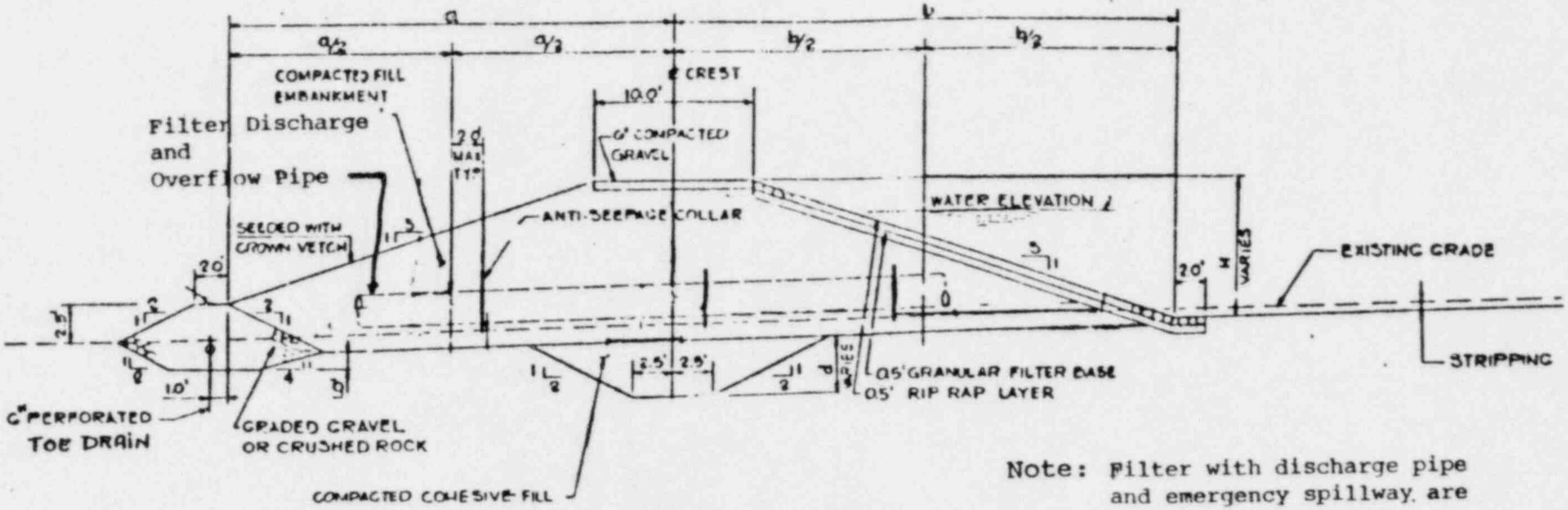
Physical Plant Modifications

- utilize surge tank for process aeration
- temporarily decrease volume of aeration tank

Process Adjustments

- adjust sludge return rate
- adjust sludge wasting rate
- adjust aeration rate
- provide supplemental feed to maintain food to mass ratio

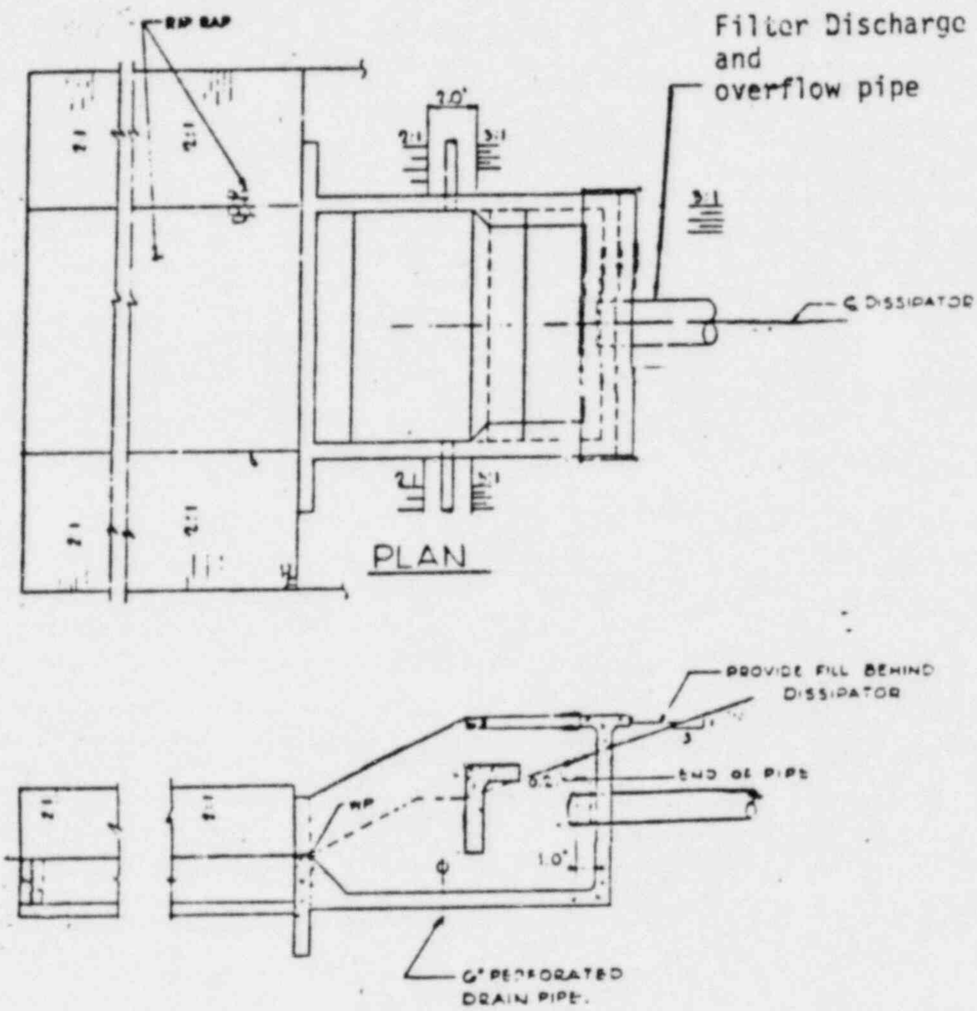
Should short term overloading occur, the process adjustments mentioned above may also be utilized to maintain treatment efficiency. Extended periods of overloading, or severe short term overloading may require the use of additional treatment units. The Owner will provide proper notification well in advance of installing any additional treatment units.



Note: Filter with discharge pipe and emergency spillway are not shown.

FIGURE 3.1-1

TYPICAL DIKE CROSS SECTION: RUNOFF TREATMENT POND (IMPOUNDING POND)
(NO SCALE)



ELEVATION

FIGURE 3.1-2

POND OUTLET DETAIL - DISCHARGE
(NO SCALE)

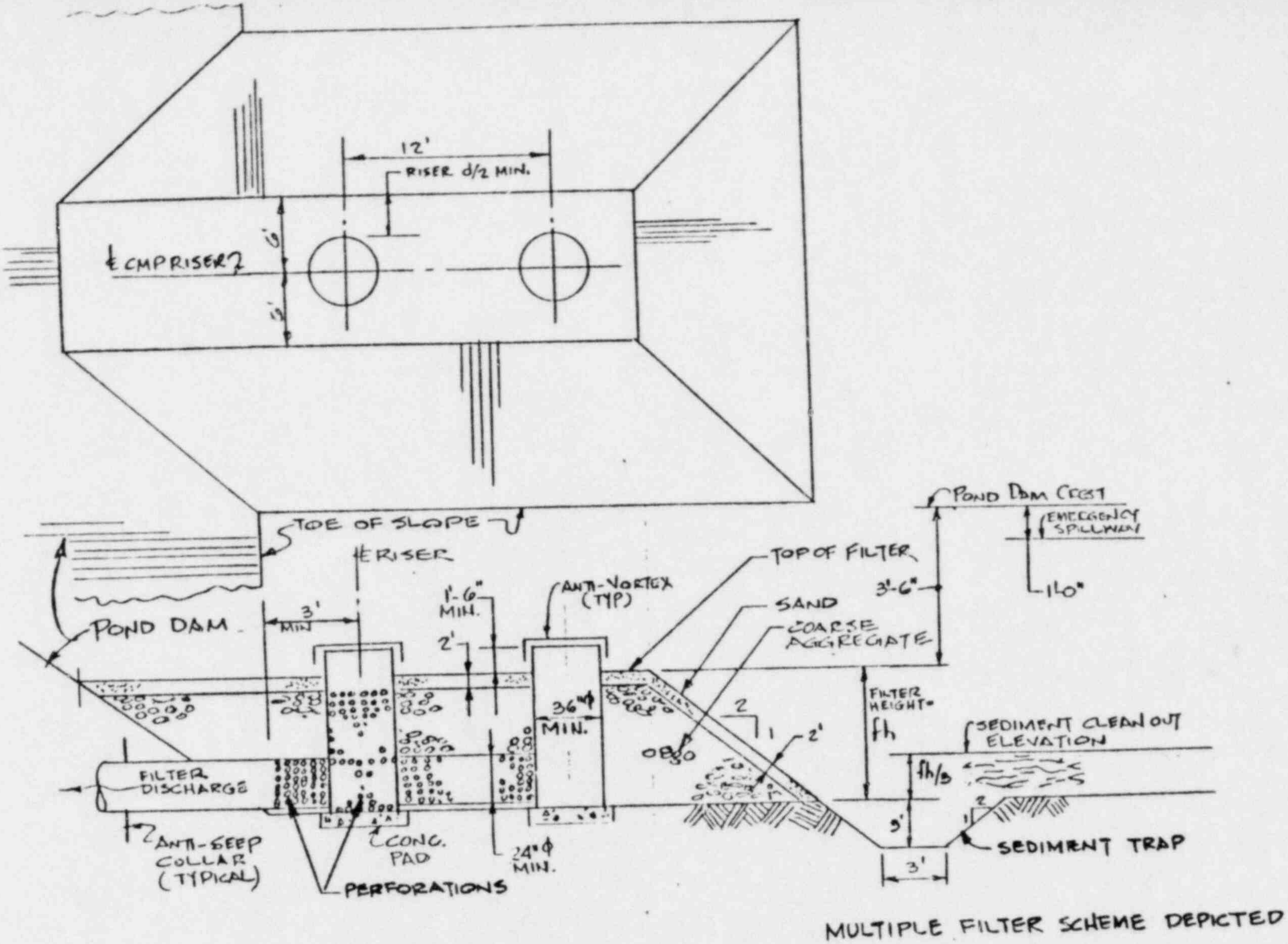


FIGURE 3.1-3
Runoff Treatment Pond - Sand Filter
(No Scale)

TABLE 3.1-1

RUNOFF TREATMENT PONDS' PHYSICAL CHARACTERISTICS

IMPOUNDING POND	DRAINAGE AREA ACRES	DESIGN STORM/ EXCAV. DEWAT. VOL., CUBIC FT x 10^3/day	AVERAGE POND DIMENSIONS, FT. (L x W x H)	POND STORAGE VOLUME CUBIC FTx10^3	SEDIMENT VOLUME AT CLEAN-OUT ELEVATION CUBIC FEET x 10^3
A	45	458/241	385 x 190 x 10	546	31
B	34	351/96	160 x 140 x 10	380	51.5
C	48	497/NA	275 x 250 x 12	391	57
D	25	182/193	230 x 110 x 12	161	14
E	83	550/NA	240 x 120 x 12	424	88
Quarry Impounding Pond	45	437/NA	100 x 200 x 10	200	60

3.2 Operating Period-General

During the operating period, the following point source discharges will be conveyed to the Clinch River via a Common Plant Discharge:

- o Sewage Treatment Plant Effluent
- o Low Activity Level Liquid Radwaste System Effluent
- o Waste Water Treatment System Effluent
- o Cooling Tower Blowdown

Stormwater discharges will occur at five separate locations: the discussion in Section 3.1.1 is applicable for the operating period runoff treatment ponds.

The design features of the sewage treatment system for the operating period are discussed in Section 3.1.2.

A layout of the plant, showing the relative location of the various structures referred tc herein, is shown in Figure 3.2-3.

3.2.1 Low Activity Level Liquid (LALL) Radwaste System-Design Features

The Low Activity Level Liquid Processing System, designed to collect, process monitor, store and dispose of radioactive liquid wastes having an activity concentration not exceeding 10^{-4} μCi/cc, is shown schematically in Figure 3.2-1. This system provides the necessary equipment and facilities to collect and process low activity level liquid wastes, chemical wastes and detergent wastes from floor and equipment drains, laboratory drains, decontamination station personnel shower drains, the Reactor Service Building Decontamination Facility and the Maintenance Shop and Warehouse Regulated Maintenance Shop. The system operates on the batch principle, wherein liquid wastes are accumulated until such time as a convenient quantity of wastes has been collected before processing is initiated. The various phases of processing, the processing components and the systems operation are described below.

LALL Collection

Low Activity Level Liquids are collected in a sump located in the Radwaste Area of the Reactor Service Building (RSB). The sump collects laboratory and decontamination station drainage and contaminated drainage from LALL Radwaste equipment such as tank drains and overflows, pump drains, leakage, etc.

Upon accumulation of a predetermined quantity of drainage within the sump, one of the sump pumps is started to transfer the collected liquid wastes to either the Intermediate Activity Level Liquid IALL Collection Tanks or the LALL Collection Tanks. A sample connection at the sump is provided to determine the activity of the sump contents. Laboratory analysis of the liquid within the sump is used to determine which processing system should be employed in treating the accumulated liquid. The discharge valving

from the sump pumps is arranged such that the operation can direct liquids with an activity level of 10^{-4} µCi/cc or less to the LALL Collection Tanks, while a batch of collected liquids in the sump having a higher activity level would be directed by the operator to one of the IALL Collection Tanks. Low Activity Level liquid wastes from the sump pump discharges are directed to the LALL Collection Tanks via one of the installed LALL Filters which serve to remove undissolved solids from the liquid stream prior to entering the LALL Collection Tanks. Personnel shower drains are piped from their source to the upstream side of the LALL Filters where they combine with the discharge of the sump pump. Filters are of the cartridge type, connected by piping, and valved in a manner which permits the operator to bypass the filters or direct flow through either one or both of the filters, thus permitting maintenance and/or replacement of one filter without interrupting flow to the LALL Collection Tanks.

Two LALL Collection Tanks, each of 2,000 gallons nominal capacity, are provided so that one tank may be receiving or be ready to receive waste influent while the contents of the other tank are being processed. The total usable LALL Collection Tank capacity of 4,800 gallons provides for approximately five (5) days of accumulation from the various input sources.

LALL Collection Tank Sampling

Two (2) centrifugal type LALL Circulation and Transfer Pumps are provided to recirculate the LALL Collection Tank contents, for purposes of agitating the tank liquids to form a homogeneous mixture which will provide a representative sample of the liquid during sample analysis.

Based on the results of the laboratory analysis performed on a small sample of liquid withdrawn from the LALL Collection Tank via the grab sample connection, it may be necessary to add an anti-foaming agent to the tanks contents. Additionally, it may be necessary to adjust the pH level of the liquid to bring the pH between 8.0 and 9.5 prior to processing.

The addition of the anti-foaming agent and the pH adjustment chemicals is performed while the contents of the LALL Collection tank are in the recirculation mode, anti-foaming agents being introduced into the tank recirculation line while pH level adjusting chemicals are introduced into the tank proper. Effectiveness of these additions is checked by drawing another sample for laboratory analysis following a suitable mixing period.

After pH adjustment and anti-foaming treatment, as required, the waste liquid from the LALL Collection Tanks is processed by the LALL Evaporator Prefilters.

The anti-foaming station is comprised of a vertical anti-foam tank to store the anti-foaming agent, a positive displacement anti-foam feed pump and the necessary piping, valving, controls and instrumentation to inject small quantities of the anti-foam agent into the LALL waste. Anti-foam agent is added to minimize degradation of the processing system performance when detergents are present in the LALL waste batch.

The pH adjustments are made utilizing either acid or caustic: appropriate tanks and pumps are provided for this purpose. pH adjustment chemicals are added in small quantities to reach a pH within the range of 8.0 to 9.5.

LALL Evaporation

The Low Activity Level Liquid Evaporator System is provided to concentrate impurities in the LALL wastes as well as the contaminants of the LALL processing system. Low Activity Level Liquids which are proven by laboratory analysis to be of low solids content, relatively free of chemical impurities, and of low activity level may bypass the evaporation process and be transferred directly from the LALL Evaporator Prefilters to the LALL Demineralizers.

The principle components of the LALL Evaporator System are the LALL Evaporator Recirculating Pump, the LALL Evaporator Heating Element, the LALL Evaporator Vapor Body, the LALL Evaporator Surface Condenser, the LALL Distillate Receiver, the LALL Evaporator Distillate Pump, the LALL Evaporator Distillate Cooler, and the LALL Evaporator Bottoms Dischage Pump.

Distillate meeting the criteria for discharge from the Evaporator System is cooled in the Evaporator Distillate Cooler and directed to one of the installed LALL Demineralizers. Concentrates from the LALL Evaporator are periodically discharged from the evaporator system by the Bottoms Discharge Pump, and are pumped to the Solid Radioactive Waste System for solidification and ultimate disposal by licensed contractors.

LALL Demineralization

All LALL wastes are demineralized as part of the LALL processing. The two possible sources of LALL demineralizer liquid feed are the evaporator system distillate discharge, and the evaporator bypass which carries liquids from the LALL Evaportor Prefilter discharge to the demineralizer. Flow through an LALL Demineralizer is accomplished by opening the inlet valve to the demineralizer through which flow is to proceed, and closing the inlet valve to the demineralizer which is to be out of service. Concurrently, the demineralizer outlet valves are positioned in an identical manner to permit demineralizer effluent to proceed from the demineralizer in service through one of the LALL Resin Traps. The resin traps are piped and valved in a manner which will permit flow through either demineralizer. Flow from the resin traps is directed to one of the LALL Monitoring Tanks wherein the processed liquid is sampled prior to being discharged through the Common Plant Discharge to the Clinch River.

The LALL demineralizer bed resins are backwashed to the Solid Radioactive Waste System for disposal upon reaching the point of ion exchange exhaustion, as indicated by conductivity elements installed in the demine-

ralization effluent lines. The procedure for backwashing is described below: backwashing is accomplished by closing the inlet and outlet valves of the demineralizer and opening the back flush outlet valve; next, air and flush water are admitted into the vessel sequentially through the backflush air inlet valve and the backflush inlet valve for water (this operation serves to fluidize the resin bed by breaking up caked material); the flushing water serves as the transport vehicle to carry the dislodged resin beads from the vessel, via the back flush outlet valve to the Solid Radioactive Waste Systems Decanting Tank.

Upon completion of this phase of the operation, the backflush air inlet valve, the backflush inlet valve and the backflush outlet valve are closed, then the demineralizer vessel vent valve and drain valve are opened and the vessel is drained of any remaining water.

A new resin bed is prepared in the Resin Feed Tank mixed with demineralized water and slurried to the demineralizer vessel through a resin feed line and the resin inlet valve. Upon complete transfer of the contents of the Resin Feed Tank, the feed tank and the resin feed line are flushed with clean water into the demineralizer vessel, excess water being drained off the bottom of the vessel and directed to a sump via a drain valve. Upon completion of the rinsing operation, the resin inlet valve, the drain valve and the vent valve are closed. The vessel is now recharged and ready for operation. The entire sequence of backwashing, rinsing and recharging a demineralizer is performed semi-automatically upon manual initiation of the process from the appropriate Radwaste Control Panel.

LALL Processed Liquid Monitoring, Storage and Discharge

Discharge liquid from the LALL Resin Traps is directed to one of LALL Monitoring Tanks. The operator positions the tank inlet valves to permit flow into one tank while excluding flow from the other. The contents of a single batch of LALL processed effluent may be accumulated since the LALL Monitoring Tanks are identical in size to the LALL Collection tanks. When an LALL Monitoring Tank is full, the LALL Distillate Circulating and Transfer Pump is st[illegible]ted and liquid is recirculated back to the tank from which suction was drawn. Following a recirculation period of approximately 30 minutes, a sample of the liquid is drawn from the recirculating line sample connection and the liquid is analyzed in the laboratory to determine if the liquid meets discharge criteria. Those liquids meeting discharge criteria may either be reused in the plant or discharged via the Common Plant Discharge to the Clinch River. Liquids not meeting the discharge criteria are recycled to the LALL Radwaste System for further processing.

The flow path for liquids collected in the LALL Monitoring Tanks, which are to be discharged to the environs is described below: The tank effluent valve pump suction valve and pump discharge valve are opened, and flow passes through a flow element and a flow control valve to the discharge header leading to the Common Plant Discharge. Prior to discharge, flow is passed through a radiation element for monitoring purposes. The shutoff valves to

the Common Plant Discharge are remotely operated from the Control Room. The valves' remote switches are equipped with a locking device to prevent inadvertent discharges to the environs, thus, they must be unlocked before the actuator can be operated to open the shutoff valve. Additionally, the shutoff valves are interlocked with a flow switch in the cooling tower blowdown line so that LALL Radwaste System discharges do not occur unless blowdown flow is 1000 gpm or greater. Radwaste System discharge flow rate is 25 gpm.

The radiation element installed in the discharge line serves to prevent the discharge of LALL Radwaste effluents which do not meet discharge criteria. Upon detecting a higher than allowable activity level, the element is interlocked to close shut the shutoff valve to the Common Plant Discharge and to annunciate the condition in the Radwaste Control Room and the CRBRP Main Control Panel.

LALL Monitoring Tank contents not meeting the discharge criteria may be directed back to the LALL Collection Tanks, to the evaporator system or to the demineralizers.

3.2.1.1 Characterization of LALL Waste

LALL waste consists of floor, lab, decontamination station, and equipment drains.

Floor drains from cell with radioactive equipment are directed to the LALL system. The quality of this influent is expected to be low in activity and high in suspended and dissolved solids. Small quantities of detergents, soaps and oils are also anticipated.

Lab drains will be relatively pure and are expected to contain dilute solutions of NaOH and NaO which are by-products of primary sodium sampling operations conducted in the Plant Service Building combined lab.

Equipment drains from the various portions of the radwaste system are directed to the LALL system. Influents will include LALL as well as small quantities of IALL waste which includes chemically pure dilute solutions of sodium hydroxide (from water vapor nitrogen sodium cleaning rinses) and spent acid decontamination solutions. The quantity of this waste is expected to be small and will not contribute significantly to the chemistry or activity of the LALL system.

Decontamination station drains consist of personnel decontamination laboratory and shower drains. They are expected to contain dilute quantities of soaps and detergents with trace amounts of activity.

The total influent to the LALL system is expected to be approximately 850 gallons/day. The typical chemistry of the influent is identified as follows:

Species	Concentration in PPM
Ca	58
Mg	21
Na	84
HCO_3	215
Cl^-	5
SO_4	57
NO_3	4
Fe	0.3
SiO_2	1.5
Insoluble Fe_2O_3	50
Oil	6
PO_4	150
TOTAL	652

The activity of the LALL influent will be less than or equal to $10^{-4} \frac{\mu c}{cc}$. The design annual concentration of activity by isotope is identified in Table 11.2-2 of the PSAR. The concentrations and volumes are based on extrapolation of typical experience from light water plants.

3.2.1.2 System Design Basis

The system design basis is to provide the capability to insure that the influents described in the previous paragraphs can be processed to produce a released activity concentration that is as low as reasonably achievable and a small fraction of the 10 CFR 20 limits. In addition, the effluent must meet the chemical purity requirements of the NPDES draft permit (#TN0028801). The design released activities and a description of the effluent release control is provided in the PSAR Chapter 11.2.

3.2.1.3 LALL Equipment Design Justification

A sump of approximately 1,200 gallon capacity is provided to collect the various inputs which are discharged by gravity. The sump is sized to hold a minimum of a days worth of influent. The sump is provided with sampling capability. A manway provides access for visual inspection and, if necessary, skimming of oil films. Two sump pumps (50 GPM @ 140 ft) are provided to transfer the sump contents to the collection tanks. Pumps are selected to suit the system hydraulic needs while keeping transfer time to a minimum.

Two system inlet filters are provided to trap undissolved solids prior to entering the collection tanks. The filters have disposable paper and stainless steel cartridges and are rated at 10 microns. Filtration ratings

can be changed to suit the operating conditions by simply changing cartridges. Approximately 16.3 ft^2 of filtration area is provided. Filters will be changed based on pressure drop or radiation level. Filtration prior to collection will serve to minimize accumulation of activity in collection tanks.

Two 2,000 gallon nominal capacity, stainless steel collection tanks are provided. The total usable collection tank capacity of 4,800 gallons provides for approximately 5 days worth of accumulation of system influent. The tanks will be designed in accordance with ASME Section VIII and are vertical, cylindrical, 7' diameter x 13' high.

The capability to add pH adjustment and anti-foam chemicals is provided by metering pumps. Pre-determinted volumes of either H_2SO_4 or NaOH can be metered into the collection tank proper during recirculation. Final selection of the antifoam agent has not been made. However, it will be similar chemical composition to Diamond Shamrock Foamaster "A". Selection of the chemical will be based on compatibility with the process system requirements in particular, the evaporator. Predetermined volumes of antifoam will be metered into recirculation line of either tank.

The LALL system equipment is sized to process the normal daily influent of waste in a single 8 hour shift. A recirculation pump is provided for each tank. These pumps are centrifugal type rated at 25 GPM @ 140'. This capacity provides tank contents recirculation within 96 minutes, which is compatible with the objective stated above.

The LALL evaporator prefilters are similar in design to the system inlet filters. These filters will remove suspended solids from the flowpath between the collection tanks and the evaporators or demineralizers. The filtration rating of these filters has been tentatively selected at 1 micron. As with other cartridge filters, the rating can be adjusted to suit operation by changing the element.

System process equipment (demineralizer/evaporator) is sized at 10 GPM. This flow has been selected to be compatible with the design objective to process the normal daily influent within a single 8 hour shift.

The process to be employed will be dictated by the result of the collection tank grab sample analysis. If the activity or chemical composition warrants, both evaporation and demineralization will be employed. Conversely, relatively pure and low activity fluid will be demineralized only.

The liquid radioactive waste evaporators are of the forced circulation submerged tube type and will be provided by HPD of Naperville, Illinois. High temperature hot water is employed as a heating medium. Cooling is provided by the normal plant service water system. The primary evaporator recirculation loop utilizes Incoloy material which has proven to be superior to stainless steel in this application. High velocities and the design which prevents boiling in the heating element tubes, serve to minimize degradation of heat transfer surfaces. An entrainment separator with

bubble trays and a mesh pad demister will serve to remove entrained droplets and impurities from the steam. On the distillate side, a vertical four pass stainless steel condenser is provided. A single pass heat exchanger is provided to subcool the liquid prior to discharge to the demineralizers. Separate hot water, concentrates discharge, evaporator recirculation and distillate pumps are provided in the evaporator package. Sampling capability is provided for evaporator concentrates and distillate to monitor evaporator performance. Instrumentation is provided to continuously monitor the evaporator distillate and will prevent discharge of fluids with conductivity greater than 50 umho and temperatures greater than 150°F. Concentrates from the evaporator are directed to the radwaste solidification system for encapsulation in concrete.

Evaporator decontamination factors are identified as follows:

Feed (IALL)	Decontamination Factor
Iodine - 131	10^3
Cesium - 137	10^4
Other Fission Products	10^4
Other Corrosion Products	10^5
Volatile Solids (tellurium, strontium, ruthenium)	10^4
Non-Volatile Solids	10^5

Discharge from the evaporator is directed to a polishing demineralizer. The demineralizer will be supplied by Crane Cochrane of King of Prussia, Pennsylvania. Two 5.3 ft^3 mixed bed demineralizers are provided. Flow can be directed through one demineralizer at a time or both in series. The demineralizers are of the non-regenerative type. Spent resins are backflushed to the solid radwaste system for dewatering and encapsulation in concrete when exhausted. Backflush is accomplished using a combination of compressed air and demineralized water. The resin that has been selected is Rohm and Hass IRN-150. The vessels are vertical, cylindrical, stainless steel, 150 psi design. Sampling connections and conductivity cells are provided in the demineralizer discharge pipes to monitor performance. The conductivity cell alarm is set at 15 umho. Expected decontamination of influent is 10^1 for iodine and cesium and 10^2 for all other isotopes.

Resin trap filters are provided on the discharge path of the demineralizers. The filters are provided to prevent resin fines which may pass through the demineralizer retention element from entering the LALL monitoring tanks. These filters are identical in design to the other system filters previously described.

A resin feed tank is provided to refill the demineralizers after discharge of the bed. New resin is slurried by gravity with demineralized water to the empty demineralizer.

Consistent with the batch philosophy of the system design, two monitoring tanks which are identical to the collection tanks are provided. Two 25 GPM 230 ft. recirculation pumps are provided. Grab sample connections are provided in the tank recirculation lines. Tank effluent samples will be evaluated in order to determine if discharge criteria are met. If the discharge criteria are not met, fluid can be reprocessed by either evaporation and demineralization or only demineralization.

As previously mentioned, the discharge criteria for activity and chemistry is provided in 10 CFR 20 and the NPDES draft permit respectively. In general, it is expected that the actual activity of discharged fluid will be orders of magnitude below the 10 CFR 20 limits. A breakdown of the expected activity is provided by isotope in the Environmental Report Table 3.5-3. Discharge from the plant takes place through a continuous radiation monitor. A radiation alarm will automatically shut two air operated valves in the discharge path securing the discharge. Adequate holdup volume is provided to insure that fluid causing the alarm will not be discharged due to response time of instrumentation. The common plant discharge header provides the means of discharge to the river and additional reduction is activity concentration due to dilution.

System materials are generally stainless steel with the exception of materials exposed to acid and the evaporator recirculation path which are high nickel alloys. Small tanks (acid, caustic, antifoam, resin feed) have been standardized in size of 150 gallons. These tanks are vertical cylindrical type (8'6" high by 2'6" in. diameter) designed in accordance with ASME Section VIII. Pressure vessels such as filters and demineralizers are designed and fabricated in accordance with ASME Section VIII.

The LALL evaporator may be used as a backup to the IALL evaporator in the event of equipment failure. Following processing of IALL fluid the LALL evaporator will be thoroughly cleaned and flushed to restore compability with LALL fluid. Piping crossover connections are provided upstream and downstream of the evaporators such that only the LALL evaporator will be exposed to IALL fluid.

A crossover connection is provided between the IALL distillate tanks and the LALL monitoring tanks. In the event that excess liquid is present in the IALL system, it must be discharged. This fluid will be processed in the IALL system to radiation levels that are as low as practical and then discharged to the LALL monitoring tanks. It will then be sampled and processed in the LALL system to meet the same off plant discharge criteria. It should be noted that this is not an expected occurrence. Section 3.5 of the Environmental Report describes the design philosophy and provides the concentration at discharge to the river based on an assumed IALL discharge.

Pump curves are not available at this time since procurement has not been completed.

Because of the nature of the LALL waste, no traceability or pilot plant studies are considered necessary. Pilot plant studies have been conducted on IALL system decontamination solutions. These studies have concluded that the solutions are fully compatible with the evaporator design.

Because of the varied nature of the LALL system influents, no titration curves can be provided. As a by-product of collection tank grab sample analysis, during operation, titration curves for the various chemical adjustments (e.g., pH) will be generated.

The system is designed to be operated remotely from a central control area consistent with good practice and ALARA.

3.2.2 Waste Water Treatment System - Design Features

The Waste Water Treatment System handles non-radioactive floor drainage and process water treatment system waste. The Waste Water Treatment System is shown schematically in Figure 3.2-2.

The process units of the Waste Water Treatment System are located outside the main CRBRP plant buildings, east of the Steam Generator Building Maintenance Bay. The collection-equalization basins and the sludge lagoons are located east of the Sewage Treatment Plant. Figure 3.2-3 shows the location of these facilities.

The unit processes to be employed at the CRBRP for treatment of waste water include neutralization, equalization pH adjustment, coagulation, flocculation, sedimentation and filtration. These processes have proven themselves to be effective in the treatment of the types of wastes that will be generated by the CRBRP and provide the needed flexibility for wastes that vary in chemical composition. Power plants that have used or specified equipment using these processes include Seminole Electric Cooperative, Inc., Seminole Units 1 and 2, in Florida, and New Jersey Central Gas and Electric, Gilbert Station, in New Jersey.

The waste water treatment system has been included in Technical Specification 3066-76-1, "Waste Water Treatment Equipment". The contract for this system has been awarded to ERC/Lancy, Equipment and Services Division of Dart & Kraft of St. Paul, Minnesota. Specific design information and details are not available at this time. Equipment design criteria imposed on the equipment manufacturer are given in Table 3.2-1.

Process Description

Floor drain wastes that may contain oil undergo oil-water separation prior to discharge to the equalization basins. Oil from the separation process is discharged to a waste oil tank which will be periodically pumped out by a licensed contractor who will dispose of the waste oil off-site. Non-oily drains discharge to the equalization basins directly.

Chemical wastes associated with process water treatment consist of regeneration cycle wastes and rinses from the Condensate Polishing System and the Make-up Water Treatment System, feedwater and steam sampling wastes, and Turbine Generator Building chemical storage area drains, discharge to the chemical waste sump in the Turbine Generator Building. The wastes are then pumped to the batch chemical waste neutralization system located in the Waste Water Treatment area of the plant yard. Following neutralization, these wastes are discharged to the equalization basins.

The equalization basins consist of two equal capacity compartments, each compartment sized to provide one full day of storage capacity for normal plant waste volumes. Dual compartment design permits the basins to operate alter-

nately: one in service, one in clean-up or standby. Since plant wastes are discharged at variable frequency and duration, and have variable characteristics, the basins provide equalization of flow and characteristics and hold-up capacity prior to processing in downstream treatment units.

Plant wastewater is pumped from the equalization basins to downstream treatment units by three submersible pumps which are located in a pre-cast concrete wetwell adjacent to the equalization basins. Each pump is designed to provide continuous discharge of wastewater based on average plant flows. Two pumps will handle unusual waste volumes resulting from intermittent discharges such as fire protection system discharge, high volume tank and basin cleanings and unscheduled discharges. The third pump is a standby in case of pump failure. A flow meter on the discharge line monitors and records plant waste flows and provides a signal for pacing chemical feed in downstream treatment units.

The wastewater treatment units consist of the following major components: pH trim tank, solids contact clarifier and automatic gravity filters. These units are located in the Waste Water Treatment area of the plant yard. Appurtenant equipment, consisting of bulk chemical storage tanks, mix tanks, chemical feed pumps, controls, instruments and associated panels, are located within the Waste Disposal Building in the same area of the yard.

Wastewater pumped from the equalization basins is discharged to the pH trim tank which provides sufficient detention time for adjustment of wastewater pH to optimize the performance of the downstream solids contact clarifier. The pH trim tank is fitted with a mixer at the inlet end and a pH sensor at the outlet end. This sensor works in conjunction with a pH sensor located in the wastewater wetwell at the equalization basins to provide pH control. The pH controls pace a set of acid or caustic feed pumps, as required, to maintain a narrow preset pH range. The optimum pH range will be determined on a regular basis by plant operators.

From the pH trim tank, wastewater flows by gravity to the solids contact clarifier. The clarifier removes suspended solids and dissolved iron and copper from the wastewater stream. The clarifier provides flash mixing of chemicals and previously formed precipitates with inlet wastes, flocculation, and clarification of wastewater. Solids produced in the clarifier are moved by a sludge scraper mechanism to a hopper in the clarifier bottom and are removed from the clarifier by an automatic system of backflush and blow-off valves. The sludge removal cycle is adjustable and is paced by inlet flow. Cycle adjustments will be established and modified as required to maintain optimum clarifier performance based on waste characteristics. Chemical feed to the clarifier is paced by the flowmeter in the influent pump discharge line. Chemical dosage rates will be determined by plant operators on a periodic basis by means of jar tests.

Following the solids contact clarifier, treated wastewater flows by gravity to two full design capacity automatic gravity filters. The filters remove traces of suspended solids, oil and grease and assure that effluent

meets the discharge limits stipulated in the CRBRP discharge permit. The backwashing of the filters is completely automatic and is based on loss of head through the filter media. The filter backwash system includes air scour of filter media to enhance the removal of sticky or gelatinous materials. Filter controls are interlocked so as to prevent simultaneous backwash of both filters.

Filter effluent is monitored for turbidity (turbidity limits to be correlated to total suspended solids), oil and grease, and pH by automatic analyzers located in the Waste Disposal Building. An excursion in any of these parameters beyond discharge limits automatically diverts plant effluent back to the equalization basins so as not to contravene discharge limits.

Normally, effluent is combined with cooling tower blowdown and discharged to the Clinch River. If chemistry permits, plant effluent can be discharged to the cooling tower basins for recycling. Chemical considerations influencing the decision to recycle include total dissolved solids concentrations on the Circulating Water System and in the Waste Water Treatment Plant effluent. The conditions under which recycle will take place will be determined during CRBRP operation.

Wastes which contain high suspended solids, including Make-Up Water Treatment System clarifier blowdown, gravity filter backwash and activated carbon filter backwash; Waste Water Treatment System clarifier blowdown and gravity filter backwash; and other plant wastes such as cooling tower basin clean-up, are discharged to the sludge lagoons. The sludge lagoons are located adjacent to the equalization basins and are comprised of two equal capacity compartments. Dual compartment design permits the lagoons to operate alternately: one in service, one in clean-up or standby. Each compartment is sized to hold the solids production of approximately six months operation. Accumulated solids (sludge) will be removed and disposed of off-site by a licensed contractor. As sludge settles and thickens, clear supernatant is recycled to the equalization basins.

The Waste Disposal Building contains bulk storage tanks for acid and caustic; acid and caustic feed pumps; coagulant mix tanks and feed pumps; coagulant aid mix tanks and feed pumps; and instruments and controls and alarms associated with the waste water treatment process.

In general, the Waste Water Treatment System is designed to treat and dispose of all process chemical wastes and non-radioactive floor drainage at a rate of 100 gpm average annual flow. Average winter flow is estimated to be 75 gpm; average summer flow is estimated to be 125 gpm; summer start-up flows are estimated to be 225 gpm. The design flow rate for the pH trim tank, the solids contact clarifier, and the gravity filters is 200 gpm for each unit, which is adequate for treating the summer start-up flow, since this is considered to be an infrequent occurrence.

Each compartment of the equalization basins is sized to provide hold-up capacity for 200,000 gallons.

Each compartment of the sludge lagoons is sized to provide approximately six months sludge storage, which is equal to 13,000 cubic feet.

The treatment requirements and parameters controlling discharges from the Waste Water Treatment System are defined in the NPDES permit issued for the CRBRP. The Waste Water Treatment System is designed to meet these requirements by imposing the following effluent limits on the manufacturer of the waste water treatment system:

Total Suspended Solids	15 mg/l (Daily Avg.)	20 mg/l (Daily Max.)
Oil and Grease	15 mg/l (Daily Avg.)	15 mg/l (Daily Max.)
pH	7 to 9	7 to 9

Equalization Basins and Sludge Lagoons

The equalization basins consist of two equal capacity compartments, divided by a concrete wall. Each compartment is sized to provide one full day of storage capacity for normal plant waste volume of 200,000 gallons. The total volume of each compartment, including dead storage and operating volume, is 470,000 gallons.

A concrete inlet structure permits the diversion of wastes to either compartment by means of hand slide gates.

The sludge lagoons consist of two equal capacity compartments, divided by a concrete wall. Each compartment is sized to provide one half years storage volume of settled sludge; 13,000 cubic feet at 10% solids concentration. The total volume of each compartment, including depth for decantation of dilute sludge is 33,000 cubic feet.

A concrete inlet structure permits the diversion of sludge to either compartment by means of hand slide gates. A concrete outlet structure permits the release of supernatant to the equalization basins by means of wooden flashboards.

The equalization basins and sludge lagoons will be constructed of cohesive (clay) soils, compacted to at least 95% of Modified Proctor density as determined by ASTM D-1557. The highly compacted clay soils will be impervious from a practical point of view, thus ensuring the water tightness of the basins and lagoons and protection of the groundwater environment.

Pumping Station

The pumping station consists of a buried pre-cast concrete wetwell, 8 feet in diameter, which contains three equal capacity submersible pumps. Each pump is designed to be installed and removed from the wetwell without disturbing discharge piping, adjacent pumps, or controls. The pumping station includes access lid and frame assembly, pump removal guide rails and fixed discharge piping. A pre-cast concrete valve chamber with access hatch is located adjacent to the pumping station.

A locally mounted weather-proof panel includes motor starters and pump controls.

pH Trim Tank

The pH trim tank is a free standing open vessel which provides 10 minutes minimum detention time, at a design flowrate of 200 gpm, for adjustment of pH to a preset range.

The tank contains a mixer at the inlet end, and a pH sensor/transmitter at the outlet end. A bridge and ladder are provided for access to the top of the tank.

The tank is constructed of steel plate with an interior coating for corrosion protection.

Solids Contact Clarifier

The solids contact clarifier is a free standing open vessel, designed to provide a rise rate in the effective settling zone of 0.5 gpm/sf, minimum, at the design flow rate of 200 gpm.

The inner mixing and flocculation zones are provided with agitators for effective mixing and flocculation.

The sludge scraper mechanism, which moves sludge to a bottom hopper, is powered by a drive motor working through a gear reducer. The automatic sludge removal system consists of motorized blowoff and backflush valves. The clarifier is provided with a bridge and ladder for access.

The shell is constructed of steel plate with an interior coating for corrosion protection.

Gravity Filters

The two automatic gravity filters consist of two equal capacity units, each designed for a flow rate of 200 gpm. The filtration rate at design flow is 3 gpm/sf, maximum. The filters have a self-contained backwash compartment which provides an average of 15 gpm/sf backwash rate. The backwash sequence is automatic and is initiated by headloss through the filter.

The filter media consists of sand, supported by a sand retaining underdrain system.

An air blower is provided for air scour of the filter media during the backwash cycle.

The gravity filters are provided with a bridge and ladder for access.

The gravity filters are constructed of steel plate. An interior coating is provided for corrosion protection.

Chemical Waste Neutralization System

The batch chemical waste neutralization system consists of the following components: two 50,000 gallon horizontal tanks; two recirculation pumps and in-tank water sparger system; pH control instrumentation; acid and caustic feed pumps; and associated piping, valves, and controls.

The two 50,000 gallon tanks are mounted horizontally on concrete saddles. The tanks are fabricated of steel plate and are coated for corrosion protection. A ladder and a hatch is provided at the top of the tank for access. Each tank has a flanged outlet nozzle and a motorized valve for discharge of neutralized waste. In addition, flanged inlet and recirculation line connections are provided.

The water sparger is a pipe with diffusers spaced along its length, installed in the bottom of the tank. The recirculation pumps are centrifugal type pumps, designed to provide flowrates consistent with the sparger system requirements. The pumps are fabricated of corrosion resistant materials. Acid and caustic are introduced on the discharge side of the pumps for pH adjustment.

The batch chemical waste neutralizing system is designed to neutralize condensate polisher and make-up demineralizer regenerant wastes in a period of 4 hours, maximum. Disch[illegible] f tank contents takes 2 hours, maximum.

Bulk Chemical Storage and Chemical Feed

The Waste Water Treatment System requires the following chemicals for treatment of wastes: sulfuric acid, caustic soda, coagulant and coagulant aid.

The Waste Disposal Building houses the bulk storage and feed systems associated with these chemicals. The areas around the acid, caustic and coagulant tanks are individually curbed to prevent discharge of hazardous materials to the environment. The volumes within the curbed areas are designed to contain a spill of the entire tank volume.

The acid storage tank is a free standing 4,000 gallon vented vessel, fabricated of c[illegible]bon steel plate. The tank is furnished with vent, flanged inlet connection, flanged outlet connection, and a valved drain. A flanged manway and ladder provide access into the tank. The tank includes a level indicator with local level alarms.

The acid feed pumps are fabricated of corrosion resistant materials. Each pump is rated for a maximum and minimum capacity consistent with the range of dosages anticipated for the system. The pumps are provided with manual speed adjustment and automatic stroke adjustment. The pumps can be used interchangeably for feeding acid to the pH trim tank, or to the batch chemical waste neutralization tanks.

The caustic storage tank is a free standing 4,000 gallon vented vessel fabricated of steel plate and coated for corrosion protection. Insulation and heating is provided to maintain tank contents 80°-100°F. The tank is furnished with a vent, flanged inlet connection, flanged outlet connection, and a valved drain. The tank includes a level indicator with local level alarms. A flanged manway and ladder provides access into the tank.

The caustic feed pumps are fabricated of corrosion resistant materials. Each pump is rated for a maximum and minimum capacity consistent with the range of dosages anticipated for this system. The pumps are provided with manual speed adjustment and automatic stroke adjustment. The pumps can be used interchangeably for feeding caustic to the pH trim tank, or to the batch chemical waste neutralization tanks.

Caustic piping is insulated and heat traced to maintain a temperature of 80-100°F.

The coagulant system consists of two mix tanks furnished with mixers. The tanks are fabricated of corrosion resistant materials. A flanged connection and valve are furnished at the outlet. The tank includes a level indiator with local level alarms. Coagulant is delivered to the mix tanks by a dry chemical delivery system. Tank size is 550 gallons, minimum.

The coagulant pumps are fabricated corrosion resistant materials. Each pump is rated for a maximum and minimum capacity consistent with the requirements of the system. The pumps are provided with automatic stroke adjustment.

The coagulant aid system consists of two mix tanks furnished with mixers. The tanks are fabricated of corrosion resistant materials. A flanged connection and valve are furnished at the outlet. The tank includes a level indicator with local level alarms. Tank size is 100 gallons, minimum.

The coagulant aid pumps are fabricated of corrosion resistant materials. Each pump is rated for a maximum and minimum capacity consistent with the requirements of the system. The pumps are provided with automatic stroke adjustment.

Oil/Water Separator

The oil water separator is of the corrugated plate type, designed to operate under intermittent flow conditions of up to 500 gpm. The separator is furnished with an oil and grease monitor with adjustable alarm setpoint, unit freeze protection, and all accessories necessary to assure that the discharge oil/grease content does not exceed 15 mg/l. The separator includes flanged connections for sludge blowdown, oil discharge and influent/effluent.

Waste Oil Tank

The waste oil tank is a 10,000 gallon capacity buried tank of standard commercial design. The tank includes a flanged pump-out connnection, sacrificial anodes for cathodic protection, and a high level alarm.

The tank is located adjacent to the oil/water separator and also receives direct discharge from CRBRP oil sumps.

Waste Treatment Effluent

The waste treatment effluent control and monitoring functions are located in the Waste Disposal Building.

The waste treatment effluent is monitored for turbidity (correlated to total suspended solids), oil and grease, and pH. An excursion in any of these parameters beyond discharge limits is alarmed at the Back Panel in the Control Room, and closes the motor operated valve on the discharge line to the Common Plant Discharge. The effluent is then recycled to the equalization basins by automatically opening the motor operated valve on the line leading to the basins.

Waste treatment effluent can be discharged to the cooling tower basins by opening the motor operated valve on the line going to the basins and closing the other two discharge valves.

3.2.3 Cooling Tower Blowdown

Blowdown is provided to maintain the quality of the closed cycle circulating water system in a non-corrosive, non-scaling condition and is a function of ambient wet bulb temperature. The annual average total dissolved solids concentration in the circulating water is approximately 300 ppm.

Cooling tower blowdown is provided by circulating water pumps and normal plant service water pumps. These pumps, as well as the blowdown monitoring and control functions are located in the Circulating Water Pumphouse. Blowdown flow is recorded and control interlocks permit discharge of low level liquid radioactive waste system effluent only when minimum required flow of 1000 gpm is available. Blowdown flow is terminated whenever total residual chlorine exceeds 0.14 mg/l. The flow control valve is reopened when residual chlorine drops below 0.14 mg/l. This discharge is controlled for pH, temperature and total residual chlorine concentration. Generally, the dissolved solids in this water are the same as those in the Clinch River, reconcentrated approximately 2 1/2 times. No corrosion inhibitors are required.

Cooling tower blowdown is discharged to a 20-inch diameter gravity line which also receives effluents from the Wastewater Treatment System, the LALL Radwaste System and the Sewage Treatment System.

Based on "worst case" climactic conditions, maximum blowdown flow is anticipated to be 4.5 mgd.

Blowdown Monitoring and Control

Blowdown flow is measured by a flow element and transmitted by a flow transmitter to a local indicating flow controller and a local recorder/totalizer. The flow controller set point is manually adjustable and is a

function of the circulating water chemistry. A specific conductivity element and recorder are provided to aid in the determination of proper blowdown flow rate. The flow controller modulates a control valve to maintain blowdown flow rate at the set value. The control valve is designed to fail closed.

The control valve is interlocked to close in the case of the following:

- o Circulating water high total residual chlorine
- o Circulating water high or low pH
- o High blowdown temperature

These excursions in discharge limits are alarmed at the Main Control Panel. A return to acceptable limits automatically opens the control valve to its setpoint condition.

The sampling tap for the pH, total residual chlorine, and specific conductivity analyzers is on the 12-inch blowdown line in the Circulating Water Pump House. The tap and the analyzers are located as close as practicable to the circulating water discharge manifold in order to avoid lagtime in monitoring and blowdown control.

As previously described, the LALL Radwaste System shutoff valve, which controls discharge to the Common Plant Discharge, is interlocked with a low flow switch so that radwaste system effuent cannot be discharged unless a minimum blowdown flow of 1000 gpm is available.

TABLE 3.2-1

WASTE WATER TREATMENT SYSTEM

EQUIPMENT DESIGN CRITERIA

A.	pH Trim Tank	
	Detention time @ 200 gpm	10 minutes
	pH ± 0.2 units, based on optimum pH for clarifier operation.	
B.	Solids Contact Clarifier	
	Maximum rise rate in effective Settling area @ 200 gpm	0.5 gpm/sf
C.	Automatic Gravity Filters	
	Maximum filtration rate @ 200 gpm	3 gpm/sf
	Average backwash rate	15 gpm/sf
	Filter air scour	as approved
D.	Bulk acid storage tank	
	Tank size	4000 gallons
	Chemical strength	66°Bé H_2SO_4
E.	Bulk caustic storage tank	
	Tank size	4000 gallons
	Chemical strength	50% NaOH
F.	Acid and Caustic Feed Pumps	
	Pump System size	Maximum: Sufficient to neutralize 40,000 gallons of condensate polisher waste during 4 hour period (maximum)
	Minimum:	pH trim @ waste flow rate of 20 gpm
G.	Coagulant system	
	Mix tank size	24 hour capacity, minimum, but not less than 550 gallons
	Chemical strength	5% alum solution
	Pump size	Sufficient to feed up to 85 ppm at 225 gpm
H.	Coagulant aid system	
	Mix tank size	24 hour capacity, minimum, but not less than 100 gallons
	Chemical strength	1% polymer solution
	Pump size	Sufficient to feed up to 3 ppm at 225 gpm
I.	Chemical Waste Neutralization	
	Tank size	Two @ 50,000 gallons
	Maximum neutralization time	Four (4) hours
	Maximum time for discharge of tank contents	Two (2) hours
	Discharge pH	6.5 to 8.5
J.	Oil/Water Separator	
	Design flowrate	500 gpm

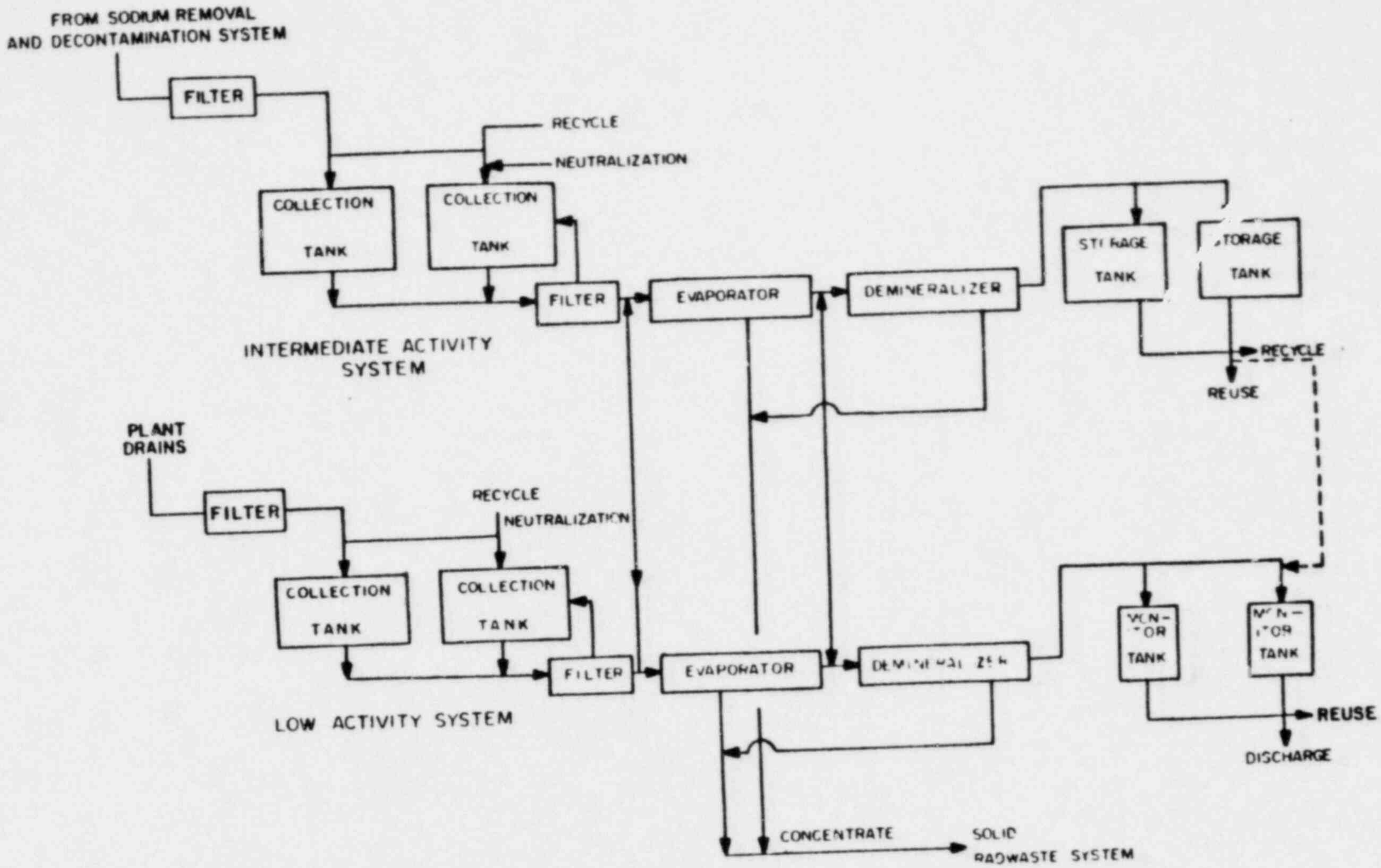


Figure 3.2-1 LIQUID RADWASTE SYSTEM FLOW DIAGRAM

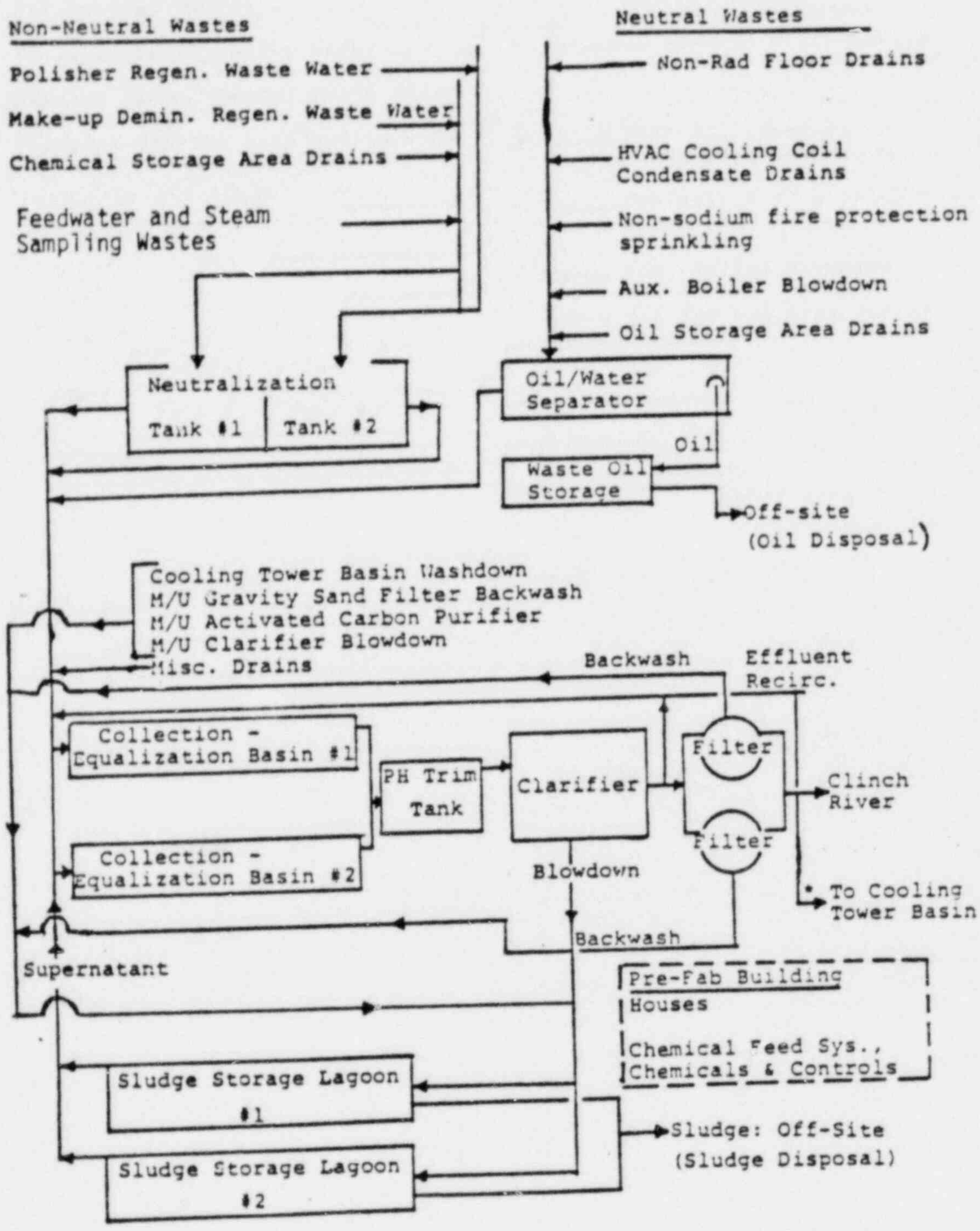
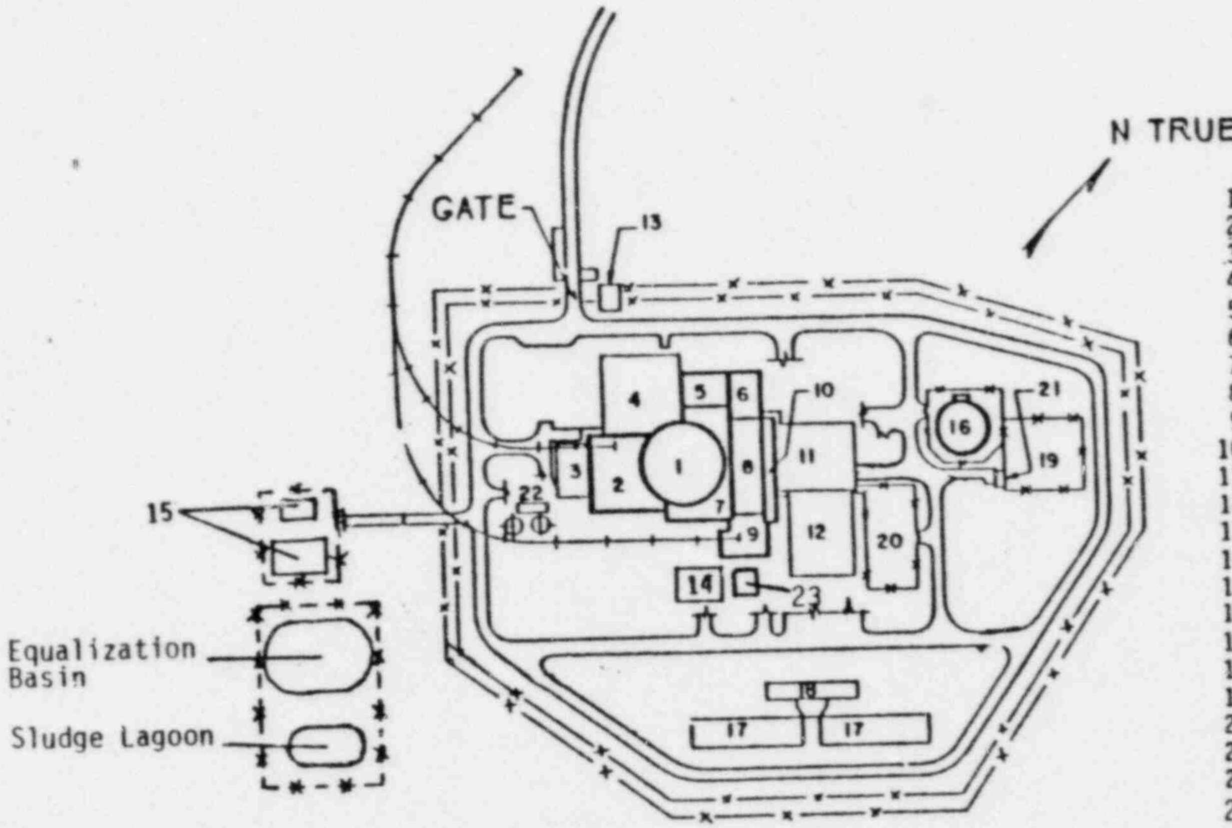


FIGURE 3.2-2. WASTE WATER TREATMENT SYSTEM SCHEMATIC

* Whenever cooling tower chemistry permits, will discharge effluent to the cooling tower basin



1. REACTOR CONTAINMENT BUILDING
2. REACTOR SERVICE BUILDING
3. RADWASTE AREA
4. PLANT SERVICE BUILDING
5. CONTROL BUILDING
6. DIESEL GENERATOR BUILDING
7. INTERMEDIATE BAY
8. STEAM GENERATOR BUILDING
9. MAINTENANCE BAY
10. AUXILIARY BAY
11. TURBINE GENERATOR BUILDING
12. MAINTENANCE SHOP & WAREHOUSE
13. GATE HOUSE
14. Waste Water Treatment Area
15. Sewage Treatment Plant
16. EMERGENCY COOLING TOWERS
17. COOLING TOWER
18. C. W. PUMP HOUSE
19. GENERATING SWITCH YARD
20. STARTUP RESERVE YARD
21. SWITCHYARD RELAY HOUSE
22. FIRE PROTECTION PUMP HOUSE
23. Waste Disposal Building

Figure 3.2-3. LAYOUT OF PLANT STRUCTURES

4.0 COMMON PLANT DISCHARGE

Effluents from the Waste Water Treatment System, the Sewage Treatment System, Radioactive Waste System and blowdown are discharged by a submerged single-port diffuser located at approximately Clinch River Mile 16. This discharge structure is shown in Figure 4.0-1. It is located approximately 25 ft from the shoreline and has a minimum depth to centerline of 4 feet. The discharge velocity varies with the effluent and blowdown flow rates and is approximately 15 fps at full load assuming average water and weather conditions.

As is typical of nuclear power plants, effluents resulting from operation of the condenser cooling system will dominate the CRBRP discharge both in terms of waste heat and chemicals. The CRBRP will employ a closed recirculating cooling system utilizing mechanical draft wet towers for heat dissipation. The annual average cooling tower blowdown flow is 3.35 mgd. Other contributors to the discharge flow are minor and include liquid radwaste, treated plant wastes and sanitary system effluents. These discharges constitute approximately 150,000 gpd and none contain significant amounts of waste heat.

The Common Plant Discharge (CPD) is a 20-inch diameter cement-lined ductile iron pipe designed as a gravity sewer at a minimum slope of 0.4%. The design capacity of the CPD is approximately 5.8 mgd, which is approximately 20% greater than maximum anticipated discharge from the CRBRP. Complete mixing of all effluents which enter the CPD is assured since the CPD includes several drop manholes along its route, after all discharges have entered the line.

Approximately 1100 feet of the CPD immediately upstream of the discharge diffuser may experience pressure flow depending on river stage and CPD flow rate. Consequently, this section of the line does not contain any manholes. This section of the CPD is located adjacent to the Clinch River along an existing road, and continues uphill in an easterly direction adjacent to Stormwater Retection Pond B up to approximately elevation 760 above MSL.

During normal operation, the CRBRP will discharge to the Clinch River an effluent stream whose temperature and chemical composition will differ from ambient river values. As an initial step in determining the environmental impact of plant discharges on the environment, a characterization of the anticipated thermal and chemical plumes resulting from these releases was made on the basis of a thermal-hydraulic modeling study performed by the University of Iowa, Institute of Hydraulic Research (Iowa Institute). The results of this study are contained in Appendix A to Section 10.3 of the CRBRP Environmental Report. Appendix B to Section 10.3 of the Environmental Report contains a description of the model, modeling procedures, experimental results and discussion.

The study basically investigated four cases for the CRBRP discharge:

- Typical winter conditions
- Typical summer conditions
- Extreme temperature winter conditions at short duration no flow
- Extreme temperature summer conditions at short duration no flow

Input parameters for the above cases are given in Table 10.3A-4 of the CRBRP Environmental Report, presented herein as Table 4.0-1.

The results of the study for the thermal plume cases described above are given in Tables 10.3A-5, 10.3A-6 of the CRBRP Environmental Report, presented herein as Tables 4.0-2 and 4.0-3.

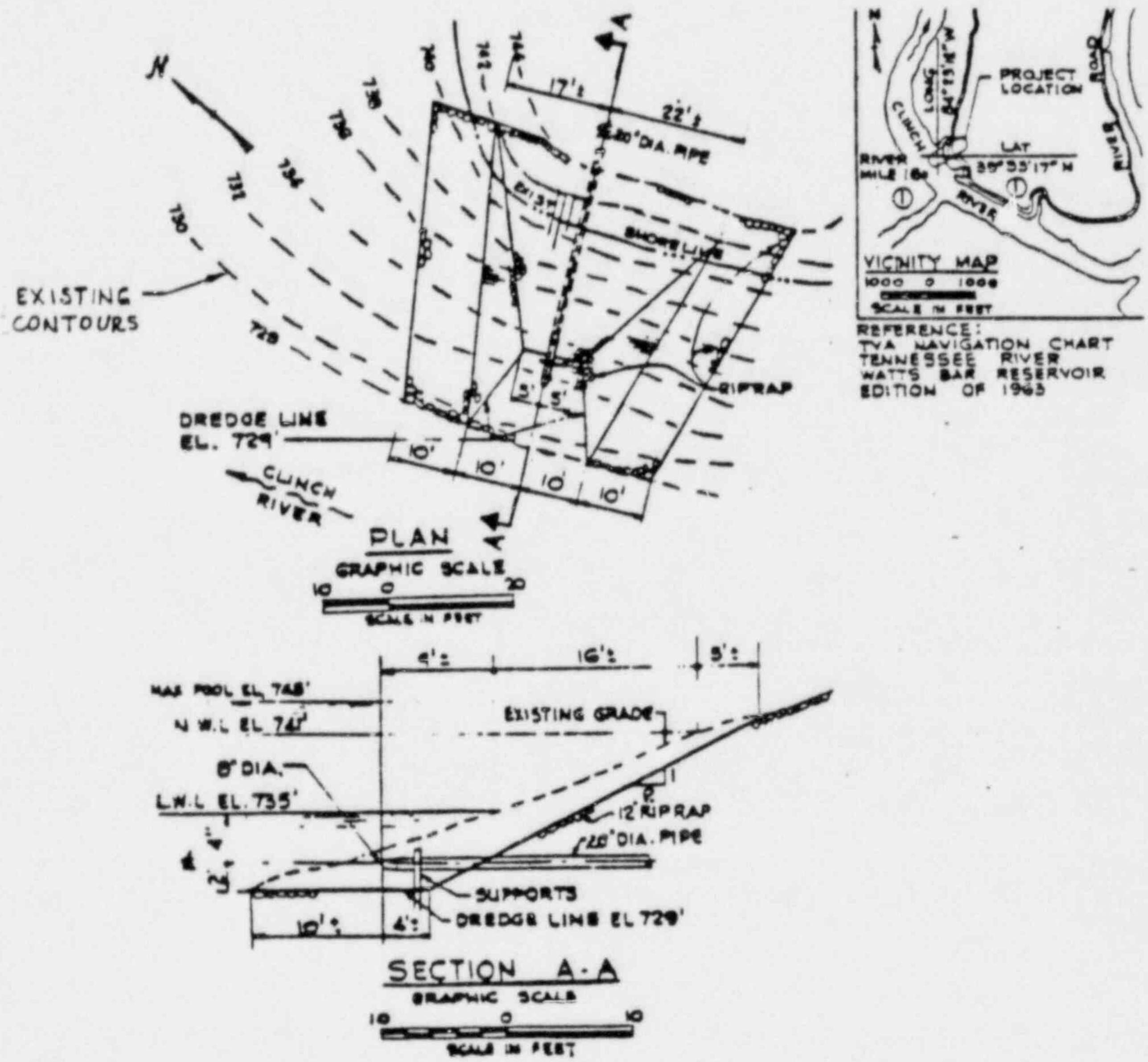
The results of the study for the chemical plume cases described above are given in Tables 10.3A-7, 10.3A-8 of the CRBRP Environmental Report presented herein as Tables 4.0-4 and 4.0-5.

Data concerning bottom scour of the Clinch River are presented in Table 10.3A-9 of the Environmental Report, presented herein as Table 4.0-6.

Predictions of thermal plume formation for the physical model are given in Figures 10.3A-4 through 10.3A-7 of the CRBRP Environmental Report. These figures have been scaled up to redrawn from the model scale to full scale and are presented herein as Figures 4.0-2 through 4.0-5 for the purpose of predicting the extent and configuration of plume formation in the Clinch River. Valves for chemical isopleths which coincide with isotherms are also shown in Figure 4.0-2 through 4.0-5.

Isopleths are given as percent difference in chemical concentration of discharge versus Clinch River background chemical concentration. These valves have been translated into dilution ratios.

Based on the data shown in Figure 4.0-2 through 4.0-5, it is reasonable to expect that under actual conditions, isotherms and chemical isopleths that form in the Clinch River will be modest in extent and near ambient river temperature and chemical concentration valves.



DISCHARGE STRUCTURE

Figure 4.0-1

TABLE 4.0-1

INPUT PARAMETERS FOR MODELING OF THE CRBRP DISCHARGE PLUMES

Mixing Conditions	Plant Discharge: Atmospheric Wet Bulb (°F)	Plant Discharge: Blowdown Temp. (°F)	Plant Discharge: Blowdown (gpm)	Plant Discharge: Flow[e] (cfs)	Ambient River Conditions: Water Temp. (°F)	Ambient River Conditions: Flow Rate (cfs)	Ambient River Conditions: Velocity (fps)	Ambient River Conditions: Pool Elevation[h] (ft MSL)	Initial Jet Parameters: ΔT_o (°F)	Initial Jet Parameters: V_o (fps)	Initial Jet Parameters: F_o	Initial Jet Parameters: Z/D
Typical Cases												
Average Winter (Jan/Feb/Mar)	43.3[a]	74.9[c]	2,500	5.57	43.9[c]	5,338[g]	1.39	736	31.0	15.96	67.8	7.5
Average Summer (July/Aug/Sep)	73.2[a]	89.3[c]	3,240	7.22	65.7[c]	4,777[g]	0.63	741	23.6	20.68	77.1	15.0
Thermal Extreme Cases												
Hypothetical Winter (Jan)	56.2[b]	79.8[d]	2,810	6.26	33[f]	0	0	735	46.8	17.93	68.2	6.0
Hypothetical Summer (June)	74.4[b]	89.6[d]	3,280	7.31	78[f]	0	0	739	11.6	20.94	84.3	12.0
Chemical Extreme Cases (Short Duration No Flow)												
Winter (Jan)	56.2[b]	79.8[d]	2,810	6.26	33[f]	0	0	735	46.8	17.93	68.2	6.0
Summer (June)	74.4[b]	89.6[d]	3,280	7.31	78[f]	0	0	739	11.6	20.94	84.3	12.0

[a] Table 3.4-3 (ER)

[b] Bull Run Steam Plant Data, 1/70-12/73

[c] Table 10.3A-1 (ER)

[d] Figure 10.3A-2; account taken of cooling effect of makeup flow (ER)

[e] Figure 10.3A-2 (ER)

[f] Clinch River (m 21.6) Data, 6/62-9/72

[g] Table 2.5-3 (ER)

[h] Table 2.5-5 (ER)

TABLE 4.0-2

SURFACE AREA OF CLINCH RIVER AFFECTED BY THERMAL PLUMES*

	Area (acres)				
Isotherms (F°):	0.7	1.0	1.2	1.5	2.3
Mixing Conditions					
Typical Cases					
Winter		0.05	0.01	0.01	
Summer	0.07	0.02	<0.01		
Hypothetical Extreme Cases					
Winter		3.92**			0.06
Summer	0.02				

*Determined from Iowa Institute physical model study.

**Estimated based on extrapolation of model plume boundaries to achieve closure of isotherm (see Figure 10.3A-10 · ER)

TABLE 4.0-3

BOTTOM AREA OF CLINCH RIVER AFFECTED BY THERMAL PLUMES*

	Area (acres)				
Isotherms (F°):	0.7	1.0	1.2	1.5	2.3
Mixing Conditions					
Typical Cases					
Winter		0.01	<0.01		
Summer		0.01	<0.01		
Hypothetical Extreme Cases					
Winter					0.01
Summer		<0.01			

*Determined from Iowa Institute physical model study.

TABLE 4.0-4

SURFACE AREA OF CLINCH RIVER AFFECTED BY CHEMICAL PLUMES*

Mixing Conditions	Area (acres)				
Chemical Isopleth** (%):	2	3	4	5	6
Typical Cases					
Winter		0.05	0.01	0.01	
Summer		0.07	0.02	<0.01	
Extreme Case - Short Duration No Flow					
Winter	3.92⁺			0.06	
Summer			0.07**		0.02

*Derived from Iowa Institute physical model study.

**Percent difference between initial blowdown and river ambient chemical concentrations

⁺Estimated based on extrapolation of model plume boundaries to achieve closure of 0.46F° isotherm (see Figures 10.3A-10 and 10.3A-7 , ER)

TABLE 4.0-5

BOTTOM AREA OF CLINCH RIVER AFFECTED BY CHEMICAL PLUMES*

	Area (acres)				
Chemical Isopleth (%):	2	3	4	5	6
Mixing Conditions					
Typical Cases					
Winter		0.01	<0.01		
Summer			0.01	<0.01	
Extreme Case - Short Duration No Flow					
Winter				0.01	
Summer			0.03**		

*Derived from Iowa Institute physical model study

**Estimated based on extrapolation of model plume boundaries to achieve closure of 0.46F° isotherm (see Figure 10.3A-7 ER)

TABLE 4.8-6

BOTTOM AREA OF CLINCH RIVER AFFECTED BY SCOURING*

Mixing Conditions	Area (ft^2)	Area (acres)
Typical Cases		
Winter	71	<0.01
Summer	85	<0.01
Hypothetical Extreme Cases		
Winter	59	<0.01
Summer	54	<0.01

*Based on actual scouring of model flume bottom material. Areas computed assuming elliptical-shaped scour hole.

FIGURE 4.0-2

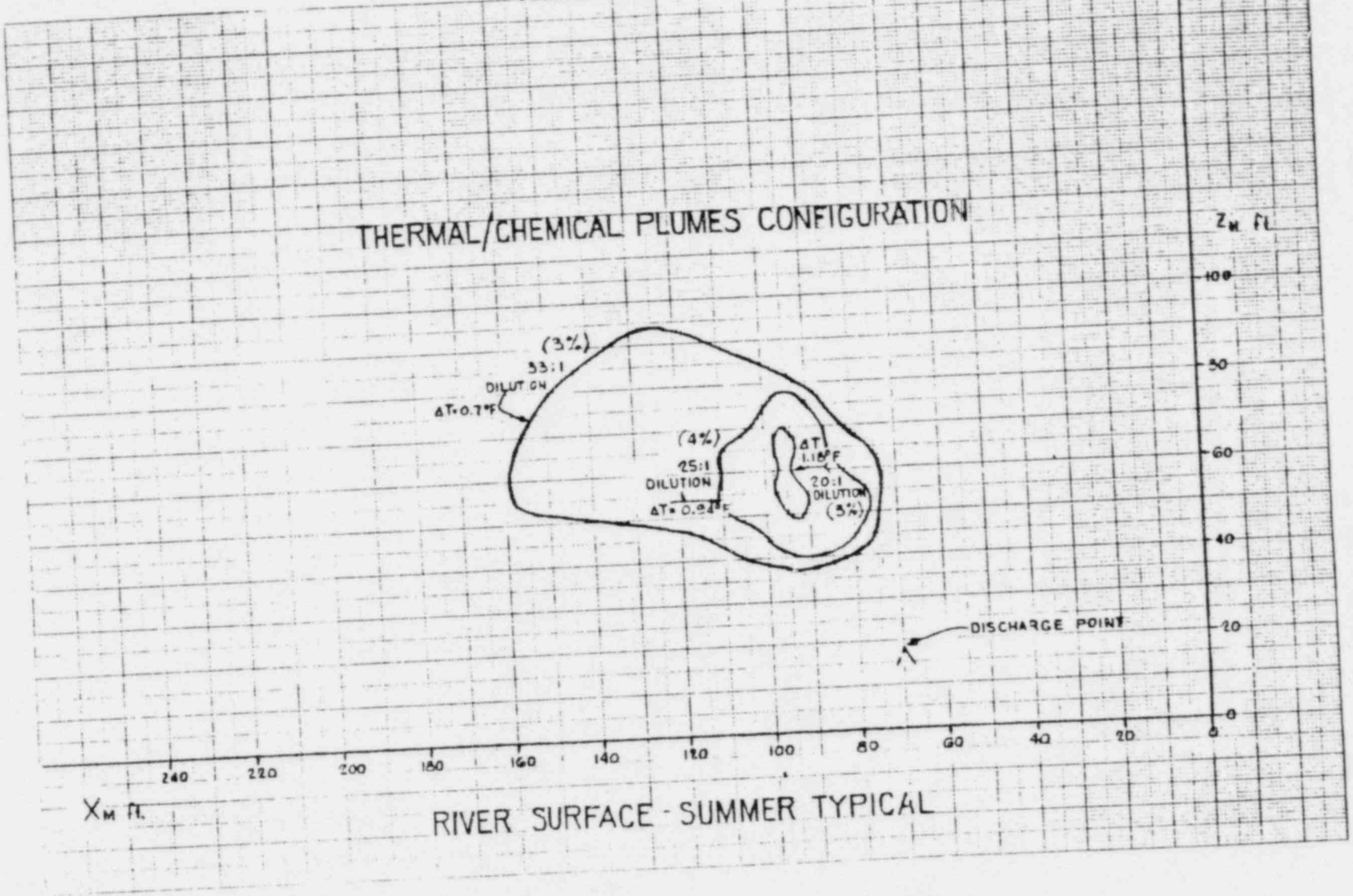

THERMAL/CHEMICAL PLUMES CONFIGURATION
(3%)
33:1
DILUTION
ΔT=0.7°F
(4%)
25:1
DILUTION
ΔT=0.92°F
ΔT
1.18°F
20:1
DILUTION
(5%)
DISCHARGE POINT
ZM ft.
XM ft.
RIVER SURFACE - SUMMER TYPICAL

FIGURE 4.0-3

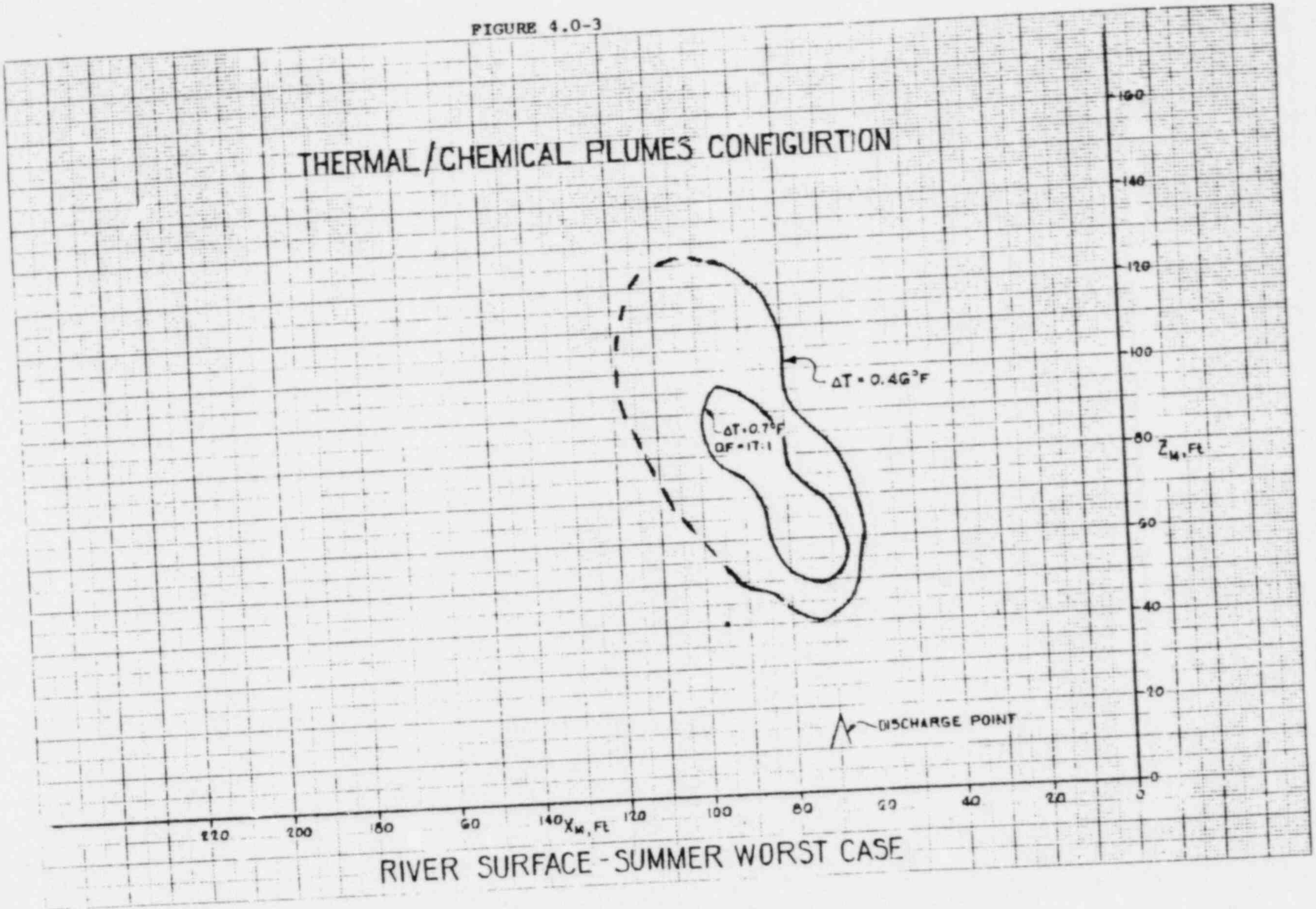

THERMAL/CHEMICAL PLUMES CONFIGURTION
ΔT = 0.46°F
ΔT = 0.7°F
DF = 17:1
DISCHARGE POINT
Z_M, Ft
X_M, Ft
RIVER SURFACE - SUMMER WORST CASE

FIGURE 4.0-4

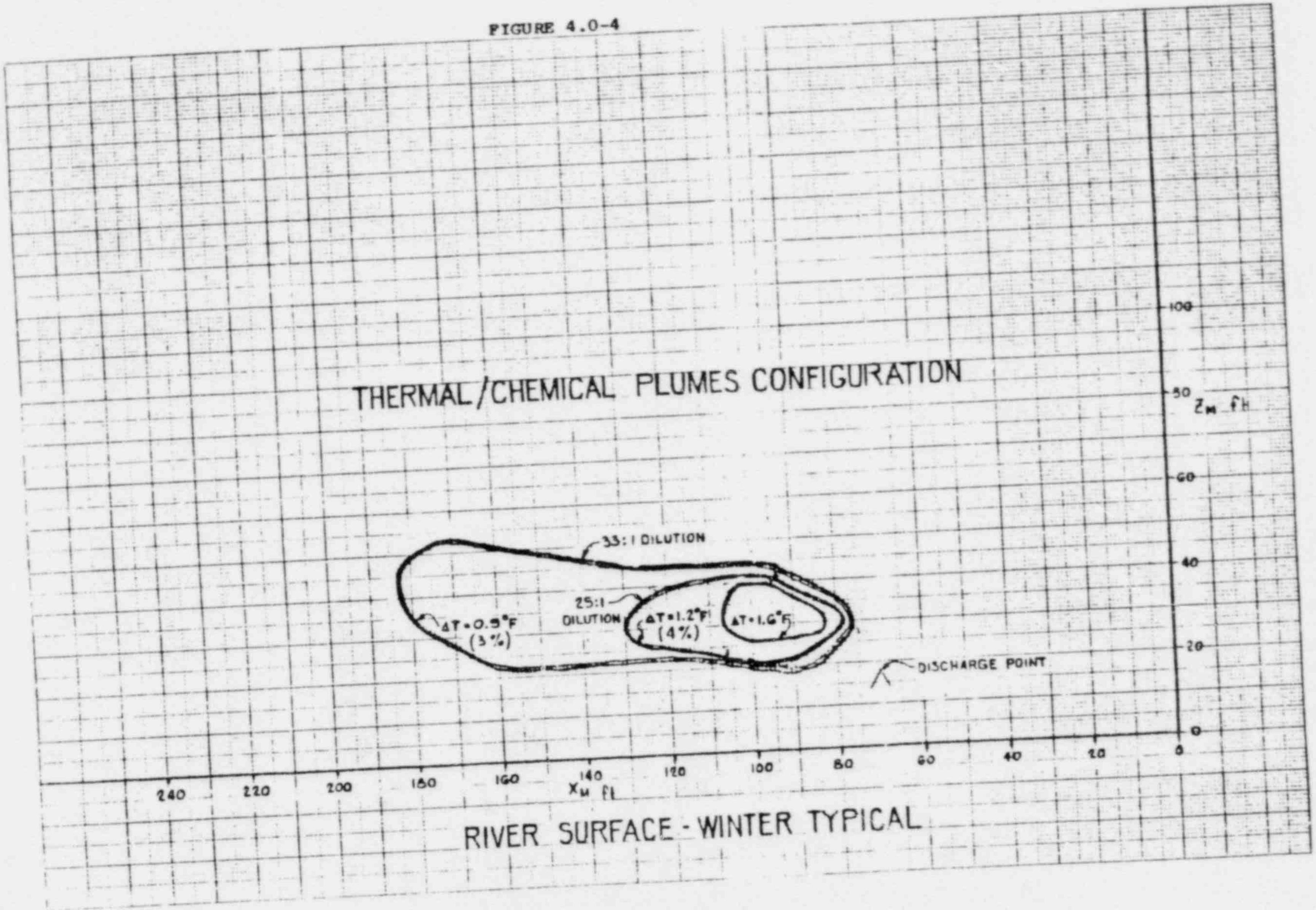
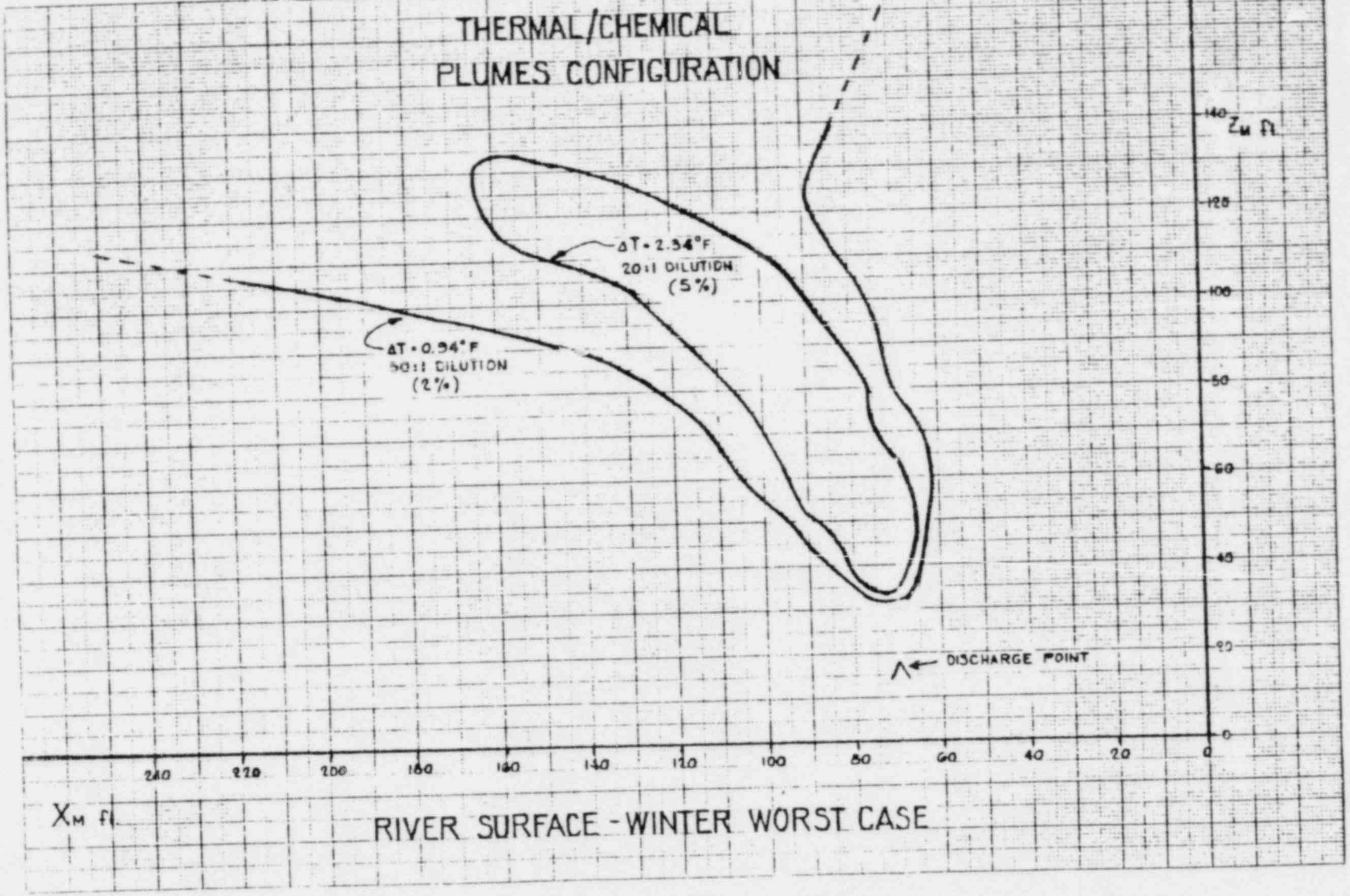

THERMAL/CHEMICAL PLUMES CONFIGURATION
33:1 DILUTION
25:1 DILUTION
ΔT = 0.5°F (3%)
ΔT = 1.2°F (4%)
ΔT = 1.6°F
DISCHARGE POINT
Z_M ft
100
80
60
40
20
0
240
220
200
180
160
140
120
100
80
60
40
20
0
X_M ft
RIVER SURFACE - WINTER TYPICAL

FIGURE 4.0-5


THERMAL/CHEMICAL
PLUMES CONFIGURATION
ΔT = 2.34°F
20:1 DILUTION
(5%)
ΔT = 0.94°F
50:1 DILUTION
(2%)
DISCHARGE POINT
140 Z_M ft
120
100
80
60
40
20
0
240
220
200
180
160
140
120
100
80
60
40
20
0
X_M ft
RIVER SURFACE - WINTER WORST CASE