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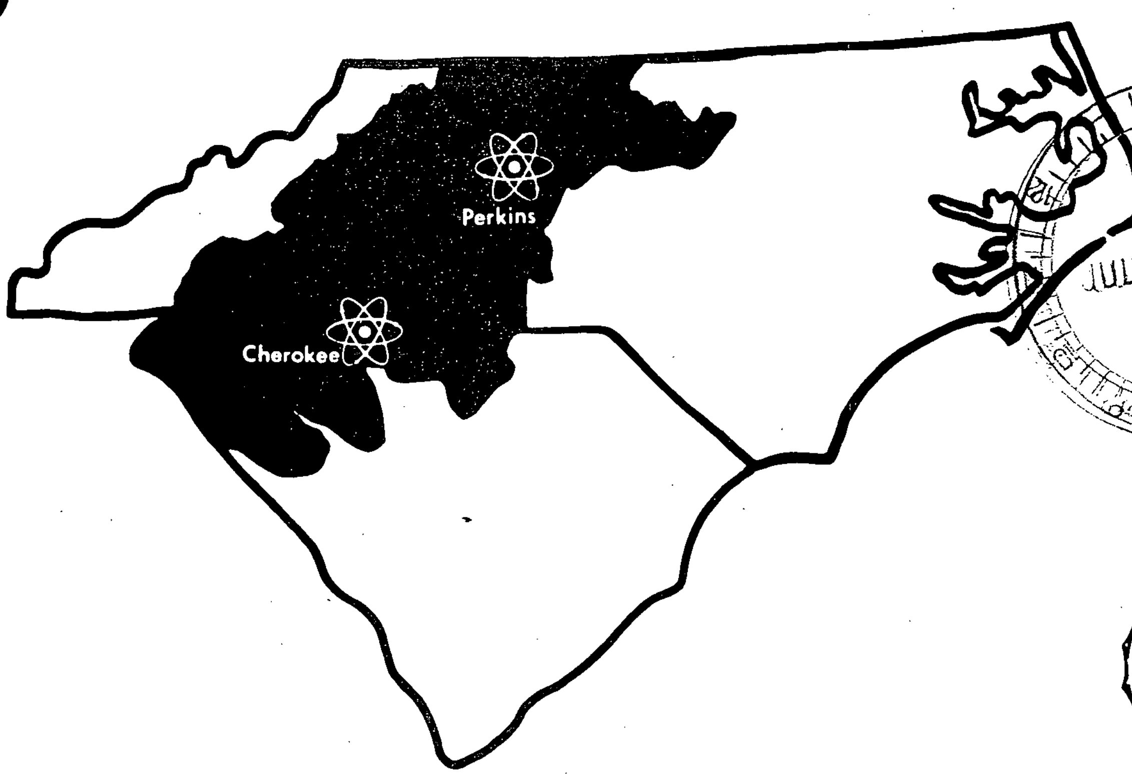
Duke Power Company

PROJECT 81

Perkins Nuclear Station

Environmental Report

Volume II



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5.0 ENVIRONMENTAL EFFECTS OF PLANT OPERATION

The site environment, discussed in Chapter 2, and the proposed Perkins Nuclear Station, discussed in Chapter 3, will be joined during station construction into an operational electrical generating facility, as discussed in Chapter 4.

This chapter discusses the environmental effects of that station's operation. Included are discussions of the effects of the closed cycle heat dissipation system, the station's radiological impacts on man and biota other than man, chemical and biocide discharges, other discharges, the transmission system directly associated with the station, the commitment of resources during station construction, and the future decommissioning and dismantling of the facilities.

5.1 EFFECTS OF OPERATION OF HEAT DISSIPATION SYSTEM

5.1.1 THERMAL STANDARDS

The Environmental Protection Agency (EPA) has not yet approved North Carolina's state permit program pursuant to Section 402 (a) (5) of the Federal Water Pollution Control Act Amendments of 1972. Therefore, until the state's permit program is approved, discharge permits must be obtained from the EPA. Guidelines for North Carolina surface waters, as adopted by the Board of Water and Air Resources on October 13, 1970, and approved by the EPA on January 10, 1971, were in effect when the 1972 Amendments were passed. These guidelines classify the Yadkin River, as "A-II" waters, subject to the following thermal standards: Q5.1.13

1. Temperature is "not to exceed 5 F above the natural water temperature, and in no case to exceed . . . . 90 F for lower piedmont and coastal plain waters".

2. Mixing zones are permitted. However, "the limits of mixing zones will be defined by the Department on a case-by-case basis after consideration of the magnitude and character of the waste discharge and the size and character of the receiving waters. Such zones shall be restricted to as small an area and length as possible, and shall not prevent free passage of fish or cause fish mortality".

Duke will comply with these standards or with the federally approved standards once they become effective.

5.1.2 EFFECTS ON THE SURFACE WATER

As described in Section 3.4, cooling tower operation will require that make-up water be withdrawn from the river and that cooling tower blowdown be returned to the river. The following subsections are concerned with the potential effects of withdrawing water from the river and returning warm water in the form of cooling tower blowdown to the river. The effects of blowdown chemicals on the river are discussed in Section 5.4.

5.1.2.1 Thermal Plume Considerations

The extent of the thermal plume caused by discharging blowdown into the river has been analyzed for two cases, summer and winter. The summer case chosen is representative of the warmest water being discharged and the winter case represents the greatest temperature difference (ΔT) between the blowdown water and the ambient river water. In each case the discharge is assumed to be into the 7 day-10 year low flow of the river.

Temperature profiles were calculated using the analytical model described by Sill and Schetz.[1] This model assumes that a surface discharge is injected into a bounded, coflowing mainstream, and includes both near and far field mixing and heat transfer. The procedure employs the conservation equations in integral form with the solution obtained by numerical integration of six, first order, ordinary differential equations. Sill and Schetz[1] present experimental verification of the jet growth and temperature as predicted by the analysis. Additional verification of the model has been performed at Duke Power Company by comparison of predicted results with thermal imagery scans for both the Dan and Broad Rivers, on which Duke has operating steam electric plants.

Figure 5.1.2-1 represents the maximum expected thermal plume under summer conditions. The discharge temperature (90 F) represents the highest cooling tower blowdown temperature reasonably expected. It was obtained by adding the cooling tower approach temperature (12 F) to the highest expected wet bulb temperature (78 F). This wet bulb temperature is equaled or exceeded only 1% of the hours during the months of June through September as recorded at Charlotte, North Carolina[2]. The ambient river temperature is the highest measured during the period represented by Figure 2.5.1-6. As can be seen from Figure 5.1.2-1, the thermal plume is very small. The calculated area inside the 1F and 3F isotherms is calculated to be .05 acres and .02 acres, respectively. The primary reason for such small areas is that in summer the temperature of the blowdown water is close to that of the river. Therefore the density differences are not great and mixing is not impeded. Q5.1.12

However, in winter the temperature of the blowdown water will generally be much warmer than the temperature of the river. The density differences will thus be greater. Mixing will be impeded and density currents enhanced, resulting in larger plume areas. Figure 5.1.2-2 represents the maximum expected thermal plume under winter conditions. The discharge temperature (70 F) represents the warmest expected blowdown temperature in winter and the river temperature (40 F) represents the coolest expected river temperature; therefore these extremes will result in the greatest plume area. The 70 F discharge temperature was obtained from the cooling tower performance curves using a 40 F wet bulb (lowest monthly average from Charlotte Airport data 1955-1964). The 40 F river temperature is the lowest measured temperature in Figure 2.5.1-6. The thermal plume presented in Figure 5.1.2-2 is larger than for the summer case but is still relatively small. The 2, 3, and 5 F isotherms are calculated to encompass 1.3, 1.0, and 0.5 acres, respectively. Q5.1.12

The plume is not expected to extend across the entire river in either summer or winter conditions.

5.1.2.2 Effect of Heated Discharge on Aquatic Life

As explained in Subdivision 5.1.2.1, the thermal plume caused by discharge of blowdown water to the river will be very small. It is not expected to extend across the entire river at any time. Under winter conditions, which tend to maximize plume size, the 5 F isotherm will extend across only 1/2 of the river's width (Figure 5.1.2-2). This is not expected to restrict passage of fish in either direction.

The effects of this plume on the fish population of this reach of the river are not expected to be appreciable for these reasons:

2 1. Fish will be able to swim around and under the plume (Figures 5.1.2-1 and 5.1.2-2).

2 2. The density of fish in the region of the discharge (Station 27) is low, as shown in Table 2.7.2-17 and Figure 6.1.1-2. A detailed description of the distribution of fish in this section of the Yadkin River is presented in Section 2.7.2.6. Q5.1.15

3. The most severe effects which may be expected from the thermal discharge may be evaluated in the case of the bluegill (<u>Lepomis</u> <u>macrochirus</u>) using the data of C.C. Coutant as cited in the AEC's <u>Final Environmental</u> <u>Statement</u> on the William B. McGuire Nuclear Station (1972). Assuming an ambient summer temperature of 77 F (acclimation temperature) an upper lethal threshold temperature for this species may be expected at 91.4 F. The maximum discharge temperature is calculated as 90 F (Subdivision 5.1.2.2). Therefore, at no time will the discharge temperature exceed the lethal threshold temperature for this species. Furthermore even this 90 F temperature will dissipate rapidly downstream. (Figure 5.1.2-1)

   The ambient temperature for the winter months is expected to be 40-45 F (Figure 2.5.1-6). Coutant does not provide an estimated upper lethal threshold for the bluegill at this acclimation temperature. However, bluegills exposed to an ambient temperature of 59 F are reported to reach threshold at 87 F.

   Ambient river temperatures in the neighborhood of 59 F generally occur in the months of November and March (Figure 2.5.1-6). Average wet bulb temperatures for these months are 51 F and 48 F (Charlotte Airport data 1955-64). Therefore the cooling tower performance curves predict blowdown temperatures of 75F and 74 F, respectively. These figures are well below the lethal threshold temperature for the bluegill.

   2 In predicting the possible environmental effects of the 30 F Δt in winter, and in viewing Figure 5.1.2-2, it is important to keep in mind that the average flow of the Yadkin River is 2850 cfs and that late fall, winter and early spring are, historically, periods of high flow (Figure 2.5.1-6). The range of the discharge will be 8-12 cfs.

The thermal discharge plume is primarily a surface phenomenon and is therefore not expected to have an appreciable effect on the benthos downstream from the discharge. Planktonic organisms will only be exposed to the heated discharge for a brief amount of time. The worst effects would be to those plankton passing through the immediate area of the discharge. In the winter especially this will be a small portion of an already small population (Sections 2.7.2.1 and 2.7.2.2).

5.1.2.3 Impingement and Entrainment by Cooling Water Intake Structures

Operation of the Perkins Nuclear Station requires a maximum of 272 cfs
4 makeup water from the Yadkin River. Of this, a maximum of 122 cfs (112 cfs consumed) will be used for various purposes in the plant, and a maximum of 150 cfs will be used on an intermittent basis for dilution of radioactive wastes and returned directly to the river. The intake structure is described in Section 3.4. Maximum intake velocities will occur at the screens and will be approximately 0.5 feet per second.

Velocities on the Yadkin River in the vicinity of the intake (Figure 3.4.0-1) are about 2.5 feet per second (Section 2.5). Adult fish are acclimated to this velocity, which is many times that expected in the immediate area of the intake. Swim speeds of selected fish species from the Piedmont Carolinas are discussed at length in Appendix IV. Q2.7.9 All adult fish tested exhibited the ability to swim at speeds greater than 0.5 fps. Since the intake is sized such that the maximum intake velocity is less than 0.5 feet per second even at lowest river flow, low flows will not increase fish impingement due to velocity considerations. However, assuming the numbers of fish in the vicinity of the intake remain the same at low flows, the decreased quantity of water could cause overcrowding and stress causing the fish to become weaker. In this respect increased impingement, though unlikely, could occur due to low flows. Q5.1.11

The intake will be protected by a 3/8 inch mesh traveling screen (Section 10.2). Therefore, no fish with a diameter larger than 3/8 inch can pass through, and no healthy adult fish will be impinged. Furthermore, fish population are low in the area of the intake (Table 2.7.2-17). Fish eggs and ichthyoplankton are not expected to reach high levels in the turbid and swift flowing reach of the Yadkin where the intake structure is to be located. The fish populations of the Yadkin River are discussed at greater length in Subdivision 2.7.2.6.

4

Q5.1.17

4 The proposed bankside intake structure (Subdivision 10.2.2.1) incorporates the "best available technology" for a conventional cooling water intake structure as proposed by the U.S. Environmental Protection Agency.

At present there is no provision for removing fish too weak to withstand the 0.5 fps intake velocity. The intake structure traveling screens are to be inspected by Duke biologists on a scheduled basis to monitor fish impingement. Q5.1.16

A 100 percent loss to the river is assumed for those plankton contained in the 122 cfs used by the station. Based on numerical density data presented in Tables 2.7.2-3 (phytoplankton) and 2.7.2-6 (zooplankton) for Station 27, average over a one year period, this will amount to a loss of approximately 10^{14} phytoplankters and 10^{8} zooplankters per day. No loss is expected, however, for the plankton entrained inthe 150 cfs used for radwaste dilution water since this water returns directly to the river. Q5.1.19

The percent loss of plankton to the river is assumed to be equal to the percent of river flow withdrawn. This quantity could range from four percent loss at average river flow to twenty percent loss at 7Q10 flows. Loss of even twenty percent of the standing crop of the plankton at the intake is not considered detrimental because of their short regeneration time. Furthermore the river ecosystem is dependent on allochthonus organic matter to form the base of what is primarily a detrital food chain. The phytoplankton are not the principal source of either oxygen or food. This topic is covered more fully in Subdivision 2.7.2.1. Q5.1.18

Furthermore, the zooplankton population of the Yadkin River is much smaller than and different from that of High Rock Lake (Table 2.7.2.5). Hence the river is not considered to be an important source of zooplankton for the lake, and the minor losses to entrainment suffered by zooplankton in the river are not expected to have any appreciable effect on the natural population of the lake.

5.1.2.4 Impingement and Entrainment at Carter Creek

Carter Creek enters the right bank of the Yadkin River approximately nine river miles upstream of the proposed location of the Perkins intake structure, and slightly more than six river miles below Muddy Creek. The closest upstream riffle area lies about three miles away in a bend in the river; downstream (also about three river miles) there is an extensive shallows just below the Highway 64 bridge. The only other creek of comparable size is People's Creek, which enters the Yadkin about four river miles upstream of Carter Creek.

3

The intake pumps for Carter Creek Reservoir are to be located on the Yadkin approximately one-half mile upstream of the mouth of Carter Creek. They will have a maximum capacity of 200 cfs and a maximum intake velocity of 0.5 ft/sec. It is estimated that initially it will take approximately 50 days to pump to full pond level. This will be done in the late fall or early winter, historically a period of high flow, and also a time when the reproductive activity of fish is at its lowest. Thereafter it may be necessary to run the pumps briefly to make up for evaporative losses and releases, but this should not occur during the spring season of fish larval activity. The operation and design of the pumping station is described in more detail in Subdivision 5.1.4.2. Q8

There is no remarkable feature of the Yadkin River between Muddy Creek and Dutchman Creek which would cause a marked change in the ecological characteristics of the Yadkin. It is therefore felt that the sampling done on the river

from the shallows, below the Highway 64 bridge, is sufficient to allow a reasonably accurate characterization of the river in the vicinity of Q8
3 Carter Creek itself. Furthermore, the operation of the intake structure associated with the impoundment will be irregular and infrequent. No significant impact on the river biota is expected.

3 5.1.2.5 Effects of Reduced River Flow

Makeup water to the cooling towers is obtained from the Yadkin River at a
1 maximum rate, under extreme meteorological conditions, of 112 cfs. Q5.1.4
In view of the tentative agreement with DNER regarding withdrawal from the Yadkin River, makeup water storage will be provided in the Nuclear Service Water Pond and in an upstream storage pond. A storage pond, capable of
3 supplying sufficient makeup water, to allow continuous plant operation (with imposed withdrawal limitations) during the worst drought of record is discussed in Subdivision 5.1.4.2. Blowdown from the cooling towers will Q5.1.9
be released to the river under all flow situations.

The storage requirements account for all present uses of water in the river. Q5.1.5
They also account for the only known substantial future use which is the increase of the Winston-Salem, North Carolina water supply withdrawal to 100
1 million gallons per day. Therefore based on the period of streamflow records Q5.1.6
available, it is anticipated that there will be no occasions during the life of the plant when low river flow will limit plant operations. If historical
3 low flows are not equaled or exceeded and makeup water storage is insufficient, plant operation will be curtailed.

According to USGS Stage-Discharge determination made June to November 1972 at the Yadkin College Gage about six miles above the site, a drop in discharge from 733 cfs to 625 cfs would result in a drop in water level of slightly less than 0.1 foot. At average discharge (2850 cfs) the drop would be less. Input from Dutchman Creek and the South Yadkin will not be affected by plant water use, and no appreciable effect in water level will be noted on High Rock Lake.

Q5.1.2

Since the water withdrawn for plant consumption will contain a proportional amount of waste, consumptive use of water will not affect the assimilative capacity of the river as far as upstream dischargers are concerned. Since there are no major dischargers, other than the Perkins Station itself, between the Perkins intake and upper High Rock Lake (Figure 2.5.3-1), plant consumptive use and subsequent reduction in assimilative capacity will not be a problem for downstream dischargers.

The blowdown discharge from Perkins will contribute somewhat to the oxygen demand in the Yadkin River below the plant. As shown in Table 3.6.2-1, the maximum expected increase in downstream BOD_5 is 0.72 mg/l. This is based on discharge of a maximum of 2475 lb/day of BOD at 5300 gpm (12 cfs) into the 7 Q 10 river flow of 625 cfs. At lower river flows the incremental BOD_5 Q5.1.10
increase would be proportionally greater. Therefore, assuming 7 Q 10 low river flow and an average river BOD_5 concentration of 4 mg/l (Table 3.6.2-1) the BOD_5 concentration downstream of Perkins could be increased from 4 to 4.72 mg/l. Realistically, low river flow situations would likely be times of high BOD concentrations; therefore assuming 7 Q 10 low flow and the high ambient BOD concentration of 16 mg/l (Table 3.6.2-1) the river concentration

could be increased from 16 to 16.72 mg/l. It is thus seen that the relatively small blowdown quantity from Perkins station will have a slight effect on river BOD levels and will decrease river dissolved oxygen concentrations accordingly a slight amount. It should be pointed out that
2 since the cooling towers will act as aeration devices, levels of volatile Q5.1.10
substances in the makeup water will be decreased and dissolved oxygen levels will be increased with the result that blowdown water will be at saturated oxygen levels.

5.1.3 EFFECTS ON GROUND WATERS

No adverse effects to the area ground waters are expected from operation of the cooling water system. Some deposition of salts from the cooling tower drift is expected, however, the quantity of salts that reach the ground water will be negligible.

Using the drift isopleth map (Figure 5.1.5-2), salt deposition and resultant average concentration at the ground surface has been calculated for a 25,000 foot radius from the cooling towers. As shown on the drift isopleth map, the salt deposition rate in the immediate vicinity of the plant (approximately 0 - 5000 feet) varies from about 40 to 2 lb/acre/mo. Since the deposition rate continues to drop off rapidly with distance from the plant,
2 an average rate of one lb/acre/mo. has been conservatively assumed for the Q5.1.3
area between the two lb/acre/mo. isopleth and a 25,000 foot radius. Using a weighted-average deposition rate and average yearly rainfall rate of 40 inches (typical for this region), the average increase in salt content of surface runoff would be 3.8 ppm. Therefore, assuming no dilution or dispersion in the soil, groundwater concentrations could also increase by 13.8 ppm. Due to the conservatism of the assumptions made, especially the deposition rate in the 5000 to 25,000 foot radius, the actual increase in salt concentration is considered negligible.

The filling of the Nuclear Service Water pond and the Auxiliary Holding Pond will raise the groundwater table in the vicinity of the ponds above the ambient water levels of the ponds. Theoretically, this raising of the groundwater levels will extend to groundwater divides and groundwater sinks
2 represented approximately by the existing groundwater ridges and valleys. Q5.1.4
However, the relatively low permeability of the in-situ materials will cause the area of significant rise in groundwater levels to be limited to the immediate vicinity of the respective ponds. The ponds will act as sources of recharge to the groundwater system.

5.1.4 ENVIRONMENTAL EFFECTS OF ONSITE PONDS

5.1.4.1 Nuclear Service Water Pond

A 190 acre Nuclear Service Pond will be constructed by damming one of the small site creeks approximately one-half mile above its confluence with Dutchman Creek. As shown in Figure 3.1.0-2, the pond will be roughly oblong and follow the 695 foot contour line along the southern edge of the
2 exclusion area. In normal use it will act primarily as a settling basin Q5.1.1
for cooling tower make-up water drawn from the Yadkin River. Except in periods of very low river flow, when withdrawal from the Yadkin must be reduced or eliminated to maintain its historic low flow, or in the event

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of an emergency need for cooling water, pond level is not expected to fluctuate appreciably.

The principal environmental effect of the construction of the pond will be the replacement of about 1 1/2 miles of creek habitat and some 190 acres of terrestrial vegetation (which will be cleared prior to flooding) with the pond, which will hold 3600 acre-feet and reach a depth of 40 feet just behind the dam. The site creek has a drainage area of 1469 acres. In the portion which will be affected it ranges from two to three meters in width and is never more than 1.0 meter deep. Most of the substrate is hard packed sand.

Aquatic sampling station 3 (Figure 6.1.1-2) is located on the creek. Data for water quality measurements are given in Table 2.5.0-1. Information concerning the biota collected at Station 3 is presented in Subsection 2.7.2. Fish sampling by electroshocking has yielded very low numbers (Table 2.7.2-32), mostly the creek chub (Semotilus atromaculatus) and the green sunfish (Lepomis cyanellus). Lepomis cyanellus will, in all likelihood, become established in the pond; Semotilus atromaculatus may survive in small numbers in what remains of the creek environment above the influence of the impoundment. It is also expected that the settling of silt from the Yadkin intake will result in the establishment of a chironomid/oligochate/Chaoborus bottom community typical of ponds. Q5.1.1

The area flooded by the Nuclear Service Water Pond presently consists of approximately 50 acres of mixed mesic hardwood forest, 26 acres of mesic pine forest, 25 acres of pine plantation, 21 acres of oak-hickory forest, 18 acres of alluvial fields, 18 acres of upland fields, 16 acres of alluvial forest, 10 acres of upland abandoned fields, and 7 acres of upland thicket (Figures 2.7.1-2 and 3.1.0-2). In addition, approximately three acres of alluvial field and two acres of mixed mesic hardwood forest will be destroyed in construction of the NSW Pond dam.

It is expected that the half mile of creek bed below the dam will essentially be lost as a habitat for stream organisms, although overflow from the dam will be fed back into it during high and average flows. As noted above, this site creek has a drainage area of slightly over two square miles. Since the drainage area of Dutchman Creek is approximately 130 square miles, loss of the discharge from this creek is not expected to have a marked effect on Dutchman Creek, even at low flows. It is the last creek to enter Dutchman before the latter reaches the Yadkin River.

There are at present no plans to use biocides in the NSW pond. Aquatic macrophytes would be removed mechanically should they develop in any numbers along the shore. High populations (e.g. Dorosoma spp.) of trash fish, if they should develop to nuisance levels, could be removed by extensive shocking and netting. Biocides will be used to keep condenser tubes and cooling towers free of growths, but blowdown will be treated before release to the Yadkin, and in no event will it be returned to the NSW pond. Q2.7.5

5.1.4.2 Carter Creek Reservoir

The Carter Creek impoundment (Figure 2.1.1-1) is designated to the sole function of providing makeup water to allow continuous operation of the Perkins Nuclear Station, during low flow periods, when the Yadkin River flow is below the minimum flow established by North Carolina Department of Natural and Economic Resources (Subdivision 5.1.4.2.2). A comparison of the proposed impoundment required for three minimum flow restrictions is given in Table 5.1.4-1. Q 10a

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5.1.4.2.1 Alternate Sites

Between Muddy Creek and Dutchman Creek, numerous rivulets and intermittent streams enter the Yadkin River from either bank above the proposed location of the intake structures for the Perkins Nuclear Station. Of these, only seven are large enough to be named on USGS topographic maps. Going downstream from Muddy Creek, they are: Peoples Creek, Reedy Creek, Carter Creek, Dykers Creek, Gobble Creek, Mill Creek, and Lick Run. Carter Creek is one of the longest and has one of the largest drainage areas (8.1 sq. mi). A remarkable feature about it is that it is very straight over most of its length. Its possible importance as a site for fish spawning will be evaluated in the special sampling effort which began in March, 1975.

In selecting the Carter Creek impoundment site, alternate creeks along the Yadkin River were considered. Carter Creek was selected over the others as the most acceptable, based on hydrologic, economic, social, and environmental considerations. Alternate creek sites considered which are closer to the plant site are Dutchman Creek and Mill Creek.

Dutchman Creek is located west of the plant site and joins the Yadkin River about two miles downstream of the station intake structure. Mill Creek is located east of the Yadkin River in Davidson County and joins the Yadkin River about one mile upstream of the Perkins intake.

The Carter Creek site is preferred over the Dutchman Creek site because the land requirement to store an equal volume of water on Dutchman Creek is about twice that of the land requirement at Carter Creek. Also, the Dutchman Creek site is more heavily populated and construction of an impoundment on it will have a greater impact on the local population. The larger surface area of Dutchman Creek would also increase evaporation losses from the pond. The impoundment of the Dutchman Creek site would require road and railroad relocations, increasing the cost of the impoundment by about 35 percent. Q 12

The Carter Creek site is considered a better choice than the Mill Creek site in Davidson County based on economic and environmental considerations. The construction cost of the Mill Creek impoundment is about 10 percent greater than that of the proposed Carter Creek impoundment. The impoundment of Mill Creek would require inundation of over 200 acres of the Cooleemee gameland which is currently under management of the North Carolina Wildlife Commission.

5.1.4.2.2 Reservoir Operation

Based on tentative agreement reached between Duke and NCDNER on January 20, 1975, river flow above which pumping will be allowed is 880 cfs (measured at the Yadkin College gage). All flow above 880 cfs can be withdrawn from the river subject to a maximum of 25 percent of the total stream flow. The average flow of the Yadkin River is 2853 cfs. Since the operation of the W. Kerr Scott Reservoir began in 1962, the flow of the Yadkin River has been above 880 cfs 98 percent of the time.

During normal filling operations, one to four of the 50 cfs capacity intake pumps will operate at full capacity to bring the reservoirs to full pond. The number of pumps operating is a function of streamflow available for pumping. The pumping rate into the Carter Creek Reservoir will be limited to the excess river flow above 880 cfs minus any consumptive withdrawals being made at the Perkins intake. The historical river flow since W. Kerr Scott began operation has exceeded 1,248 cfs 93 percent of the time. At this level of flow, the maximum plant consumptive requirement plus the maximum pumping capacity (200 cfs) into the Carter Creek Reservoir may be withdrawn from the river without violating the tentative agreement restricting withdrawals to 25 percent of the total river flow. Q 10 c, e, f

The expected drawdown, based on Yadkin River historical flow records, of the Carter Creek Reservoir once in 10 years is 20.5. The reservoir will be refilled by pumping available river flow (based on State of North Carolina restrictions) up to 200 cfs, into the reservoir. The area capacity curves for the reservoir are shown in Figure 5.1.4-1 and other design basis are given in Table 5.1.4-2. Q 14

4 |

The average annual estimated operating cost of the Carter Creek Reservoir is $8,000 which will have only minimal effect on the cost of producing power at Perkins. Q 17

Releasing impounded water from Carter Creek to Yadkin River during periods of low flow will not only maintain a larger flow rate in the river, it should improve the average quality of water flowing downstream into High Rock Lake. Improvement in the average quality of water by flow augmentation involves several factors.

Reduced stream flow at Yadkin College Gaging Station reduces the dilution factor for wastes discharged by Winston-Salem's waste treatment plants through Salem Creek, Town Creek and Muddy Creek.

The lowered stream flow carries a smaller amount of dissolved oxygen. Consequently both the assimilative capacity of the river and the dilution capability of the stream are smaller at a time when wastes from the metropolitan area continue at a relatively constant level of Biochemical Oxygen Demand. In fact, waste discharges tend to become more concentrated because of the absence of dilution water in storm sewers and because of the smaller amount of infiltration of ground water into a sewer collection system during drought periods.

The quality of water released from storage will be better than the quality of water in the river. Sedimentation and biological stabilization during storage will remove suspended solids and break down nutrients. The biochemical oxygen demand of the stored water will be lowered and the dis-
4 solved oxygen content of the water will tend to increase. The release of 112 cfs to maintain a river flow of 880 cfs downstream at Perkins Nuclear Station would result in more than 12 percent of the stream flow being improved by impoundment. At the 7Q10 river flow of 625 cfs, a release of 82 cfs from storage improves 13 percent of the flow by storage. A release of 108 cfs from storage to a 7Q10 flow of 625 cfs is more than 17 percent of river flow.

Flow augmentation from the Carter Creek impoundment to Yadkin River should improve the capability of the stream to assimilate the impact of wastes that enters the river at upstream point sources. The environmental improvement will extend downstream into High Rock Lake.

5.1.4.2.3 Intake Discharge Structure for Carter Creek

The preliminary layout of the Carter Creek impoundment, the reservoir discharge structure, and the river intake discharge structure are shown in Figure 2.1.1-2.

The bankside intake discharge structure will have four vertical pumps of 50 cfs capacity each. Q 10b, g The structure (Figure 5.1.4-2) will include a skimmer wall to prevent floating objects from entering the intake, trash racks to prevent larger submerged objects from entering the screen well and traveling screens to protect larger fish and to keep larger debris from entering the pump well. The geometry of the inlet and screen will provide a velocity equal to or less than 0.5 fps for all stages of the river. Q 10d

The traveling screens will be 3/8 inch mesh wire panels attached to an endless belt. The screen would travel vertically and pass through a backwash jet spray for cleaning. Debris washed from the screens will be transported to the end of the structure and removed for proper disposal.

The intake discharge structure will be equipped with remote controls and operated by personnel at the Perkins Nuclear Station. Operation of the structure will be initiated by plant personnel monitoring the flow at the Yadkin College gage and plant water requirements.

A dual port discharge structure, shown in Figure 5.1.4-3, will be located inside the reservoir (Figure 2.1.1-1) for the release of water to the Yadkin River. This structure will have a high level and a low level sluice gate, Q 11 each of sufficient size to pass the maximum release of 112 cfs required to replenish consumptive plant loss during low flow periods.

The reservoir discharge structure will be provided with an overflow inlet at elevation 723.0 ft. to maintain the water level at full pond.

Water will be conveyed back and forth from the reservoir to the river through the same pipe. At the river intake discharge structure, the water released from the reservoir will be routed around the pump well and discharged through a single pipe located on the downstream side of the pump structure. The maximum discharge velocity is about 6 fps. Q 11

5.1.5 EFFECTS ON AIR AND LAND Q5.1.2

Visible Plume Occurrence

An unavoidable consequence of operating the station cooling towers will be the occasional occurrence of a visible plume. The frequency and extent of the plume for any given tower depends on prevailing meteorological conditions. Figure 5.1.5-1 depicts frequencies of condensate plumes by length and direction from the plant for an annual period. Percentage occurrence is cumulative and is without regard to height of the plume. Q 5.1.12

Frequencies were derived from empirical data on plume parameters for a mechanical draft cooling tower at the Duke Power Cliffside Plant (September, 1972 - August, 1974), a 600 MW(e) station located 85 miles southwest of Perkins Nuclear Station. Plume frequencies were derived from observations made at 0800 LST of plume rise, length and direction of drift to eight compass points. Rise characteristics were assessed by reference to a 500 foot stack adjacent to the cooling towers. Length and direction were estimated from an area map provided with range markers. Three helicopter flights were made at observation time during the period of record to ascertain the adequacy of ground based observations and assess other factors relating to plume behavior; e.g., effects of elevated and ground based inversions on plume dissipation. Q 2.6.18 Application of measured plume parameters at Cliffside Steam Station to represent plume behavior for mechanical draft cooling towers at Perkins involves: the extrapolation of observed lengths at Cliffside to account for a different heat load and redistribution direction-wise of length by direction frequencies to coincide with observed 130 foot level wind directions at the Perkins site. This redistribution maintains the percentage breakdown of plume lengths within each sector as reported at Cliffside but changes the wind direction distribution to that at the Perkins site. No observation of wind direction was shifted more than one sector to achieve this redistribution. Q 2.6.19 Tower heat loads amount to approximately 820 MW at Cliffside as versus 7650 MW at Perkins. Heat load was adjusted assuming the same proportions of sensible and latent heat released at both plants. A factor then of nine is applied to the evaporation rate at Cliffside to approximate evaporation from the Perkins towers. In translating length frequencies by direction as observed at 0800 LST to frequencies representing occurrences based on total time or all hours of the day, persistence was assumed for 24 hours following each 0800 LST observation. This leads to an overstatement of the frequency of extended plume lengths in that early morning is a favored time for long plume occurrences. Differences in evaporation rate were accounted for by extrapolation of observed plume lengths at Cliffside assuming a gaussian material distribution in the plume and a spread rate tending to maximize plume length[3] (Stability Class E for a plume height of 925 feet).

Fogging due to cooling tower operation is not expected to be a problem. For mechanical draft towers based on two years of experience from the Cliffside towers, ground contact would be limited to within 1/2 mile of the plant, occurring at a combined frequency of less than one percent for all temperatures and wind directions. The estimate for the extent of ground level fogging from mechanical draft cooling towers at Perkins (to 1/2 mile) is based on the observation of ground level fogging from the Cliffside towers. All cases of cooling tower plumes at ground level were reported to occur within 1000 feet of the towers. All plumes at ground level were observed to "take off" from the ground (buoyant rise) instead of dissipating from the action of atmospheric dilution. Consideration of the differences in tower shape (circular at Perkins with cross-sectional area approximately 21,000 ft^2 per tower; rectangular at Cliffside with maximum cross-sectional area approximately 21,000 ft^2/tower) and in heat load per tower (about 850 MW at Perkins to 410 MW at Cliffside) suggests some amelioration of ground level fogging at Perkins; low pressure wake effects would be lessened while plume buoyancy would be increased. A 1000 foot distance criterion has been used in design considerations with regard to the positioning of electrical equipment in the station yard. Since the nearest highway, NC 801 is approximately 3600 feet from the cooling tower yard, no effect on ground transportation is expected. Q 2.6.20

Climatology of the Perkins Plant is influenced by the same regional weather regimes that affect the Cliffside Plant. With regard to the specifics for diffusion and background moisture considerations the following comparisons are drawn: Q 5.1.6

	Mean Maximum[4] Temperature (°F)	Mean Minimum[4] Temperature (°F)	Mean Wind[4] Speed (mph)
Winston-Salem Airport	68.6	48.3	8.6
Greenville Airport	70.5	51.5	8.2

	Mean Maximum[6] Mixing Height (meters)	Mean Surface[5] Dew Point (°F)
Cliffside	1500	47
Perkins Plant	1500	46

It is reasoned with similar maximum and minimum temperatures and maximum mixing heights that stability conditions are likely to show positive correlation. With similar mixing characteristics, surface dew point is taken as an index to moisture comparison at any level.

Cooling Tower Drift

As warmed condenser cooling water falls through the fill section of the cooling tower, some smaller water droplets are entrained by the relatively high velocity air flowing inside the tower. The amount of entrained water droplets, called drift, depends on the volume of the circulating system and the efficiency of the drift elimination system. The distribution of drift is dependent on the size of drift droplets and ambient weather conditions. Large droplets fall out rather close to a plant, while smaller droplets may evaporate to saturated droplets or dry nuclei and be carried greater distances by surface winds. The chemical composition of drift droplets is related to the chemical composition of the intake water, the concentration gradient of the operating system, and the concentration of any additives such as biocides and scale inhibitors. These concentrations are discussed in Section 3.6.

For previous analyses, estimates of drift anticipated from the cooling towers were based on extremely conservative estimates of percentage drift loss and particle size distribution. The specifications of the towers planned for the Perkins station are now known in much more detail. These revised specifications have been used to generate isopleths of drift deposition on an annual basis around the towers. These isopleths are presented on Figure 5.1.5-2.

Deposition was computed solely from trajectory considerations as per nomograns by Hosler, Pena and Pena.[7] In the prediction techniques the following parameters and assumptions have been used:

1. The drift droplet size distribution reflect data taken by[8] the Marley Company applicable to their circular mechanical draft towers.[8]

Distribution of Drift Mass (drift rate - 0.005%)

Droplet Diameter (microns)	Percent of Total Mass
0-60	50
60-125	22
125-180	5
180-225	4
225-325	8
325-425	6
425-525	5

2. Drift loss has been assessed at .005%[8] of circulating water and the solids content of the drift is assumed to be 1150 ppm.[9]

3. The profile of exhaust air vertical speeds assumes a linear decrease from
4 tower exit to 925 feet above ground level with an exit speed of 35.5 feet/sec. The final plume height is based on recommendations of Briggs (174)[10] for multiple stack sources.

4. In the interest of conservatism, no evaporation is assumed. Calculations done with evaporation show no substantial difference within 1000 feet of the towers, and only slightly lower deposition rates beyond 1000 feet.

5. Meteorological parameters used are average wind speed by 22.5° sector and wind direction frequency by 22.5° sector. This data is derived from one year of onsite wind observations at the 130 foot level.

As can be seen from Figure 5.1.5-2, the maximum salt deposition rate is about Q
40 lb/acre-month. The deposition rate decreases rapidly with distance from 5.1.12
the tower. The figure also indicates the vegetation occurring in the drift 5.4.2
field. 5.1.7
5.1.8

5.1.6 OTHER ENVIRONMENTAL EFFECTS OF OPERATION OF THE COOLING WATER SYSTEM

The mechanical draft cooling towers will have a certain level of noise associated with their operation. Maximum noise levels which the cooling tower manufacturer must meet are as follows:

1) The sound levels at any location on the fan deck or any cell (near field) shall not exceed 90 db when measured on the "A" scale of a standard sound level meter at slow response with all fans in operation.

2) The combined sound pressure levels measured at a distance of 250 feet from any point on the outer casing in any direction shall not exceed the following values:

Octave Band Center Frequency, Hz	63	125	250	500	1000	2000	4000	8000
SPL, db, re 0.0002 Microbars	84	77	72	69	69	65	65	65

The site boundary is approximately 3000 feet from the cooling tower at the closest place.

The levels presented above are maximums; actual noise levels are expected to be considerably lower. Vegetative screening should further reduce noise levels so that offsite noise will not be a problem.

Restrictions as to water use and resultant flow conditions is regulated only to the extent that compliance with water quality standards are maintained. Section III Rule 6-d, "Rules Applicable to All Classes and Standards", states that "The criteria are applicable to any fresh water stream when the flowrate is equal to or greater than the minimum seven-day average flowrate that occurs with an average frequency of once in ten years".

The discharge of cooling tower blowdown into the Yadkin River while maintaining the 7Q10 is not expected to cause contravention of the State of North Carolina water quality standards at Perkins Nuclear Station.

Emissions from cooling towers at Perkins Nuclear Station are expected to meet any applicable ambient air quality standards of the State of North Carolina that may be promulgated. There are no standards at the present time for cooling tower emissions pursuant to the "Rules, Regulations, and Standards Governing the Control of Air Pollution" for the State of North Carolina, adopted January 21, 1972.

The behavior of cooling tower plumes under varying areal meteorological conditions is described in Subsection 5.1.5.

5.2 RADIOLOGICAL IMPACT ON BIOTA OTHER THAN MAN

The low-level releases of radioactivity that is normally present in the gaseous and liquid effluents from Perkins Nuclear Station expose all living species in the environment to some small amount of radiation, which results in doses whose magnitude depends upon the habitat and feeding characteristics of the species of interest. This section presents quantitative estimates of annual doses for a broad category of organisms which encompass the "important" biota identified in Section 2.7.

5.2.1 EXPOSURE PATHWAYS

Important local flora and migratory fauna are discussed in Section 2.7. Subsection 5.2.1 considers only those important species whose aquatic and terrestrial habitats provide the highest potential for radiation exposure, and the maximum potential doses have been calculated for these organisms. It is expected that the actual doses received by these organisms from the operation of the station will be much less.

The most important exposure pathways to biota other than man from radioactive materials released to the aquatic or terrestrial environment are shown in Figure 5.2.1-1; however, in the case of the Perkins Nuclear Station, many potential Significant pathways are not available because of the water and land usage, and the nature of the releases. (This statement on water and land use refers to ecological Q
2 considerations; that various "important" plant and animal species are not present 5.2.1
or are present in limited numbers, due to the agricultural use of the land, and the condition and use of the river.) The major pathway for exposure from gaseous waste effluents is direct external radiation from the airborne radioactive material itself as it is dispersed in the environment of the station by the wind. Very small quantities of radioactive iodine are also released in gaseous effluents. This material deposits on vegetation and ingestion is therefore another exposure pathway for grazing animals. Radioactive materials are also released in liquid form in dilution water to the river. Direct radiation exposure from immersion, as well as ingestion and assimilation of the waterborne activity, are the pathways for exposure of aquatic biota.

The significant exposure pathways for biota other than man from gaseous waste releases at the Perkins Nuclear Station are determined to be

1. the iodine dose to the thyroids of grazing animals, i.e., cows, from ingestion of contaminated grass; and

2. the external exposure of terrestrial organisms from the radioactive materials in the gaseous waste plume.

For liquid waste releases, the significant pathways for exposure affecting aquatic plants, invertebrates, fish, and ducks are

1. the external exposure due to submersion in water containing dissolved radioactive materials;

2. the external exposure to organisms living in or on shoreline or bottom sediment containing deposited radioactive materials; and

3. the internal exposure due to ingestion and assimilation of dissolved radioactive materials from the water.

5.2.2 RADIOACTIVITY IN THE ENVIRONMENT

4 Estimates of radionuclide releases from the MLWMS and the GWMS from one
unit appear in Tables 3.5.1-3 and 3.5.2-2 respectively.

Radioactivity concentrations in the waters downstream of Perkins Nuclear
Station are calculated from the annual release from three units Q5.3.1
4 diluted by the annual average river flow of 2853 cfs (Subdivision 2.5.1.2).
Results are presented in Table 5.3.2-1. Q5.3.2

Estimates of radioactivity in sediments have been made for areas downstream
4 of Perkins Nuclear Station. Concentrations listed in Table 5.2.2-1 are
calculated from the following relationship.[1]

S_i = $100. \text{ X } Ti \text{ X } Ci \text{ X } W \text{ X} (1-e^{-\lambda i TL})$

Ti = Half life of isotope i

Ci = River concentration of siotope i at the concentration listed in Table 5.3.2-1. Q5.2.3

W = 0.2 = Shore width factor

λi = Decay constant for isotope i

TL = Life of the plant

3 Si = Sediment concentration for isotope i

A discussion of the distribution of gaseous effluents in the environment appears in Subsection 5.3.3.

5.2.3 DOSE RATE ESTIMATES

4 In order to evaluate the dose to the important terrestrial and aquatic bi-
ota, certain simplifying assumptions were made, i.e., representative or-
ganisms were chosen and the maximum hypothetical doses to such organism
4 were calculated. For example, radionuclide concentrations in aquatic biota
(fish, invertebrates and vegetation) have been determined by multiplying
the average concentrations of radionuclide expected in the Yadkin River by
appropriate biological concentration factors for each radionuclide. It was
3 also assumed that waterfowl (ducks) consumed only aquatic plants containing
the above concentrations of Radionuclides. Dose estimates are summarized
in Table 5.2.3-1.

The models used for calculation of the doses are presented in Attachment 5A. Q5.2.5
The assumptions are included in this section.

The dose to the thyroid of a representative important grazing animal was calculated through the iodine-atmosphere-grass pathway to the nearest dairy cow.

The doses calculated are as follows:

1. The direct external exposure to an aquatic organism was estimated by considering an infinite medium (water) and assuming that the organism immersed in the water receives the same dose rate as the exposure rate to the water itself.

2. The direct external dose to organisms living in or on the river bottoms or shoreline sediment was conservatively estimated by first determining the radionuclide concentrations in the bottom sediment and then calculating the contact dose received (in air) from exposure to a thin, infinite plane (2π geometry) of sediment. The model used for estimating sediment activity is intended to provide an order of magnitude estimate of this activity.[1]

3. The internal doses to aquatic plants, invertebrates and fish (primary organisms) due to assimilation of water were evaluated assuming biological reconcentration of the radionuclides present in the water. The doses were determined from the equilibrium specific burdens of the radioisotopes within these organisms and from the effective decay energies for each of these isotopes within each organism. The bioaccumulation factors[2] used appear in Table 5.2.3-2. Effective energies for the primary organisms were based on the assumption that these organisms can be represented as spherical masses of tissue having an effective radius of 2 cm. Q5.2.4

   The internal dose to duck (secondary organism) was determined assuming that its diet consists of 100 grams per day of aquatic plants. The effective energies deposited in the duck by the radioisotopes consumed in this food were based upon a representation of the duck as a spherical tissue mass having an effective radius of 5 cm.

4. A terrestrial dose from I-131 to the thyroid of grazing animals was evaluated for the nearest dairy cow. The calculation was made by utilizing a relationship between the amount of I-131 that remains in the cow's thyroid versus the amount secreted in milk (3 picocuries per gram of cow's thyroid, per picocurie per liter of milk).[3] The dose obtained is that to the cow's thyroid from ingesting fodder contaminated with I-131. The method used to determine the amount of iodine in the cow's milk is that described in USAEC Regulatory Guide 1.42 (June 1973).

   Meteorological information discussed in Section 2.6 and listed in Table 2.6.2-5 is used to estimate the dispersion factors in the cow thyroid dose calculation. The location of the nearest cow is shown in Figure 2.2.2-1. Q5.2.2

5.3 RADIOLOGICAL IMPACT ON MAN

The radioactivity in the environment resulting from normal radioactive discharges from Perkins Nuclear Station is characterized in Subsection 5.2.2, where the radiological impact on biota other than man is considered. Man is exposed to this same environment in which low-level radioactive contamination of air, land, and water exists, and this produces external and internal doses to the general public via similar exposure pathways. In this section, the radiological impact on man from station operation and from transportation of radioactive materials is assessed.

5.3.1 EXPOSURE PATHWAYS

Man is continuously exposed to natural background radioactivity: naturally-occurring radioactive materials in the air, water, land, and in his food, as well as cosmic rays from outer space, which subject him to an irreducible minimum internal and external dose of radiation. The average person also receives a somewhat smaller dose from manmade radiation; that is, from medical x-rays, television sets, and nuclear weapons fallout. On the other hand, an operating nuclear power station contributes a much smaller additional dose to people living nearby than the above-mentioned sources. This dose is due to the small amounts of radioactivity in liquid and gaseous waste releases from the nuclear station to the environment.

Radionuclides that are released into the air or water may take a number of different pathways leading to radiation exposure of man. The pathways are indicated in Figure 5.3.1-1.

Although the amount of radioactivity added to the environment from station operation is minimal and as low as practicable, possible critical exposure pathways to man have been evaluated in order to estimate the maximum dose to an individual and to the surrounding population, as well as to establish the sampling requirements for the Offsite Radiological Monitoring Program. These pathways include:

1. The whole body dose from submersion in air containing radioactive materials from gaseous waste releases.
2. The inhalation dose from gaseous waste releases.
3. Drinking water from that portion of the river affected by the radioactive liquid waste releases, from wells directly associated with this portion of the river, or, more likely, from the nearest water-supply intake downstream.
4. Eating fish and invertebrates taken from the river immediately adjacent to the station.
5. Swimming, boating, fishing, or walking along the shore of the river within this same area.
6. Consuming milk or other dairy products from locations affected by gaseous waste releases (radioiodine deposition).
7. Eating other foods (crops, animals) grown in areas or raised on feeds affected by gaseous waste releases.

5.3.2 LIQUID EFFLUENTS

Estimates of annual average concentrations of plant liquid releases have been made for waters downstream of the effluent discharge. The annual average river flow at the station discussed in Subsection 2.5.1 is used to calculate the river concentrations listed in Table 5.3.2-1. The concentrations are used in the dose calculations discussed later in this section.

Instantaneous radionuclide concentration in the station discharge are held at or below the 10CFR20 limits by providing dilution during period of discharge. Peak dilution flow is 150 cfs. Fractions of maximum permissible concentrations are calculated by dividing the river concentrations by their 10CFR20 limits.

The analysis demonstrates that concentrations of radioactivity in the river channel resulting from normal operation of the station are quite small when compared with the limits of 10CFR20.

5.3.2.1 Land and Water Usage

Recreational and similar land and water usage are discussed in Section 2.2. Fish species found in the vicinity of the station are discussed in Subdivision 2.7.2. An estimate of the annual fish catch in the Yadkin River is Q
2 provided in Subdivision 2.7.2.6.8 (Table 2.7.2-48). 5.3.2.1

5.3.2.2 Maximum Doses to an Individual Resulting from all Receiving Water Related Exposure Pathways

2 The models used for the calculation of the doses are presented in Attachment Q
5B. 5.3.2

2 The assumptions used for the water-related doses shown in Table 5.3.2-2 are as follows:

1. The annual dose received via the drinking pathway are calculated assuming that a person's only source of drinking water for an entire year is directly from the river at the station discharge.

2. The annual dose from fish ingestion was calculated assuming that a person eats 18 Kg/yr of fish which have been caught from the station discharge, and that these fish have reconcentrated the radionuclides (see Table 5.2.3-2 for bioaccumulation factors).

3. The annual doses received from aquatic recreation are calculated by assuming that an individual devotes 100 hr/yr to swimming (fully submerged), 100 hr/yr to boating, and 500 hr/yr to shoreline activities such as walking along the shore of the Yadkin River.

All doses except those received from external exposure for the liquid pathways have been calculated assuming that exposure to ICRP maximum permissible concentrations produces ICRP maximum permissible dose rates which are:

	Gonads and Total Body	0.1 rem/week	
1	Skin and Thyroid	0.6 rem/week	
	All other Soft Tissues	0.3 rem/week	Q5.3.4
	Bone	0.56 rem/week	

The above dose rates are based on 50 weeks exposure per year.

The external doses received through the liquid pathways are based on immer-
1 sion in an infinite medium; water for exposure from swimming (4 π geometry), and air for exposure to shoreline sediments, and for exposure from boating (2 π geometry).

The maximum doses that an individual might receive from all of the above pathways are summarized in Table 5.3.2-2. It should be emphasized that these dose estimates represent the maximum dose to a hypothetical individual and that the total dose for people living in the immediate vicinity of the station or beyond (Critical population group) will be very much lower.

5.3.3 GASEOUS EFFLUENTS

The bases for the airborne-related doses shown in Table 5.3.3-1 are as follows:

1. The whole body and skin submersion doses were estimated for 2π geometry using half infinite cloud dose equations.[2] For the skin dose calculations, all gamma energy as well as electron energy (both from beta and from internal conversion electrons) was assumed to be deposited in the skin. In addition, occupancy was assumed to be continuous (a full year).

2. The inhalation doses to the thyroid and whole body were calculated with the assumption that exposure to ICRP maximum permissible concentrations produces ICRP maximum permissible dose rates (see Subdivision 5.3.2.3). Occupancy was assumed to be continuous.

   The above doses are postulated as being maximum doses that an individual adult might receive based upon gaseous waste release rates appearing in Table 3.5.1-3.

3. The airborne-related ingestion doses have been calculated based on a child being the receptor; a 1 year old for the milk pathway, and a 4 year old for the vegetable pathway. The milk pathway was assumed to
   2 be operative for 12 months; the vegetable pathway for 12 months and Q
   the critical organ assumed to be the thyroid. These thyroid doses have 5.3.3.2
   been calculated using methods described in AEC Regulatory Guide 1.42 with exceptions as noted in Table 5.3.3-2.
   Q

4. Meteorological information discussed in Section 2.6 and listed in Table 5.3.3.0
   2 2.6.2-5 is used in the dose calculations. The one year exclusion area Q5.3.4
   1 radius diffusion factor is used for individual doses at the exclusion Q
   area radius. The one year diffusion factor at the nearest farm, shown 5.3.3.1
   in Figure 2.2.2-1, is used for the vegetable pathway, and at the nearest cow, for the childs thyroid dose from the milk pathway.

5.3.4 DIRECT RADIATION

5.3.4.1 Radiation From Facility

Direct radiation exposure due to the Perkins Nuclear Station is expected to be well within applicable regulations for the operating staff and maintenance personnel, and negligible for the population living in the vicinity of the station in comparison with the exposure due to natural background radiation. Exposure to the population residing near the station is conservatively estimated at less than 0.03 man-rems/year. For the period of time when one unit or two units are in operation and construction of the remaining unit(s) is being completed, it is estimated that construction personnel receive an exposure of 76 man-rem, assuming the exposure times shown in Table 5.3.4-2. The dose rates from Unit 1 are 9.0×10^{-6} rem/hr and 1.2×10^{-6} rem/hr at Unit 2 and Unit 3 respectively. The dose rate at Unit 3 resulting from operation of Units 1 and 2 is 1.02×10^{-5} rem/hr. Dose rates at selected offsite locations are estimated as follows:

Location	Dose Rate (rem/year)
Exclusion area boundary	1.8×10^{-4}
Nearest residence	1.2×10^{-4}
4 Nearest school	$\ll 10^{-10}$
Nearest hospital	$\ll 10^{-10}$

The nearest residence (2625 feet north of the station), school, and hospital are indicated on Figure 2.2.2-1.

Direct radiation is taken to be that from the outside tanks (Refueling Water Tank, Holdup Tank, and Reactor Makeup Water Tank). These tanks (shown on Figure 5.3.4-1) were assumed to be 'square' cylinders containing the Q5.3.4.1
volume and radionuclide concentrations (average values for shielding) listed in PSAR Section 12.1.3. Direct radiation does not include any external com- Q5.3.5.3
ponent from radioactive effluents. The point kernel method is used to calculate offsite dose rates. Reduction by distance and air shielding is considered. No credit is taken for attenuation by offsite structures or terrain. Population projections for 1983 are used in the man-rem calculation.

5.3.4.2 Transportation of Radioactive Materials

Radioactive materials to be shipped to and from the station during operation are discussed in Section 3.8. Additional information is provided below to address specifically the radiological effects of these shipments. A summary is presented in Table 5.3.4-1.

Fresh fuel is supplied from the Combustion Engineering fabrication plant in Windsor, Connecticut. Irradiated fuel is transported by Allied-Gulf Nuclear Service to their facility at Barnwell, South Carolina. The specific AEC or Agreement State-licensed disposal site for solid radwastes has not been selected. Detailed routes for shipments of fuel and radwaste have not been defined; it should be noted that safety standards do not rely on restriction of routing for assuring safety in transport. It is expected that truck shipments will be routed to avoid congested areas and to reduce shipping time and accident probability. Except for spurs leading to the station site and to the reprocessing plant, rail shipments could be expected to travel via regular main line routes.

Radiological requirements of the fresh fuel container are minimal; the principal objectives are to prevent nuclear criticality and to protect the fuel from damage in transport. Design and licensing of the irradiated fuel shipping casks are not complete. The most likely design incorporates a dry fuel cavity and layered shield materials. A fuel assembly having clad defects through which fission products are leaking is placed in a can prior to loading into the transport cask.

Federal regulations governing the packaging and transportation or radioactive materials can be found in the Code of Federal Regulations, Title 49, Parts 170 to 199; Title 14, Part 103; Title 10, Part 71; Title 39, Parts 124.2 (d) and 125.2 (d); Title 46, Parts 146 and 149. These Federal regulations are administered by the U. S. Atomic Energy Commission and the Department of Transportation. The limitations imposed by these regulations on both quantity and method of packaging assure that any significant effects resulting from a severe transportation accident would be confined to the immediate area.

Because of the care and concern taken by shippers to comply with these Federal regulations, the record of safety in the transportation of radioactive materials has been excellent. It is estimated that more than 800,000 packages of radioactive materials are now being shipped annually throughout the United States. Some transportation accidents have occurred; but to date there have been no known deaths or injuries due to radiation from fissile or radioactive materials in the transportation environment.

5.3.5 SUMMARY OF ANNUAL RADIATION DOSES

A summary of estimated population whole body doses from both water and airborne related pathways may be found in Table 5.3.5-1.

The population whole body ingestion dose resulting from liquid releases have
been estimated in the following way. The populations listed in Table 2.2.2-3 Q
2 which are located downstream of the plant as shown in Figure 2.2.2-7 are 5.3.5.1
assumed to draw their water supply at concentrations listed in Table 5.3.2-1.
3 Further, it is assumed that ingestion of water at ICRP maximum permissible
concentrations produces ICRP maximum permissible dose rates. The major contributions to man-rem are those isotopes released at the highest fraction of 10CFR20 limits and as can be seen from Table 5.3.2-1 these are, Tritium, I-131 and I-133.

The whole body dose to the population from airborne effluents within 50 miles of the station have been estimated in the following way. Atmospheric dilution factors for each radius band of a sector are calculated according to the method described in Section 2.6 and are applied to the releases shown in Table 3.5.1-3. It is assumed that exposure to ICRP maximum permissible airborne concentrations produces ICRP maximum permissible dose rates. The major contributors to man-rem are Kr-85, Xe-133 and Kr-88, which together account for almost seventy percent of the total population dose.

Other population dose pathways have not been evaluated due to the remoteness Q
2 of the site and lack of activity on the river. The doses are expected to be 5.3.5.2
small compared to doses from the above pathways.

5.4 EFFECTS OF CHEMICAL AND BIOCIDE DISCHARGES

5.4.1 APPLICABLE WATER STANDARDS

Effluent limitations for steam electric power plant discharges have not yet been promulgated for the State of North Carolina. Any discharge into the Yadkin River must meet the currently applicable State Water Quality
4 Standards for class A-II waters and the appropriate EPA standards. The Perkins Nuclear Station is designed so that chemical and biocide discharges will meet the current stream standards. Duke will comply with these standards and federally approved effluent limitations.

5.4.2 EFFECTS ON RECEIVING WATERS

The effluent concentrations of chemical and biocide discharges and the ambient river concentrations of these chemicals are given in Table 3.6.2-1. This table also gives the expected incremental increase in concentration in the river assuming instantaneous mixing with the 7 day - 10 year low flow and with the yearly average stream flow. Table 5.4.2-1 lists Public Drinking Standards which can be compared with the discharge concentrations listed in Table 3.6.2-1. The incremental increase in chemical concentration due to discharge is only a fraction of the existing river concentration. In most cases the incremental increase added to the average river concentration gives values well below even drinking water standards. North Carolina water quality standards for Class II-A waters do not give maximum concentrations for any of the chemical effluents listed in Table 3.6.2-1 except total hardness, which is not to exceed 100 mg/l. The average discharge concentration for total hardness given in Table 3.6.2-1 is 130 mg/l.

As mentioned above, the expected river concentrations presented in Table 3.6.2-1 assume instantaneous mixing with river flow. Actually a small chemical plume similar to the thermal plume described in Section 5.1 will exist. The computer program described in Subsection 5.1.2.1 was modified to calculate chemical concentrations in the river as a function of discharge concentration, discharge flow characteristics and river channel characteristics. The program computes chemical concentration at various distances downstream using the following equation:

$$C_1/C_2 = 1 + (N-1)\,\frac{(T_1-T_2)}{(T_{1_0}-T_2)}$$

where

C_1 = concentration at some point in the plume
C_2 = ambient concentration in the river
N = number of times discharge concentration is greater than ambient
T_1 = temperature of plume at some point
T_2 = ambient temperature of river
T_{1_0} = initial plume temperature

By applying this equation to the temperature prediction program, the isotherms of Figure 5.1.2-1 become lines of equal chemical contentration. Each isotherm represents chemical concentration in the river as a percent of discharge concentration according to the following translation:

Isotherm	Percent of Initial Concentrations
2°	15%
5°	25%
10°	40%
15°	55%

As an example, in order to dilute the discharge concentration of total hardness mentioned above from 130 mg/l to the state standard of 100 mg/l, a dilution to approximately 77% of the discharge concentration is required. The 15°
2 isotherm in figure 5.1.2-2 represents a dilution to 55% of initial concentration, so that the area required for dilution to only 77% would be somewhat less than that represented by the 15° isotherm and the distance from the discharge point would be less than 150 feet.

Figure 5.1.2-2 represents the case of discharge into the 7 day - 10 year low river flow and winter ambient and discharge temperatures. The 7 day - 10 year low river flow is used since it represents hydraulic conditions in which mixing would be minimized. The winter temperatures are used because they represent the greatest difference between discharge temperature and ambient river temperature and thus require a larger mixing area to dilute the discharge plume. This can be seen by comparing Figure 5.1.2-2 (winter conditions) with Figure 5.1.2-1 (summer conditions). These two conditions thus tend to maximize the size of the discharge plume. As can be seen from figure 5.1.2-2, the chemical concentrations are diluted to near ambient levels within a few hundred feet of the discharge. Other streamflow and temperature combinations clearly would produce a smaller discharge plume.

2

5.4.3 EFFECTS OF CHEMICAL AND BIOCIDE DISCHARGES ON AQUATIC LIFE

Discharges from the Perkins Nuclear Station will contain chemicals from the river which have been concentrated approximately 10 times in the cooling cycle, as well as other chemicals such as biocides and scale and deposit inhibitors. These are described in Subsection 3.6.1, and their effluent concentrations given in Table 3.6.2-1. Table 5.4.3-1 lists toxicity levels for the chemicals in the discharge where toxicity levels are available in the literature. It will be noted that, in each instance, concentrations will be below toxic levels before the discharge reaches the river with the exception of the alternate biocide (H-133) discussed below. An appreciable buildup of toxic chemicals in sediments or in backwaters downstream of the discharge is not expected due to dilution and scour by the flow of the Yadkin River.

The tendency for the increased level of nutrients (nitrates, phosphates silicates, etc.) in the discharge to stimulate an undesirable growth of blue-green algae will be minimized, if not counteracted entirely, by several factors. First is the fact that, even in the presence of adequate nutrients, light penetration in the generally turbid waters of the Yadkin River downstream of the discharge will usually not be sufficient to support rapid algal growth. Secondly, the nutrients in the 8-12 cfs discharge will be rapidly diluted back to ambient levels by the river itself, whose lowest flow of record is many times greater than the discharge. Third, phytoplankton entrained in the discharge will pass out of its influence too soon for long term growth stimulation to be a factor. Fourth, the tendence of periphytons blue-greens to develop will be diminished by scour, inadequate light penetration, and fluctuating water levels. Fifth, and perhaps most important, whatever tendency nutrients in the blowdown do have to stimulate algal growth will be countered by the tendency of residual biocides in that same discharge to suppress it. The effective zones of influence of both tendencies are expected to diminish rapidly downstream.

Bioassays were performed on two species of phytoplankton, the diatom nitzschia polea and the green alga Scenedesmus apiculalus, according to the procedures outlined in Subdivision 6.1.1.11. The results of these tests are discussed in Subdivision 2.7.2.7.

Calgon Corporation, the manufacturers of H-133, give a 96 hour LC_{50} for the bluegill (lepomis macrochirus) of F.5 mg/l. This biocide, if and when needed, will be introduced in slugs and reach a highest instantaneous concentration of 9.2 mg/l at the point of discharge, which will immediately dilute in river water. In no event will concentrations remain elevated for anything approaching 96 hours, even in the discharge pipe. It should be noted that, in nearly three years of operating experience with the cooling towers on Duke Power Company's Cliffside 5 Unit, which is located on the Broad River above the 99-Islands Dam in South Carolina, the alternate biocide (H-133) has never been needed and has not, to date, been used.

5.4.4 EFFECTS OF COOLING TOWER DRIFT

The amount of drift associated with the mechanical draft towers is reported in Figure 3.3.0-1 as 100 gpm on the average. The distribution of drift is dependent on the size of drift droplets and ambient weather conditions.

Large droplets fall out rather close to a plant, while smaller droplets may evaporate to saturated droplets or dry nuclei and be carried greater distances by surface winds. The chemical composition of drift droplets will be essentially the same as that existing in the cooling tower basin.

Although considerable work is being done on drift elimination, little information and understanding is available on the effects of drift salts on vegetation, soils and wildlife. In some areas, depending on the vegetation type, soils, and climate, up to 500 lb/acre/year of NaCl can be deposited on soil and not produce acute effects, while only a few lb/acre/year deposited on some foilage can produce toxic effects.[5] The potential for vegetation damage due to salt deposition must be evaluated on a site-by-site basis. Expected deposition rates for salts contained in the cooling tower drift at Cherokee Nuclear Station are shown in Figure 5.1.5-2. Highest concentrations of salt deposition will be encountered in the area adjacent to the cooling towers (approximately 0 to 3000 feet). Potential damage to vegetation would include immediate effects due to foliage absorption and also long-term effects due to salt concentrations buildup in the soil. The scarcity of adequate information concerning the effects of drift on vegetation precludes the formation of any definite conclusions relating to expected or potential vegetational damage, however, it is evident from Figure 5.1.5-2 that most of the drift will be confined to the site area.

5.5 EFFECTS OF SANITARY AND OTHER WASTE DISCHARGES

The sanitary waste treatment system is described in Section 3.7. Effluent from
the sanitary waste treatment system will be retained in the Holding Pond (see
2 Figure 3.3.0-1) to dissipate the free chlorine residual and will ultimately be
discharged with the effluent from the Waste Water Treatment System. The com-
bined discharge will have essentially zero free chlorine residual. The effects
of this discharge are discussed in Section 5.4.

5.6 EFFECTS OF OPERATION AND MAINTENANCE OF THE TRANSMISSION SYSTEM

After all construction is completed and the transmission lines are put into operation, they are inspected from the air periodically to see that all equipment is functioning in a safe and reliable manner and to examine the overall condition of the right of way. The towers and conductors are designed to provide a long-lasting, maintenance-free life.

Right-of-way maintenance in the form of bush-hogging and hand clearing is
scheduled on a 3 to 4 year cycle to control the resurgence of tall growth in
2 the line corridors. No herbicides are used. The objective of this program is
two fold: to retard growth that may prove a hazard to the line and to encourage
new growth of types that provide a desirable ground cover, erosion control,
improved appearance, and improved wildlife habitat. The cost considerations
2 favor bush-hogging because it is less expensive to use bush-hogging than a crew Q5.6.3
using bush axes and chain saws. Both methods achieve the same goal, but bush-
hogging is more economical.

The temporary access roads which are located on the rights of way are eliminated as soon as practicable after line construction is completed, and the area previously occupied by the roads is maintained in the same manner as the rest of the corridor. Since the roads are eliminated after use, no significant increase in public exposure is expected, and hence, no effect on resident wildlife.

A property owner may do as he wishes on the right of way located on his land as long as it does not interfere with the safe operation and maintenance of the line. Duke encourages practices that control and prevent soil erosion on the rights of way and has certain policies pertaining to erosion control:

1. That grading or filling not be done on the right of way where the fill will bring the ground clearance down to less than 25 feet Q3.9.3
   under 44 kV lines, 27½ feet under 100 kV lines, 35 feet under 230 kV lines, and 45 feet under 500 kV lines. Any grading within the right of way or around a tower, which will affect its structural integrity or prevent free access for maintenance purposes, will not be permitted.

2. Grading shall be 20 feet from a pole or tower leg, and slope shall
   2 not exceed 3:1 on the right of way.

3. Any drainage ditch causing water to pond or cause erosion around a structure is not permitted.

4. No wells, septic tanks or drain fields are allowed on the right of way.

5. Permission must be obtained from Duke Power for the installation of lakes or ponds on its right of way. Under no circumstances should the dam be constructed within the right of way.

6. Duke Power will not object to any beautification program, such as planting grass, flowers, low-growing shrubs, gardens, etc., so long as they do not interfere with the existing structures.

The electrical design of these lines is planned so that the combination of component selection and conductor size, spacing, shielding, and elevation limit the occurrence of electrical radiation outside the line right of way to a level too low to interfere with normal radio or television reception. These electrical design criteria have been monitored on existing lines using the Stoddard Model NM-25T and the Singer Model NF-105 signal strength meters. Readings of signal strength levels of commonly received radio and television transmitters, as well as ambient noise levels at several representative frequencies, have been taken and recorded. Frequency ranges were from 500 kHz to 200 mHz. These tests have verified the design of the lines and have proven that the transmission lines associated with Perkins Nuclear Station do not cause radio or television interference at any location outside the line right of way in either fair or foul weather.

All conductors on the lines are bundled to increase carrying capability and to reduce the surface voltage gradient, therefore, minimizing corona discharge. Also, care is taken in the design of the connections, fittings, hardware, and insulation to insure that no random arcing occurs anywhere on the line. With the voltage gradient of the conductor below corona onset, ozone production is not detectable.

The operation of the lines under some weather conditions may be accompanied with a very low level of audible sound. This sound can only be heard directly beneath the conductors and does not extend beyond the limits of the rights of way.

Experience with the operation of 230 kV transmission lines over a period of approximately 20 years has established that for 230 kV transmission lines no electrostatic or electromagnetic influences which are harmful in nature extend beyond the limits of the line rights of way. Tests have been made on fences within the right of way and running cross and parallel to the lines, and any currents induced on these fences closely associated with 230 kV lines are below the threshold of perception. We anticipate no problems with electrostatic and electromagnetic influences from our 230 kV lines associated with Perkins Nuclear Station. No problems with electrostatic and electromagnetic influences from the 230 kV lines associated with Perkins Nuclear Station are anticipated. Approximately 52 fences are located on the Perkins 230 kV transmission corridors. Q5.6.1

2 Duke Power has found that the electrostatic influence of transmission lines in the 525 kV class do create some electrical effect on insulated metal objects located in close proximity to the line. The following discussion is concerning the company's experience and test results from experiments conducted adjacent to 525 kV transmission lines.

METAL BUILDINGS

No buildings are allowed on Duke Power Company's transmission line rights of way. Any buildings affected by the electrostatic effect of 525 kV lines would be those buildings located adjacent or in close proximity to the right of way edge. On the lines from Perkins Nuclear Station out to the existing 525 kV transmission network, it is estimated that no more than 15 buildings will be located within 150 feet of the edge of the line right of way. Duke Power

Company has conducted tests using a small portable shed with a metal roof. These tests indicate that on small metal buildings there is no indication of induced currents of a magnitude which could be considered hazardous or harmful. Large buildings located adjacent to the right of way and having expansive metal roofs will experience an electrostatic voltage buildup on the metal roof if this metal roof is insulated from ground. If this metal roof is grounded, all induced current will be drained off and no hazard would exist.

FENCES

It is estimated that there will be no more than 40 fences on the 525 kV transmission line right of way associated with Perkins Nuclear Station. Duke Power Company has run extensive tests on the matter of fences located within 525 kV right of way. The basic test condition was a 1000 foot insulated fence with the fence parallel to the 525 kV transmission line and the fence located so as to accumulate the maximum induced current. The current measured for this condition was approximately 4.1 ma. It is an accepted fact in the electrical industry that static currents less than 5.0 ma are harmless. Q5.6.

A paper entitled EHV Transmission Lines - Fences and Things, published and presented in September 1972 by Mr. F. A. Jenkins and Mr. L. W. Long of Duke Power Company, concludes that "currents from parallel fences (up to 1000 feet at least), trucks, and low sheds in or near the right of way do not present a hazard even if well insulated." Therefore, even though it is possible for metal objects close to a 525 kV transmission line to accumulate annoying currents, these currents are harmless. Duke Power Company's stated policy is that any fence or building which is located in close proximity to 525 kV transmission lines will be grounded where induced current levels indicate that grounding is desirable.

5.7 OTHER EFFECTS

Inception of plant operation at Perkins Nuclear Station institutes no change in land use or water use in the site area not already abrogated during the construction period.

Operation of the plant supports the other power generating plants in the region by making a considerable contribution to the available power in the regional grid. There is no reason to expect thermal or radioactive waste interaction with other power plants and there are no other wastes from the plant known at this time to be disposed of by means other than those discussed in Sections 5.3 to 5.5.

Major noise sources are the atmospheric steam dump, emergency diesel power units, air handling fans, switchyard and cooling towers. The reactor and steam-electric system noises are muffled due to their containment in concrete and steel structures. The diesel units are for emergency power and are not normally used except for limited periodic testing. They are also housed in concrete structures.

There is no impact during plant operation on existing historical or natural landmarks.

5.8 RESOURCES COMMITTED

Further reduction of the wildlife habitat altered or destroyed by station construction or transmission lines construction is not expected to be caused by station operation.

There is no reason to expect further loss of aquatic resources by plant operation since the thermal, chemical, and turbid discharges to the Yadkin River are carefully monitored.

5.8.1 RESOURCES COMMITTED DURING PLANT LIFETIME

The initial fuel loadings of the Perkins Nuclear Station consists of approximately 130 tons of fuel per reactor in which the U-235 enrichment ranges from 1.9 percent to 2.9 percent by weight. The fuel is encapsulated as sintered pellets of UO_2 in sealed zircaloy rods. Each fuel assembly includes 236 fuel rods with a combined weight of 1434 pounds. With 241 fuel assemblies per reactor core, this constitutes a total weight of 226,591 pounds of uranium in each core at full loading.

3 Assuming that a Construction Permit for Project 81 is issued in March, 1976 the subsequent Operating License would expire in March, 2016 giving the Perkins Nuclear Station a projected average operating lifetime for the three units of 31 years 10 months from the fuel loading to license expiration. During this time approximately 2,420,120 pounds of zircaloy and 18,027 pounds of Inconel are commited. The zircaloy and Inconel are considered irretrievably lost because their radioactivity levels preclude reuse. When dissolved during the fuel recovery process, the alloys are destroyed and contaminated with other elements making it uneconomical to recover the alloying materials. Uranium, on the other hand, can be recycled so that approximately 185,900 pounds of U-235 and approximately 165,500 pounds of U-238 are consumed during station life. Table 5.8.1-1 indicates the material commitments per unit.

Onsite decommissioning entails the removal of the nuclear fuel, the processing and disposal of inplant water inventories, and the resultant processing and disposal of solid waste. It involves the salvage and sale or reuse of non-radioactive equipment and material. Materials and equipment contaminated or activated during station operation are sealed in and left in place along with the supporting and surrounding structures or hauled offsite. The site is then closed and placed under surveillance as detailed in Section 5.9.

5.8.2 IRRETRIEVABLE COMMITMENT OF RESOURCES

Irretrievable and irreversible commitments of resources include those resources consumed during plant operation and those that are not expected to revert to a natural state if the structures are removed at the end of the station life.

It is possible to decommission the station intact; however, decommissioning procedures are not established at this time. Intact decommissioning renders the land completely lost for other purposes for an indefinite period. The value of the land is considered in Section 2.2.

Resources consumed by station operation includes water and fuel. The average flow of the Yadkin River at the Yadkin College gage is 2853 cfs. The anticipated maximum withdrawal requirement from the river is 122 cfs. Of this amount, 10 cfs is returned to the river as flowdown. The maximum
2 net usage rate is approximately 112 cfs consumed due to evaporation from CCW cooling towers. The percentage of the Yadkin River flow, at various low flow stages, required for operation of the Perkins Nuclear Station is shown in Table 5.8.2-1.

Makeup water for station operation is pumped from the Nuclear Service Water Pond. The pond obtains its makeup from the Yadkin River.

Current major users of water from the Yadkin River, whose intakes are located up to 20 miles upstream of the river intake structure, are itemized in Table 2.2.2-3. Total consumption of these users is 24.75 cfs, which represents 0.85 percent of the average annual flow and 4.0 percent of the 7 day 10 year low flow of the Yadkin River at the Yadkin College gage of 625 cfs.

The small amounts of water lost to the atmosphere through evaporation are not actually irretrievably lost, as the water eventually returns to the earth as precipitation.

The operation of the Perkins Nuclear Station involves the irreversible consumption of a certain amount of uraninum ore, representing a fraction of the current reserves and potential resources of the United States. The NRC estimates that current U.S. uraninum ore reserves recoverable at \$8.00 or less per pound U308 totaled 270,000 tons on December 31, 1971.
3 Additional potential resources of uraninum at \$8.00 per pound are estimated to be 450,000 tons. A greater reserve exists when more expensively mined ore is considered. NRC estimates of U.S. uraninum reserves are traditionally conservative, exploration continually increases the estimate. Reserves are expected to increase significantly, thus reducing the percentage depletion caused by the operation of the Perkins Nuclear Station.

The Perkins Nuclear Station is expected to consume an average of 5,843 pounds of the U-235 isotope annually. U-238 is about 140 times more abundant than U-235 and is not considered to be a primary valuable source.
3 Because natural uraninum contains 0.711 percent of the U-235 isotope, total potential U.S. resources of the isotope amount to 2,713 pounds at \$8.00 or less per pound of U308. Operation of the three unit station consumes 0.108 percent annually of the known potential U.S. resource of U-235.

A development that would reduce uraninum depletion is plutonium recycling. Plutonium isotopes are recoverable from the spent fuel. It is estimated
3 that the three Perkins units can produce 1,568 pounds of fissile plutonium annually by the recycle process. Major fuel suppliers are currently developing the technology to fabricate fuel containing the fissile isotopes of plutonium instead of U-235. If commercial operation of the recycle process is realized by the time Perkins Nuclear Station is in commercial

operation, annual depletion of uraninum resources due to station operation can be reduced by one quarter.

5.9 DECOMMISSIONING AND DISMANTLING

3 The ultimate plans for decommissioning the Perkins Nuclear Station, estimated at about 35 years after initial commercial operation for Unit 1, will depend on regulations and requirements in effect at that time, and upon the available technology. Whatever is required at that time will be done. Up to the present date, nuclear stations have been successfully decommissioned by methods ranging from deactivating the reactor and leaving the buildings intact to the complete removal of all buildings and contents.

As of now, the estimated cost of permanently decommissioning each unit of the Perkins Nuclear Station at the end of its useful life is estimated at $4 million to $10 million, in 1974 dollars. This is based on

1. deactivating the reactor;
2. decontaminating process systems and areas;
3. removing all nuclear fuel from the site for recovery of fuel materials, and ultimate disposal of radioactive wastes;
4. sealing of buildings or portions of buildings containing activated process piping and components by means of welding, locking, bolting of doors or welding plates over openings, etc;
5. dismantling and sealing of all gaseous and liquid waste systems and effluent lines;
6. maintaining the required security and fire systems; and
7. ultimate dismantling of the unit.

   Note: If dismantling must be done immediately after initial deactivation of the reactor, due to AEC regulations or other requirements existing at the time, the incremental cost is estimated to be $3,000,000 per unit, based on 1974 dollars.

Prior to ultimate dismantling, the decommissioned unit would be isolated within the security fence and subject to periodic security surveillance, fire inspections, and radiological monitoring of the unit exterior and environs. Maintenance would be performed as required over the years to maintain the integrity of the decommissioned unit, to preclude any possible release of radioactive materials to the environment, and to otherwise assure the protection of the health and safety of the public.

It is expected that after a number of years in this decommissioned state to allow for radioactive decay to lower radiation levels, all areas of the unit could be very readily entered, and the intact systems completely dismantled and removed. The buildings could also be removed if necessary, so that other uses of this location could be made as desired. If it is necessary at the time of final shutdown to completely dismantle and remove buildings and contents, then this too can and will be done.

ER TABLE 5.1.4-1 (Sheet 1 of 4)
PERKINS NUCLEAR STATION
COMPARISON OF CARTER CREEK RESERVOIR FOR
THREE YADKIN RIVER FLOW RESTRICTIONS

Item	Units	Flow Restrictions: 625 cfs	880 cfs	1000 cfs
		Magnitude		
HYDROLOGIC FEATURES				
1. Yadkin River				
a) Flow exceeds restriction	% of Time			
	(1929-1961)	99	95	93
	(1962-1971)	100	98	96
b) Flow Restriction	% of Average Flow, 2853 cfs	22	31	35
c) Flow Restriction	% of 7Q10 Flow			
7Q10, (1929-62), 597 cfs		104	147	167
7Q10, (1962-73), 760 cfs		82	115	131
2. Reservoir Design Criteria				
a) Live storage required for drought of record.	Ac-ft.	8,200	15,502	32,888
3. Carter Creek Reservoir				
a) Full Pond Elevation	ft, msl	713	723	740
b) Area at Full Pond	Acres	605	860	1,400
c) Volume at Full Pond	Ac-ft.	11,500	18,800	38,000
d) Maximum Drawdown Elevation	ft, msl	693	693.5	697

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ER TABLE 5.1.4-1 (Sheet 2 of 4)
PERKINS NUCLEAR STATION
COMPARISON OF CARTER CREEK RESERVOIR FOR
THREE YADKIN RIVER FLOW RESTRICTIONS

Item	Units	Flow Restrictions 625 cfs	880 cfs	1000 cfs
		Magnitude		
3. Carter Creek Reservoir (Cont'd.)				
e) Maximum Drawdown	ft.	20	29.5	43
f) Area at Maximum Drawdown	Acres	245	250	305
g) Volume at Maximum Drawdown Elev.	Ac-ft.	3,300	3,298	5,112
h) Volume in Maximum Drawdown	Ac-ft.	8,200	15,502	32,888
i) 1-in-10yr Drawdown Elevation	ft. msl	703	702.5	717
j) 1-in-10yr Drawdown	ft.	10	20.5	23
k) Area at 1-in-10yr Drawdown	Acres	400	390	705
l) Volume at 1-in-10yr Drawdown Elev.	Ac-ft	6,500	6,358	14,000
m) Volume in 1-in-10yr Drawdown	Ac-ft	5,000	12,442	24,000
4. Dam				
a) Crest length	ft.	1,800	1,900	3,400
b) Maximum height	ft.	90	100	105
c) Volume	Million cu. yd.	.9	1.1	1.6

ER TABLE 5.1.4-1 (Sheet 3 of 4)
PERKINS NUCLEAR STATION
COMPARISON OF CARTER CREEK RESERVOIR FOR
THREE YADKIN RIVER FLOW RESTRICTIONS

Item	Units	Flow Restrictions: 625 cfs	880 cfs	1000 cfs
		Magnitude		
ENVIRONMENTAL EFFECTS				
1. Land Usage within reservoir	Acres at contours of 713, 720, and 740 ft. respectively			
a) Hardwood Forest		315	414	653
b) Mixed Pine - Hardwood Forest		24	31	95
c) Pine Forest		71	82	137
d) Pine Scrub		2	3	11
e) Pastures, Cropland and other cleared land.		191	256	497
f) Ponds		2	2	8
g) Total Forrested Acreage		412	530	896
h) Total Acreage		605	780	1401
2. Buildings Affected				
a) Homes	Number	4	11	13
b) Mobile Homes	Number	0	0	3
c) Farm Buildings	Number	1	2	2

ER TABLE 5.1.4-1 (Sheet 4 of 4)
PERKINS NUCLEAR STATION
COMPARISON OF CARTER CREEK RESERVOIR FOR
THREE YADKIN RIVER FLOW RESTRICTIONS

Item	Units	Flow Restrictions 625 cfs	880 cfs	1000 cfs
		Magnitude		
3. Relocations				
a) Roads (New)	Miles	0	1.2	1.2
b) Roads (Abandoned)		0	1	1
COSTS				
1. Capital Cost	Million $, 1983	12.0	14.0	22.0
2. Annual Fixed Charges	Million $, 1983	2.1	2.4	3.8

ER Table 5.1.4-2
Perkins Nuclear Station
Design Basis for Carter Creek Reservoir

Design Basis	Elevation (ft. msl)	Volume (ac. ft.)	Area (ac.)
Project Design Flood (SPF) Level	728.5	24,112	1,014
Full Pond	723.0	18,800	860
1 in 10 Yr. Drawdown	702.5	6,358	390
Maximum Drawdown	693.5	3,298	250

ER Table 5.2.2-1

Perkins Nuclear Station

Estimates of Radionuclide Concentrations in Shoreline Sediments

	Isotope	Concentration (pCi/m²)
3	I129	4.1×10^{-05}
	I131	2.7
	I132	2.8×10^{-04}
	I133	3.0×10^{-01}
	I134	6.1×10^{-06}
	I135	2.2×10^{-02}
	BR84	1.3×10^{-7}
	RB88	2.9×10^{-6}
	RB89	6.7×10^{-8}
	SR89	2.2×10^{-02}
	SR90	1.3×10^{-01}
	SR91	7.8×10^{-05}
	Y90	1.3×10^{-03}
	Y91	1.2×10^{-1}
	ZR95	4.0×10^{-02}
	MO99	6.1
	TE129	2.6×10^{-7}
4 3	TE132	1.0×10^{-01}
	TE134	2.8×10^{-7}
	CS134	2.1×10^{1}
	CS136	3.9×10^{-01}
	CS137	$7.6 \times 10^{+2}$
	CS138	4.3×10^{-6}
	BA140	9.8×10^{-03}
	LA140	9.9×10^{-04}
	RU103	3.0×10^{-02}
	RU106	5.7×10^{-02}
	PR143	7.7×10^{-03}
	CE144	1.1×10^{-01}
	MN54	9.2×10^{-01}
	CO58	1.1×10^{1}
	CO60	1.1×10^{2}
	FE59	3.7×10^{-02}
3	CR51	1.8
	ZR95	5.0×10^{-02}

ER Table 5.2.3-1

Perkins Nuclear Station

Estimate of Maximum Doses to Biota Other than Man

	Dose Estimates (millirad/yr)
Liquid Waste Releases	
External Exposure*	
4 in water from submersion	1.2×10^{-3}
3 in air from shoreline sediments	3.7×10^{-2}
Internal Exposure:	
to aquatic plants	1.2
to invertebrates	0.38
4 to fish	0.43
to duck	0.42
Gaseous Waste Releases	
4 3 *Dose to cow's thyroid	0.7

*Continuous exposure

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ER Table 5.2.3-2

Perkins Nuclear Station

Bioaccumulation Factors for Fresh Water Organisms

ELEMENT	FISH	INVERTEBRATES	ALGAE
BR	417	333	50
RB	2000	1000	1000
SR	30	100	500
Y	25	1000	5000
ZR	3.33	6.67	1000
NB	30000	100	800
MO	10	10	1000
I	15	5	40
TE	400	75	100
CS	2000	100	500
BA	4	200	500
LA	25	1000	5000
CE	25	1000	5000
PR	25	1000	5000
MN	400	90000	10000
CO	50	200	200
FE	100	3200	1000
CR	200	2000	4000
TRITIUM	0.9	0.9	0.9

*Data is lacking. A value of 100000 was used in these cases.

ER Table 5.3.2-1

Perkins Nuclear Station

<u>Radionuclide Concentrations in the Yadkin River Downstream Station Discharge</u>

Nuclide	Concentration µCi/ml	Fraction of 10CFR20
I 131	1.7×10^{-11}	5.5×10^{-05}
I 133	1.7×10^{-11}	1.7×10^{-05}
I 135	4.0×10^{-12}	9.9×10^{-07}
Mo 99	1.1×10^{-10}	2.7×10^{-06}
Cs134	1.4×10^{-12}	1.6×10^{-07}
Cs137	5.8×10^{-12}	2.9×10^{-07}
H 3	5.1×10^{-08}	1.7×10^{-05}
Total*	5.1×10^{-08}	9.4×10^{-05}

*The sum of all other nuclides comprise less than 1 percent of the total.

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ER Table 5.3.2-2

Perkins Nuclear Station

Estimated Doses to Man from Liquid Releases

	Drinking Water	Eating Fish
3 Total Body (mrem/yr)	5.5×10^{-3}	1.4×10^{-2}
4 GI Tract (mrem/yr)	5.8×10^{-3}	.28
Bone (mrem/yr)	6.3×10^{-5}	7.8×10^{-3}
Thyroid (mrem/yr)	3.3×10^{-2}	1.6×10^{-2}

Aquatic Recreation Whole Body Doses

Swimming	1.4×10^{-5} mrem/yr
4 Boating	6.9×10^{-6} mrem/yr
Shoreline	2.1×10^{-3} mrem/yr

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ER Table 5.3.3-1

Perkins Nuclear Station

Estimated Doses to Man From Gaseous Releases

	Dose to Man
Total Body (mrem/yr)	0.5
4 Skin (mrem/yr)	1.9
Thyroid (mrem/yr)	0.03

3

Estimated Dose to an Individual Child

4 3 Thyroid Dose Via. Milk Pathway	0.3 mrem/yr
Thyroid Dose Via. Vegetable Pathway	.01 mrem/yr

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ER Table 5.3.3-2

Perkins Nuclear Station

Exceptions Taken to Assumptions in Regulatory Guide 1.42*

1.	Percent Fuel Defects:	0.1%
2.	Meteorology	Partial deposition of iodine 131 from the plume prior to its reaching the nearest farm is assumed.
3.	Blowdown	50 GPM

*AEC Regulatory Guide 1.42, "Interim Licensing Policy on as Low as Practicable for Gaseous Radioiodine Releases from Light-Water-Cooled Nuclear Power Reactors" (June, 1973)

ER Table 5.3.4-1

Perkins Nuclear Station

Parameters for Evaluation of Radiological Impact of Transported Materials

Material	Fresh fuel	Irradiated fuel [1]		Radwaste
Shipping mode	Truck	Truck	Rail	Truck
Origin	Windsor, Conn.	Perkins		Perkins
Destination	Perkins	Barnwell, SC		(undetermined)
Distance (mi)	730	240		400[2]
Trips/year [3]	21	243	25	53
Dose rate (mr/hr)[4]	0.10	10.	10.	10.

1 - Figures for truck and rail are mutually exclusive.
2 - Approximate distance to Morehead, Kentucky site.
3 - Total for three units.
4 - Estimated maximum at six feet from vehicle.

ER Table 5.3.4-2
Perkins Nuclear Station
Construction Man-Hours

	Approximate Operation Date	Exposure Man-Hours to Unit 1	Exposure Man-Hours to Units 1 and 2
Unit 1	9-1-82		
Unit 2	9-1-84	4,395,040	
Unit 3	9-1-86	4,395,040	3,016,000

ER Table 5.3.5-1

Perkins Nuclear Station

Estimated Population Doses from Liquid and Gaseous Effluents

	Dose to Population Within 50 Miles (man-rem)
Liquid Effluents	1.8
Gaseous Effluents	3.2

4

Amendment 1
Amendment 2
(Entire Page Revised
Amendment 4

ER Table 5.4.2-1
Perkins Nuclear Station
Public Drinking Water Standards

		Public Drinking Water Standards (1) mg/l
pH		(6-8.5)
Color Pt-Co Mg/l		75
Turbidity JTU		Not established
Conductivity Micro Mho		Not established
B O D		Not established
M B A^{5}S		0.5
Alkalinity as Ca CO_3		400
Hardness as Ca CO_3		300
Calcium	Ca	Not established
Magnesium	Mg	Not established
Sodium	Na	Not established
Potassium	K	Not established
Iron	Fe	0.3
Manganese	Mn	0.05
Ammonia	NH	0.5 (as N)
Nitrate	NO^3	10
Phosphate	PO_4^3	Not established
Chloride	Cl	250
Fluoride	F	(0.8-1.7)
Silica	Si O_2	Not established
Sulfate	SO_4	250
Suspended Solids		Not established
Dissolved Solids		500
Polyacrylate Polymer		---
Aminomethylene Phosphonate as PO_4		---
Boron		1.0
Hydrazine		Not established
Ammonia		0.5 (as N)
Organic Biocide (Alternative)		---

(1) From Water Quality Criteria, Table II-1, FWPCA, 1968.

ER Table 5.4.3-1
Perkins Nuclear Station
Toxicity Levels For Discharge Chemicals

Parameter	Average Discharge Concentration mg/l	Toxicity Level, mg/l	Test Organism	Reference
2 pH	8.5	5-9.5[a]	"Fish"	3
Sodium, Na	116	500	Stickleback	3
Potassium, K	23	50	Stickleback	3
Manganese	.5	40	Stickleback	3
Ammonia	1.0	3.1	Bluegill	2
Fluoride	2	100	Goldfish	2
Polyacrylate Polymer	2.8	3837[b]	Bluegill	4
Aminoethylenephosphonate	2.4	3837[b]	Bluegill	4
Organic Biocide (Alternate)	9.2[c]	7.5[d]	Bluegill	See Notes

a) Non-lethal range

b) These figures represent 96 hour LC_{50} for the scale and deposit inhibitor of which the polyacrylate polymer and aminoethylenephosphonate are constituents.

2 c) Biocide is uded in slugs only for a maximum of about one hour. This number represents the discharge concentration following such a slug.

d) 96 hour LC_{50} (Reference: Personal Communication, Calgon Corp.)

ER Table 5.8.1-1
Perkins Nuclear Station
Commitment of Materials

Material	Total Kg committed during plant life	Amt. Recovered (KG)
A. Control Rods		
Boron	12257	0
B. Burnable Poison Rods		
Boron	60.2	0
C. Boron in Reactor Coolant[1]		
Boron	980 ppm	0
D. Fuel		
Uranium	3,484,000	3,275,000
Zircaloy	1,098,000	0

[1] This number represents Boron lost due to Helium production and waste from evaporator bottoms.

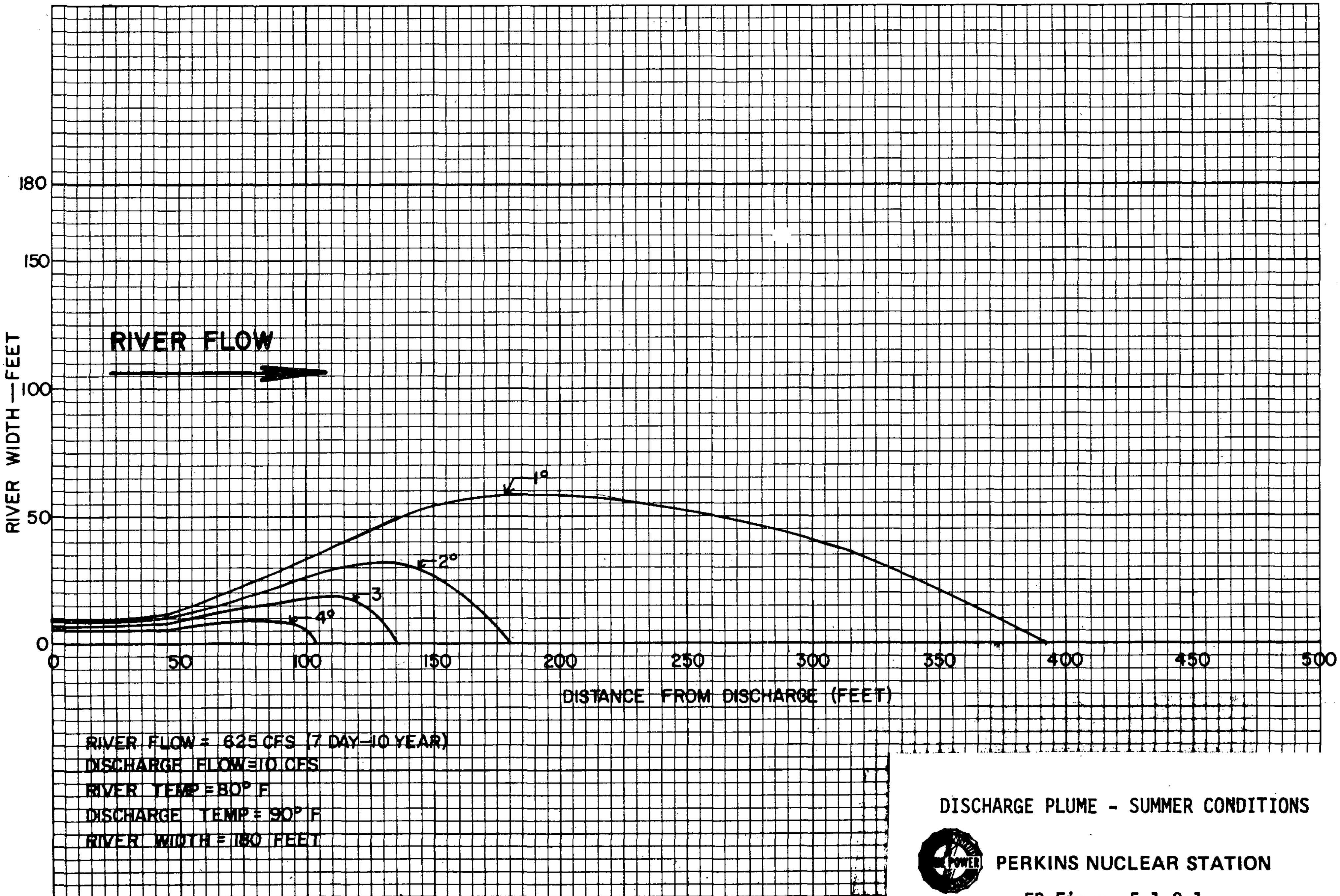
ER Table 5.8.2-1

Perkins Nuclear Station

Percent Of Yadkin River Flow AT
Yadkin College Gage Required For
Net Use of 110 CFS

2

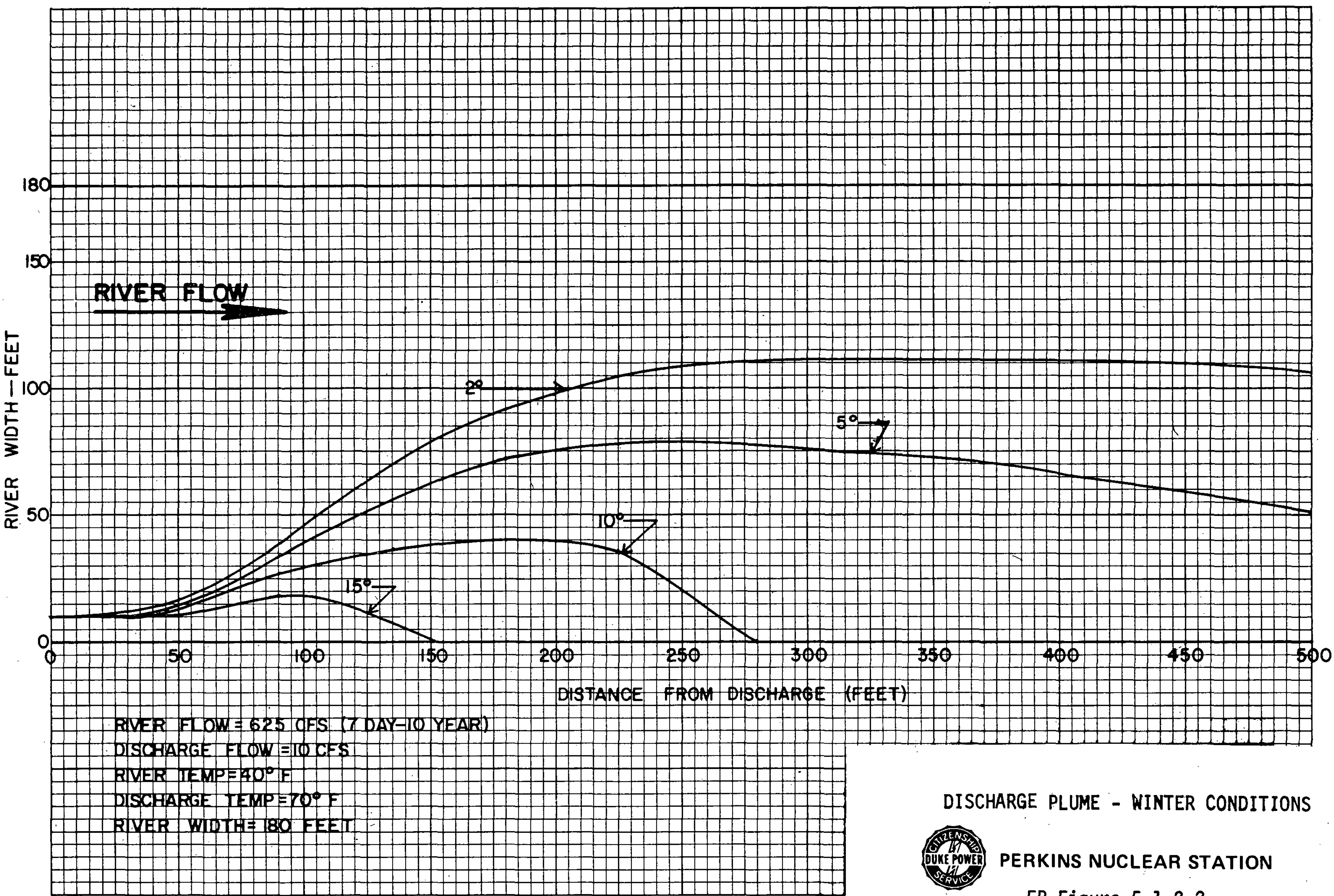
Flow Duration Frequency	Flow (CFS)	Plant Requirement (%)
1-Day, 10-Year Low	575	19
3-Day, 10-Year Low	585	18
7-Day, 10-Year Low	625	17
30-Day, 10-Year Low	1975	5
Average Annual	2850	3



DISCHARGE PLUME - SUMMER CONDITIONS

PERKINS NUCLEAR STATION

ER Figure 5.1.2-1

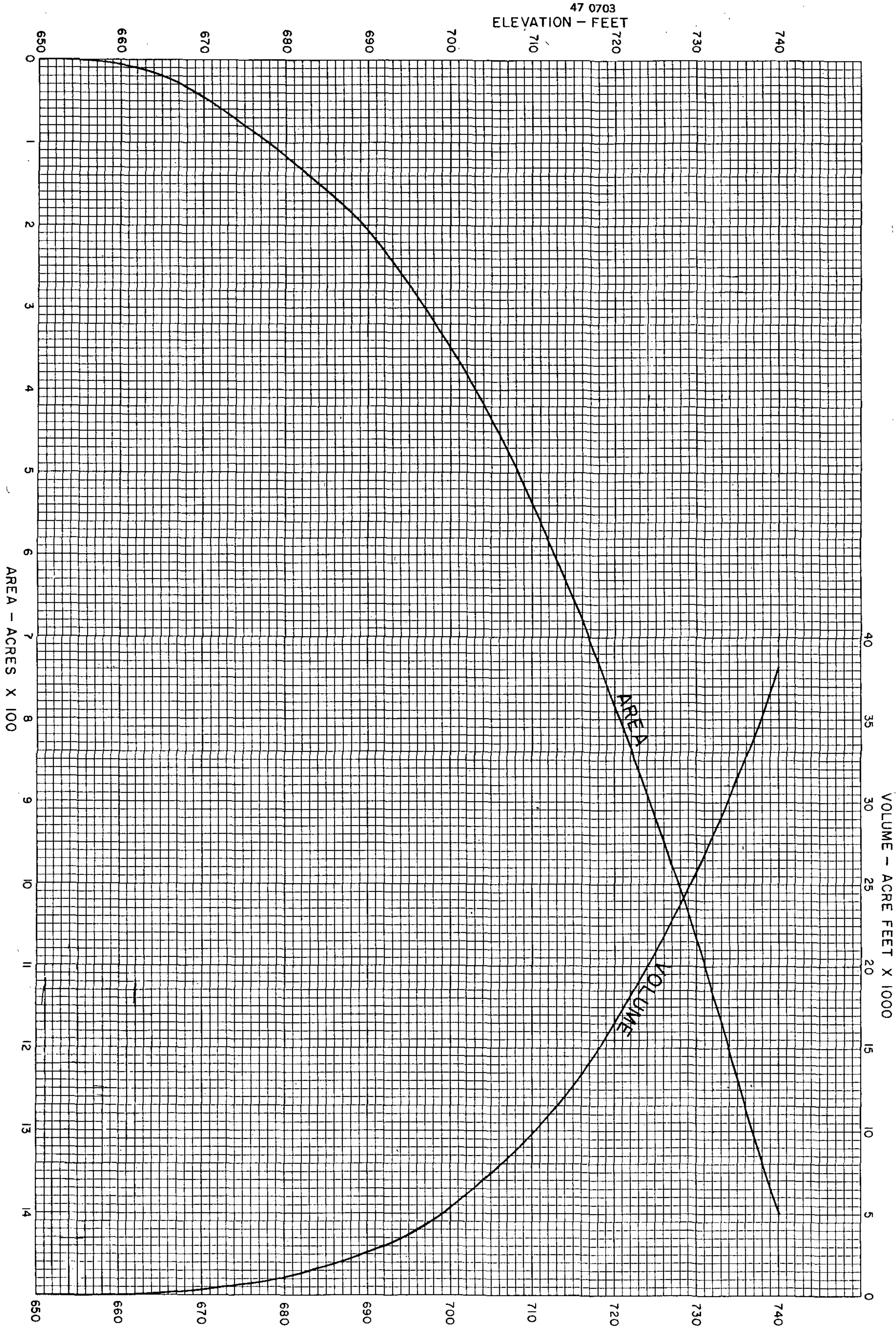


DISCHARGE PLUME - WINTER CONDITIONS

PERKINS NUCLEAR STATION

ER Figure 5.1.2-2

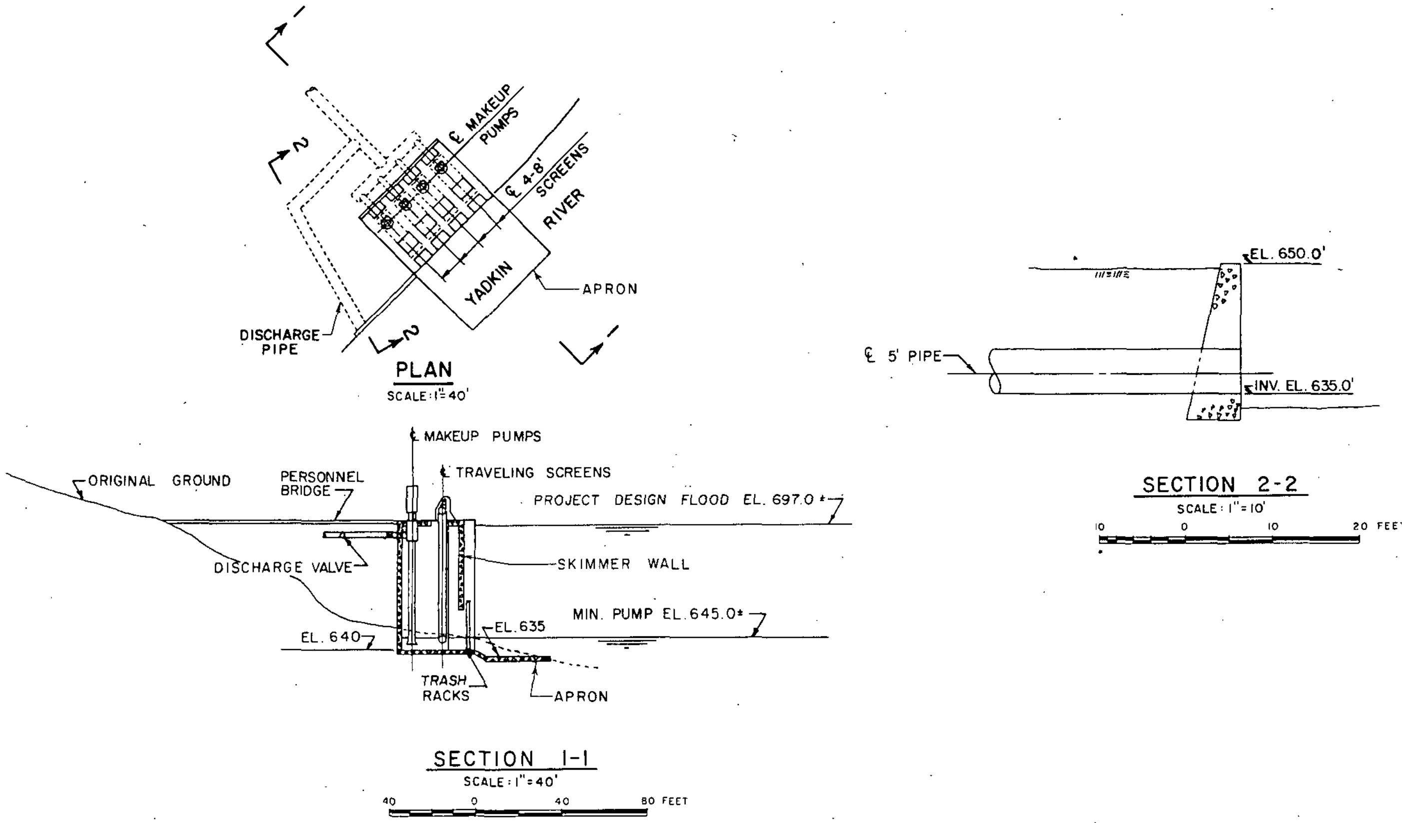
47 0703



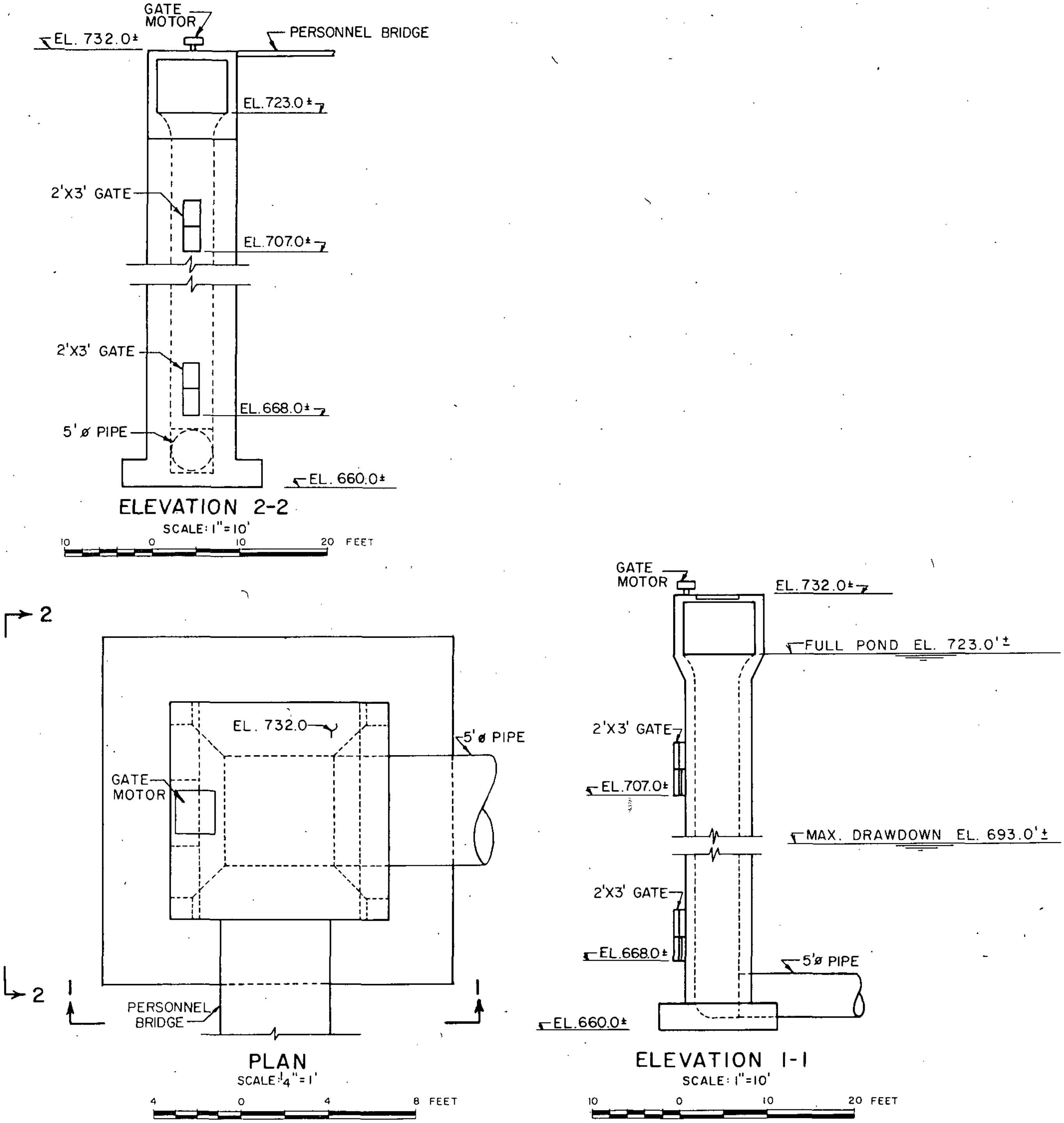
AREA CAPACITY CURVES
CARTER CREEK RESERVOIR

PERKINS NUCLEAR STATION

ER Figure 5.1.4-1
Amendment 3
(New)



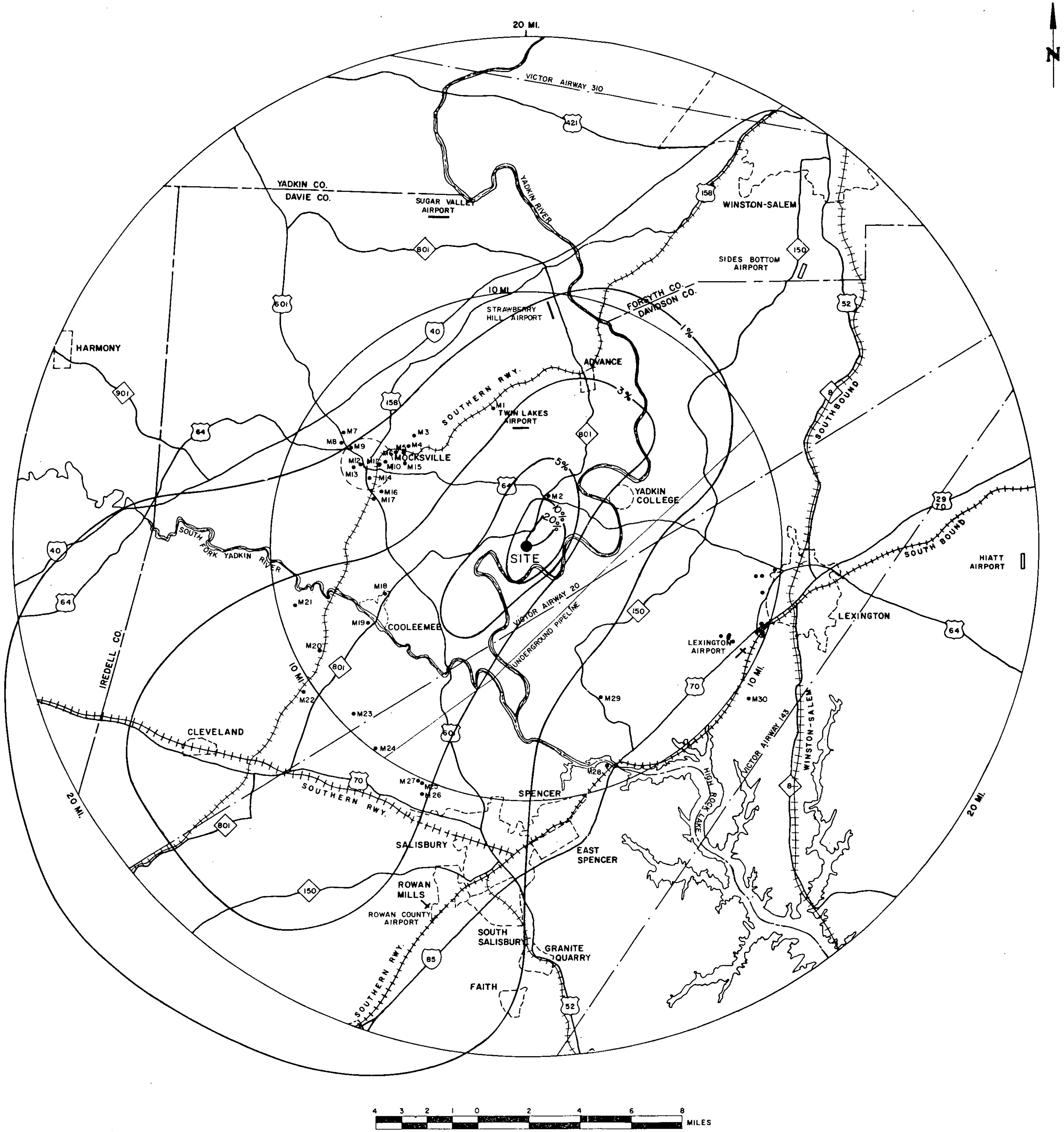
CARTER CREEK INTAKE
DISCHARGE STRUCTURE
PERKINS NUCLEAR STATION
ER Figure 5.1.4-2
Amendment 3
(New)



CARTER CREEK
DISCHARGE STRUCTURE

PERKINS NUCLEAR STATION

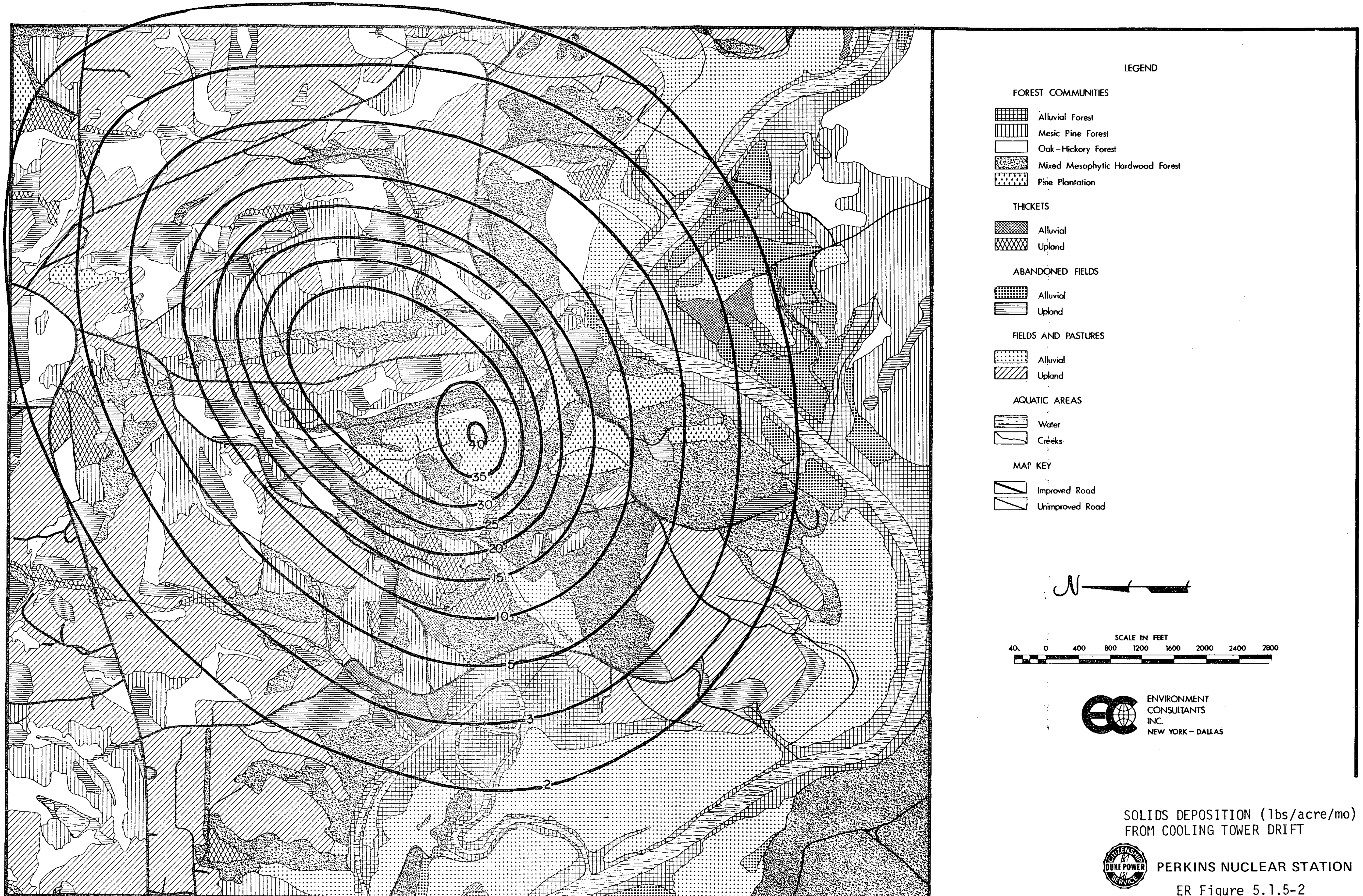
ER Figure 5.1.4-3
Amendment 3
(New)



VISIBLE PLUME LENGTH FREQUENCY

PERKINS NUCLEAR STATION

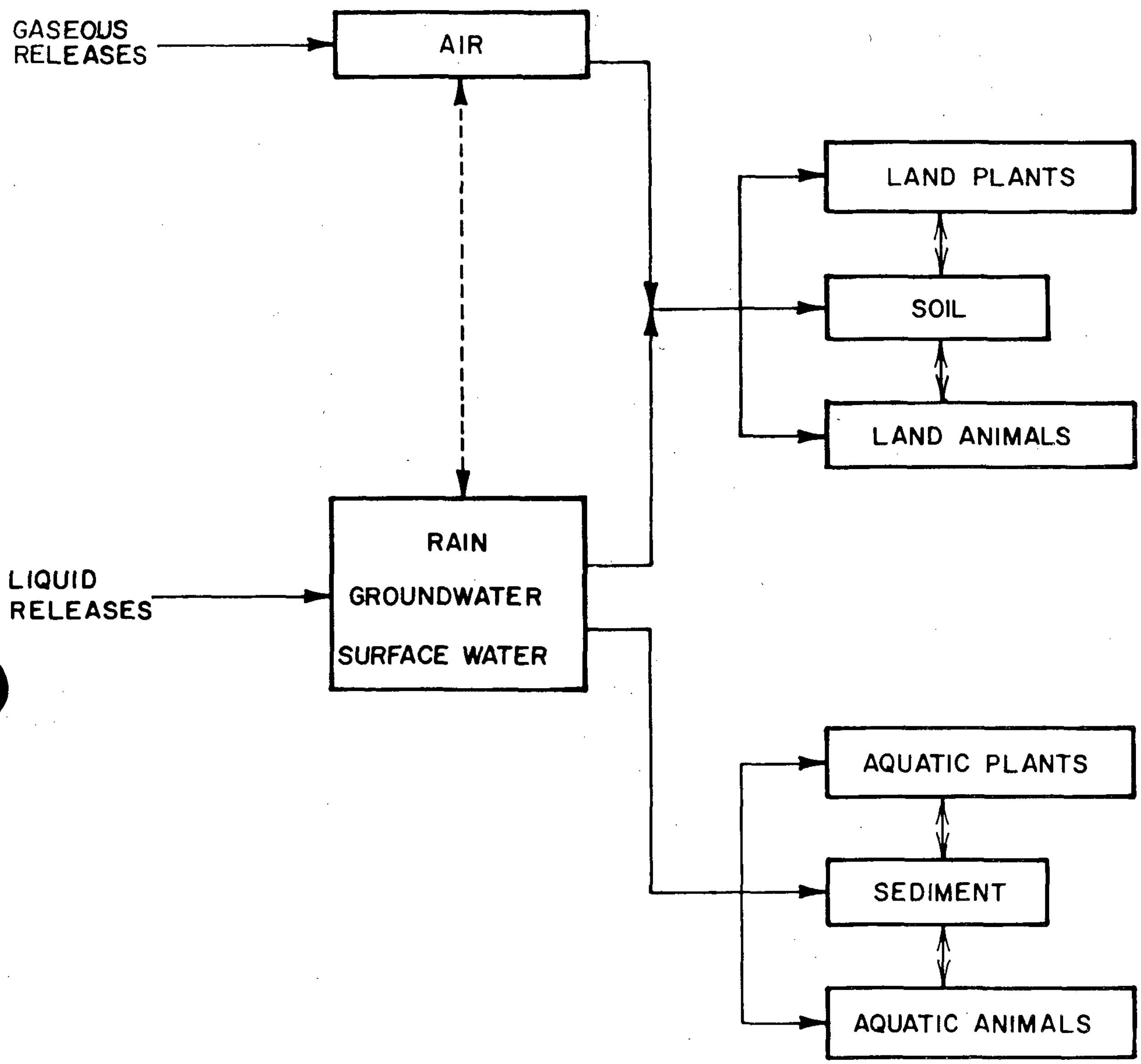
ER Figure 5.1.5-1
Amendment 2
(New)



SOLIDS DEPOSITION (lbs/acre/mo)
FROM COOLING TOWER DRIFT

PERKINS NUCLEAR STATION

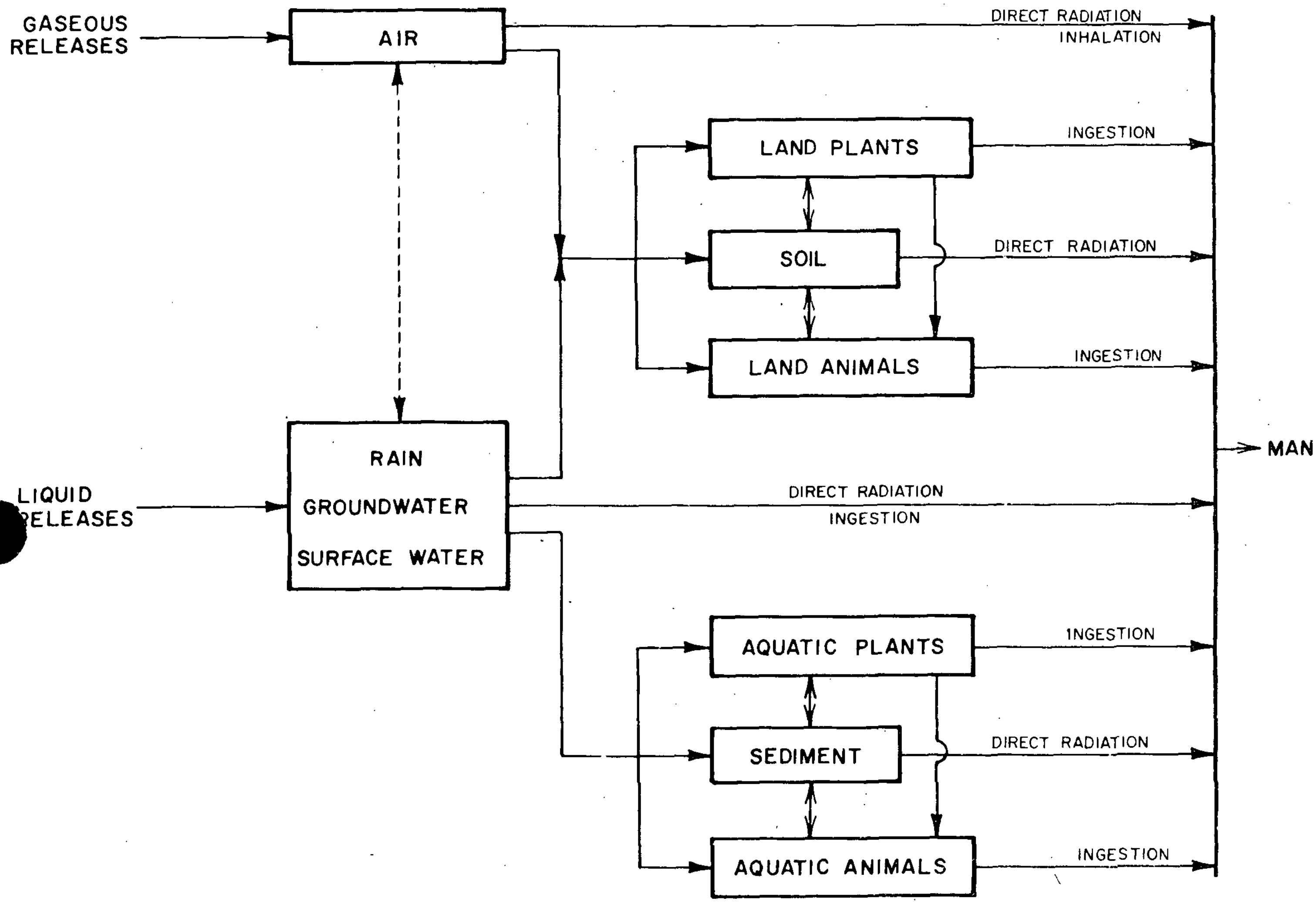
ER Figure 5.1.5-2
Amendment 2
(New)



EXPOSURE PATHWAYS TO BIOTA
OTHER THAN MAN

PERKINS NUCLEAR STATION

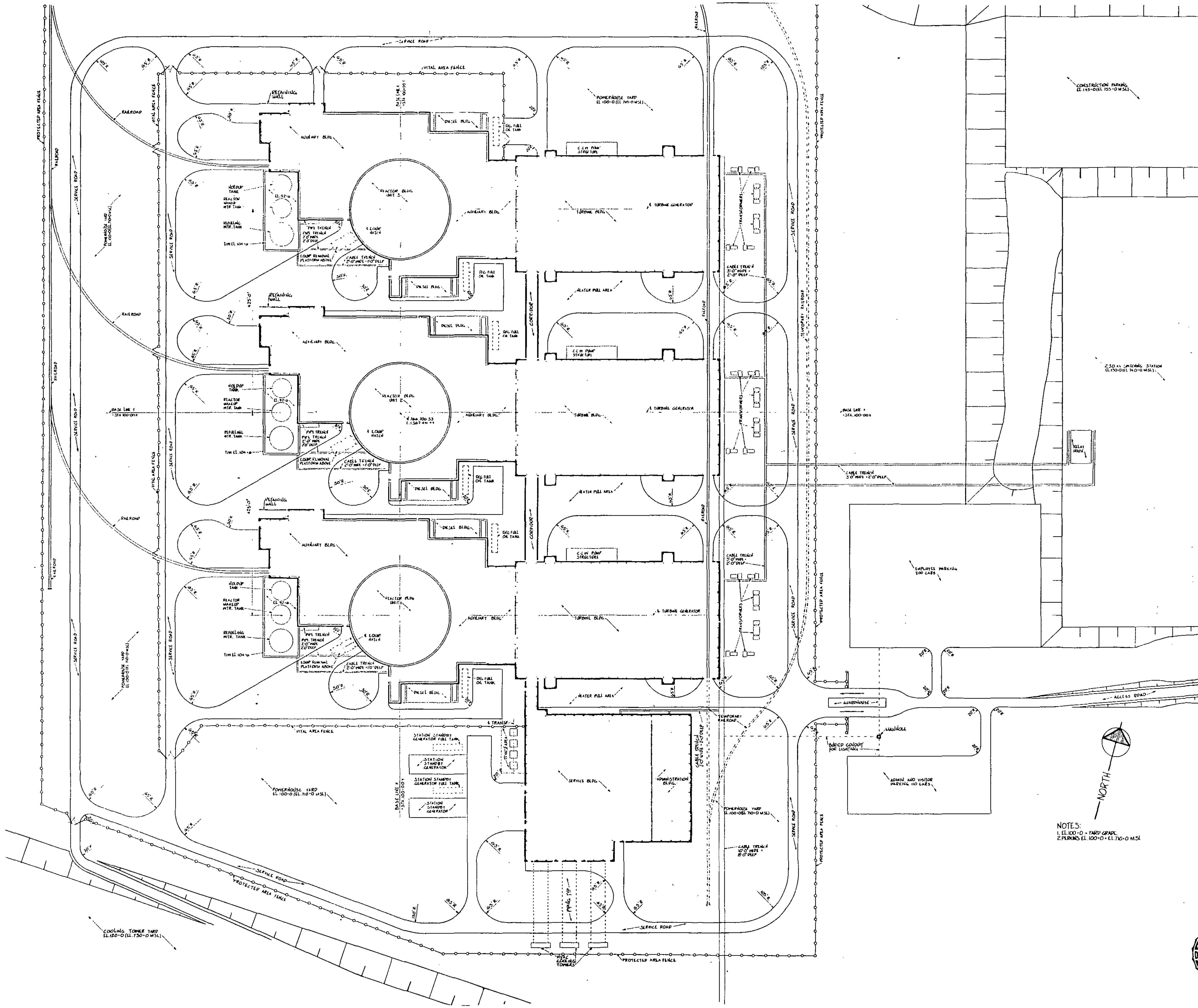
ER Figure 5.2.1-1
Amendment 1



EXPOSURE PATHWAY TO MAN

PERKINS NUCLEAR STATION

ER Figure 5.3.1-1



GENERAL ARRANGEMENT PLOT PLAN

PERKINS NUCLEAR STATION

ER Figure 5.3.4-1
Amendment 2
(New)

ATTACHMENT 5A

Calculational Models for Doses to Biota Other Than Man

This appendix provides methods for calculating the radiation doses to biota other than man resulting from the operation of a nuclear plant via the pathways presented in Section 5.2.1.

1. Water Submersion:

$$D_{\substack{\text{water}\\ \text{submersion}}} = 1 \times 10^9 \sum_{i=1}^{N} (C_{i,\text{water}})(DCSW_{i,o})(U_{cs})$$

where

$D_{\substack{\text{water}\\ \text{submersion}}}$ = The dose to an organism for submersion in water. $\frac{(\text{mrad})}{(\text{year})}$

1×10^9 = A conversion factor,

$\sum_{i=1}^{N}$ = The summation of the dose contributions from each of N isotopes.

$C_{i,\text{water}}$ = The average concentration in water for the i^{th} isotope. $\frac{(\mu\text{Ci})}{(\text{ml})}$

$DSCW_{i,o}^{(1)}$ = The dose factor for man for organ, o, (skin or whole body) and isotope, i, which converts isotope concentrations in water to dose rates from submersion in water. $\frac{(\text{mrad/hr})}{(\text{pC/l})}$

U_{cs} = The period of time that the organism is assumed to be submerged in water. $\frac{(\text{hr})}{(\text{yr})}$

2. Exposure to Sediment:

$$D_{sediment} = \sum_{i=1}^{N} (C_{i,sed})(DCS_{i,o})(U_{csed})$$

where

$D_{sediment}$ = The dose to an organism from exposure to sediment. $\frac{(mrad)}{(yr)}$

$C_{i,sed}$ = The concentration in sediment for the i^{th} isotope. $\frac{(pC)}{(M^2)}$

$DCS_{i,o}^{(1)}$ = The dose factor for man for organ, o, (skin or whole body) and isotope, i, which converts isotope concentrations on a smooth sediment surface to a dose rate at one meter above the surface. $\frac{(mrad/hr)}{(pCi/m^2)}$

U_{csed} = The period of time that the organism is assumed to be exposed to the sediment. $\frac{(hr)}{(yr)}$

Other terms are previously defined.

3. Water Assimilation by Primary Organisms

$$D_{b,r} = 1.87 \times 10^7 \sum_{i=1}^{N} (C_{i,water})(B_{i,b})(E_{i,r})$$

where

$D_{b,r}$ = The dose to primary organism, b, (e.g. fish, algae, invertebrates) of effective radius, r, from water assimilation. $\frac{(mrad)}{(year)}$

1.87×10^7 = A factor which converts specific body burden (μC/gm) and effective absorbed energy (Mev/dis) to dose rate. $\frac{(\text{dis-gm-mrad})}{(\mu\text{C-yr-Mev})}$

$B_{i,b}$ = The bioaccumulation factor for organism, b, for the i^{th} isotope in fresh water. $\frac{(\mu C/gm)\ \text{organism}}{(\mu C/ml)\ \text{water}}$

$E_{i,r}$ = The effective absorbed energy for an organism of effective radius, r, from decay of the i^{th} isotope. $\frac{(\text{MeV})}{(\text{dis})}$

Other terms are previously defined.

4. Ingestion dose to secondary (predator) organism:

$$D_{s,r,b} = 2.69 \times 10^7 \sum_{i=1}^{N} (C_{i,water})(B_{i,b})(T_i)(f_i)(E_{i,r,s,})(G_b)/M_s$$

where

$D_{s,r,b}$ = The equilibrium annual dose to predator organisms, s, (e.g. duck) of effective radius, r, from eating primary organisms, b. $\frac{(\text{mrad})}{(\text{year})}$

2.69×10^7 = A constant which multiplies the inverse of ln(2) and the factors which convert specific body burden (μC/gm) and effective absorbed energy (Mev/dis) to dose rate. $\frac{(\text{dis-gm-mrad})}{(\mu\text{C-yr-Mev})}$

T_i = Effective half-life (includes radiological and biological) of the i^{th} isotope for the whole body of standard man. (day)

f_i = The fraction of ingested isotope, i, retained by the whole body of standard man.

G_b = The rate of ingestion of primary organism, b, by the secondary organism. $\frac{(\text{gm})}{(\text{day})}$

M_s = The mass of secondary organism, s. (gram)

Other terms are previously defined.

5. Cow Thyroid Dose From Air Immersion:

$$D_{cow} = (1.87 \times 10^{13})\ (C_{air})\ (AMF)\ (MTF)\ (\bar{E})$$

D_{cow} = The annual dose to a cow's thyroid from ingesting fodder contaminated from I-131. $\frac{(mrad)}{(year)}$

1.87×10^{13} = A constant which converts the cow thyroid specific burden (pCi/gm) and effective absorbed energy (Mev/dis) to dose rate. $\frac{(dis\text{-}g\text{-}mrad)}{(Ci\text{-}yr\text{-}Mev)}$

C_{air} = The annual average I-131 concentration in air. $\frac{(\mu Ci)}{(ml)}$

AMF = Regulatory Guide 1.42 air to milk I-131 transfer coefficient. $\frac{(ci/l)\ \text{milk}}{(\mu Ci/ml)\ \text{air}}$

MTF = A cow milk to cow thyroid correlation. $\frac{(pCi/gm)\ \text{thyroid}}{(pCi/l)\ \text{milk}}$

$\bar{E}$ = The effective absorbed energy in the cow's thyroid from decay of I-131. $\frac{(MeV)}{(dis)}$

ATTACHMENT 5B

Calculational Models for Doses to Man

This appendix describes the models used for calculating the radiation doses to an individual resulting from the operation of a nuclear plant via the pathways presented in Section 5.3.1.

1. <u>Air Submersion Skin Doses:</u>

$$D_{\text{skin, air submersion}} = 3.16 \times 10^{10} \sum_{i=1} \left[(0.23\bar{E}_{\beta_i} + 0.25\bar{E}_{\gamma_i}) \times C_{i,\text{ air}} \right]$$

where

$D_{\text{skin, air submersion}}$ = The maximum annual skin dose received by an individual from submersion. $\frac{(\text{mrem})}{(\text{year})}$

3.16×10^{10} = A conversion factor from seconds to years and from rem to millirem. $\frac{(\text{sec-mrem})}{(\text{year-rem})}$

$\sum_{i=1}^{N}$ = The summation of the dose contribution from each isotope

i = the ith isotope

N = the total number of isotopes considered

0.23 = A conversion factor for the expression of the surface body dose from beta emitters in an infinite cloud. This constant takes into consideration the density of air as well as the conversion from Mev to Rem. $\frac{(\text{dis-m}^3\text{-rem})}{(\text{Mev-sec-Ci})}$

$\bar{E}_{\beta_i}$ = The average beta energy per disintergration $\frac{(\text{MeV})}{(\text{dis})}$

0.25 = A conversion factor for the expression of the tissue dose from submersion, in a semispherical, infinite cloud of gamma emitters. This constant takes into consideration the density of air, the conversion from Mev to Rem as well as the difference between the electron densities of tissue and air. $\frac{(\text{dis-m}^3\text{-rem})}{(\text{Mev-sec-Ci})}$

$\bar{E}_{\gamma_i}$ = The average gamma energy per disintegration $\frac{(\text{Mev})}{(\text{dis})}$

$C_{i,air}$ = The concentration in air of the i^{th} isotope $\frac{(\mu\text{Ci})}{(\text{ml})}$

2. Air Submersion Whole-Body Doses:

$$D_{\substack{\text{whole body}\\ \text{air submersion}}} = \sum_{i=1}^{N}\left[3.16 \times 10^{10} \; X \; 0.23\bar{E}_{\gamma_i} \times C_{i,\,air}\right]$$

where

$D_{\text{whole-body, air submersion}}$ = The maximum annual whole body dose received by an individual from submersion. $\frac{(\text{mrem})}{(\text{year})}$

Other terms are previously defined.

3. Air Inhalation Doses:

$$D_{o,\,\text{inhalation}} = 5\text{x}10^4\sum_{i=1}^{N}\left[(C_{i,air})(MPD_o)/(MPC_{i,o})\right]$$

where

$D_{o,\,\text{inhalation}}$ = The maximum annual dose to organ, o, received by an individual from inhalation. $\frac{(\text{mrem})}{(\text{year})}$

5×10^4 = A conversion factor for occupational weeks in one year and from rem to millirem. $\frac{\text{(Weeks-mrem)}}{\text{(year-rem)}}$

$MPC_{i,0}$ = The International Commission on Radiological Protection (ICRP) maximum permissible concentration in air for continuous exposure of organ, o, to isotope, i. $\frac{(\mu Ci)}{(ML)}$

MPD_o = The ICRP maximum permissible dose rate for organ, o. $\frac{\text{(rem)}}{\text{(week)}}$

Other terms are previously defined.

4. Milk Ingestion -1 year old child:

$$D_{milk} = \sum_{i=1}^{2} \left[(C_{i,air})(DCF_i) \right]$$

where

D_{milk} = The maximum annual thyroid dose to a 1 year old child resulting from milk ingestion. $\frac{\text{(mrem)}}{\text{(year)}}$

$\sum_{i=1}^{2}$ = The summation of the dose contributions from I-131 and I-133

$DCF_{i,m}$ = The thyroid dose conversion factor from milk ingestion for isotope, i, from Regulatory Guide 1.42 (rev. 1, March 1974). $\frac{\text{(mrem/year)}}{(\mu Ci/ML)}$

Others terms previously defined.

5. Vegetable Ingestion Doses:

$$D_{veg} = \sum_{i=1}^{2} \left[(C_{i,air})(DCF_{i,v}) \right]$$

where

D_{veg} = The maximum annual thyroid dose to an adult individual resulting from vegetable ingestion. $\frac{(mrem)}{(year)}$

$DCF_{i,v}$ = The thyroid dose conversion factor from vegetable ingestion for isotope, i, from Regulatory Guide 1.42, (Rev.1, March 1974) $\frac{(mrem)}{(\mu Ci/ml)}$

Other terms are previously defined.

6. Water Ingestion Doses:

$$D_{o,\ water\ ingestion} = 5\times10^{4} \sum_{i=1}^{N} \left[(C_{i,water})(MPD_{o})/(MPCW_{i,o}) \right]$$

where

$D_{o,\ water\ ingestion}$ = The maximum annual dose to organ, o, received by an individual from drinking water. $\frac{(mrem)}{(year)}$

$C_{i,water}$ = The annual average concentration in water for the i^{th} isotope. $\frac{(\mu Ci)}{(ML)}$

$MPCW_{i,o}$ = The ICRP maximum permissible concentration in water for continuous exposure of organ, o, to isotope i. $\frac{(\mu Ci)}{(ml)}$

Other terms are previously defined.

7. <u>Fish Ingestion Doses:</u>

$$D_{o,\text{fish ingestion}} = 1.37 \times 10^5 \frac{Uf}{Uw} \sum_{i=1}^{N} \left[(C_{i,water})(MPD_o)(B_i)/(MPCW_{i,o})\right]$$

where

$D_{o,\text{fish ingestion}}$ = The annual dose to organ, o, received by an individual from eating fish. $\frac{(mrem)}{(year)}$

1.37×10^5 = A factor which accounts for occupational weeks in one year and converts the water usage factor to an annual factor and converts kilograms to grams and rem to millirem. $\frac{(gm\text{-}mrem\text{-}week)}{(kg\text{-}rem\text{-}day)}$

B_i = The bioaccumulation factor of fish for the i^{th} isotope in fresh water.

U_w = The ICRP water ingestion rate assumed for standard man. $\frac{(ml)}{(day)}$

U_f = The fish ingestion rate for an individual. $\frac{(kg)}{(year)}$

8. <u>Swimming</u>

$$D_{o,\text{ swimming}} = 1 \times 10^9 \sum_{i=1}^{N} \left[(C_{i,water})(DCSW_{i,o})(U_{sw})\right]$$

where

$D_{o,\text{ swimming}}$ = The annual dose to organ, o,(skin or whole-body) from swimming. $\frac{(mrem)}{(year)}$

1×10^9 = A conversion factor $\frac{(\mu Ci/ml)}{(pCi/l)}$

$DCSW^{(1)}_{i,o}$ = The dose rate factor for organ, o, and isotope, i, which converts isotope concentrations in water to dose rates from submersion in water. $\frac{(mrem/hr)}{(pCi/l)}$

U_{sw} = The period of time that an individual is assumed to spend swimming. $\frac{(hr)}{(yr)}$

Other terms are previously defined.

9. Boating:

$$D_{o,\ boating} = 1 \times 10^9 \sum_{i=1}^{N} \left[(C_{i,water})(DCB_{i,o})(U_b) \right]$$

where

$D_{o,boating}$ = The annual dose to organ, o, (skin or whole body) From boating. $\frac{(mrem)}{(year)}$

$DCB_{i,o}$ = $\frac{1}{2}$ ($DCSW_{i,o}$), since boating is on the water's surface. $\frac{(mrem/hr)}{(pCi/l)}$

U_b = The period of time an individual is assumed to spend boating. $\frac{(hr)}{(yr)}$

10. Shoreline:

$$D_{o,shoreline} = \sum_{i=1}^{N} \left[(C_{i,sed})(DCS_{i,o})(U_{sed}) \right]$$

where

$D_{o,shoreline}$ = The annual dose to organ, o, (skin or whole body) from shoreline activity. $\frac{(mrem)}{(year)}$

$C_{i,sed}$ = The concentration of the i^{th} isotope in sediment. $\frac{(pCi)}{(M2)}$

$DCS^{(1)}_{i,o}$ = The dose factor for organ, o, and isotope , i, which converts isotope concentrations on a smooth sediment surface to a dose rate at one meter above the surface. $\frac{(mrem/hr)}{(pCi/M^2)}$

U_{sed} = The period of time that an individual is assumed to spend annually engaged in shoreline activities. $\frac{(hr)}{(yr)}$

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6.0 EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAM

The purpose of this Chapter is to describe in detail the means by which Duke Power Company obtains its baseline data previously presented and Duke's plans and programs for monitoring pertinent environmental parameters in order to evaluate the environmental impacts of site preparation, station construction, station operation, and station maintenance.

Section 6.1 is addressed to the measurement of "pre-existing" characteristics of the site and surrounding region. In this context, "pre-existing" refers to the preoperational state of the site. Section 6.2 deals with specific programs for monitoring environmental parameters which produce the data needed for reasonable estimates of the environmental impact caused by station operation.

2 Q 6.3.1

2

6.1 APPLICANT'S PRE-OPERATIONAL ENVIRONMENTAL PROGRAMS

A one year baseline ecological study of the plant site and of the Yadkin River System contiguous to it was begun in September, 1973, with preliminary sampling. The following month a full scale sampling program was implemented. The purpose of the initial program was to identify the physical, chemical and biological variables which were likely to affect, or be affected by, the construction or operation of the proposed nuclear facility.

6.1.1 SURFACE WATERS

The routine aquatic sampling program established in the fall of 1973 is presented in Table 6.1.1-1. Biological and water quality sampling were conducted every four weeks throughout the year, providing data for thirteen sampling periods. Additional water quality measurements were made on alternating two week periods according to the schedule presented in Table 6.1.1-2. Table 6.1.1-3 is a breakdown of the sampling year, showing the dates of both full and short schedule operations. This program is referred to as the Year I study.

The entire program was reviewed in April, 1973, and the number of stations reduced so that most of the effort would be spent in the site area. Two additional stations (28, 29) were established for benthos. These revisions are presented in Table 6.1.1-4. The sampling stations are described in Subdivision 6.1.1.1.

In August and September, 1974, a second, supplementary sampling program was established by Duke Power Company's Environmental Sciences Unit. The stations sampled are described in Subdivision 6.1.1.2. This program is referred to as the Year II study.

6.1.1.1 Sampling Stations: Year I

Twenty-seven sampling stations were established on the Yadkin River System, from the Idols Hydro Station, some 32 river kilometers (20 river miles) above the site, to the NC Hwy 24 crossing on the Pee Dee River, about 72 km (45 miles) below it. Monthly, and in some instances bimonthly, samples were taken in accordance with the schedules outlined in Tables 6.1.1-1 and 6.1.1-2. In addition, four stations were established exclusively for fish inventory. The text which follows characterizes each station at normal to low flow conditions.
2 Station locations are plotted in Figures 6.1.1-1 and 6.1.1-2. Q 6.1.5

Station 1 is located just below the outfall of the dam at the Idols Hydro Station on the Yadkin River. The current is strong, and the bottom has been scoured to rock and sandy gravel. The river here is roughly 50 m wide and 1-2 m deep. Both banks are sparsely forested and show a sharp drop of about 1 m to the water surface.

Station 2 is located on Muddy Creek at the NC 1485 bridge. The creek is roughly 12-14 m wide and 1-2 m deep. The current is slight to moderate over a bottom of sandy-loam. This station is strongly influenced by discharges from municipal and industrial facilities in Winston-Salem.

Station 3 is on Site Creek No. 2, a small stream roughly 3 m wide and less than 0.5 m deep which drains the southern and eastern portions of the exclusion area.

County Road 1814 crosses just below the site. The bottom is an irregular patchwork of riffles and shallow pools. The sediment is mostly hard packed sand; current is weak. Aquatic macrophytes grow along the banks.

Station 4 is located on the Yadkin at the bridge on US 64. Here the river is approximately 55 m wide. Just below the site it splits into two channels to flow around a small island. At the head of this island the bottom is characterized by gravelly riffles. On either side there are pools as deep as 2 m. Current is moderate.

Station 5 is located on a small creek (Site Creek No. 1) which drains the northwestern quadrat of the exclusion area and which feeds into Dutchman Creek. Samples are taken just above the bridge crossing of County Road 1814. Here the creek is about 3 m wide and 0.1-0.3 m deep, with a weak current flowing over a hard packed sand bottom. The banks are sparsely forested, although stumps and fallen logs are found in the water.

Station 6 is located on Dutchman Creek immediately downstream from its confluence with Site Creek No. 1. The stream at this point is roughly 12 m wide and 0.5-2 m deep. The creek bed is a sandy loam; current is moderate. Both banks are forested, and submerged logs and brush piles line the water's edge.

Station 7 is located on the Yadkin River about 50 m upstream from the North Carolina Wildlife Resources Commission Landing off NC 801. Here the river is approximately 55 m wide, with a maximum depth of 4 m. Both banks are forested to the shoreline, which drops sharply 1-2 m to the water surface. A moderate to strong current carries a high sediment load over a bottom of coarse sand.

Station 8 is on the Yadkin River just above its confluence with the South Yadkin and about 75 m upstream from the Salisbury pumping station intake. Here the river is about 70 m wide and up to 2 m deep. The current is swift and flows over a coarse sand bottom. Both banks are forested and drop sharply 1 m or so to the river surface.

Station 9 is on the South Yadkin River about 75 m upstream from its confluence with the Yadkin. Here the South Yadkin is about 50 m wide. Current is slow to moderate. Both banks are low, sloping, and heavily forested. The bottom is a mixture of sand, silt, and clay enriched with organic matter from the banks and a swamp some 8 km upstream.

Station 10 is located about 200 m below the mouth of Grant's Creek on High Rock Lake. Although the bottom is coarse sand, the current is slack. Both banks are forested, but differ in that the west slopes gradually to the shoreline while the east drops sharply a meter or so.

Station 11 is on the west bank of Abbott Creek, a tributary of High Rock Lake, at the gaging station near Lexington (on East Center Street). Here the creek is a fast-moving, rocky stream with abundant pools and riffles. At this station the creek is 8-10 m wide with an average depth of 0.5 m in the riffles. The east bank is sparsely wooded; the west bank is part of a residential section.

Station 12 is on the Yadkin River just below I-85 and directly beneath a utility crossing. The bottom is in a zone of transition between sand (upstream) and loam (downstream). Water depth is 3-4 m and current is moderate. The east bank is wooded, while on the west bank the North Carolina Finishing Company, a branch of Fieldcrest Mills, discharges its effluent just upstream of the site.

Station 13 is on the Yadkin just below the discharge from Duke Power Company's Buck Steam Station. Here the river is about 125 m wide, and has a maximum depth of about 5 m. A moderate to strong current flows over a bottom of sandy loam. Both banks slope gently and are lined with willows.

Station 14 lies just below the confluences of North and South Potts Creek and the Yadkin River, at a point where they are becoming High Rock Lake. Current here is strong. The bottom is a mixture of sandy loam and organic debris. Both banks slope gently to the water.

Station 15 is on High Rock Lake opposite Trading Ford Church. This is the first of the lake stations. The river here is nearly 400 m wide, current is negligible, and the sediment load has begun to settle out. The shoreline is characterized by several small coves and inlets.

Station 16 is located at the NC 8 bridge over Swearing Creek, approximately 1 km above where it becomes High Rock Lake. The creek is about 100 m wide and about 5 m deep. The water is normally clear and there is no appreciable current. Both banks are lined with houses.

Station 17 is on High Rock Lake near the mouth of Crane Creek. Here the lake is about 800 m wide and reaches a depth of about 4 m. Houses are on both banks, and the bottom is fine silty sand mixed with organic debris.

Station 18 is on Crane Creek at the Goodman Road Bridge. Here the creek is about 60 m wide and 3 m deep. The substrate is a fine loam mixed with organic debris. Both banks are forested and slope gradually to the water. The Salisbury Sewage Disposal Plant pumps its effluent into the creek about 7 km above the site, and this station was selected to monitor the effects of that discharge on High Rock Lake.

Station 19 is located on South Second Creek where it is crossed by Bringle Ferry Road. The creek here is approximately 50-60 m wide and 4 m deep. Both banks slope gradually to the river and are lined with homes and boat ramps.

Station 20 is on Abbott Creek at the NC 8 bridge. Abbott Creek is the largest arm of High Rock Lake, and at this site is approximately 800 m wide and 7 m deep. The bottom is a fine loam. Both banks are wooded.

Station 21 is on High Rock Lake near the mouth of Abbott Creek. Here the lake is approximately 1000 m wide and 12 m deep. The water is clear except after heavy rains. The bottom is a fine loam.

Station 22 is located on High Rock Lake near the mouth of Flat Swamp Creek, approximately 200 m above the dam. Here the lake is about 500 m wide and 15 m deep. The bottom is a fine loam. Both banks are wooded and there are many large boulders along the shoreline.

Station 23 is on Flat Swamp Creek above the NC 8 bridge. The creek here is about 70 m wide and 5 m deep. The bottom is a silty loam which contains a considerable amount of organic debris. Both banks are covered with pine trees; there are several cabins on the east side.

Station 24 is on the Yadkin River below High Rock Dam. Water samples are taken from the Bringle Ferry Road Bridge while biological samples are taken at the North Carolina Wildlife Resource Commission boat landing, which is on the right bank downstream of the dam. Here the river is about 1000 m wide and has a maximum depth of 3 m. The current is moderately strong and flows over a sand bottom. Both banks are forested; there are no houses visible on either side.

Station 25 is on the Yadkin River at the NC 49 bridge. The river has widened to about 1000 m as it becomes the Tuckertown Reservoir. The water here is 6-8 m deep, there is little current.

Station 26 is on the Pee Dee River as it becomes Lake Tillery at the NC 24 bridge below Morrow Mountain State Park. The river here is approximately 1000 m wide. The bottom is uneven and there is little current. The banks are steep and heavily wooded.

Station 27 is on the Yadkin River just upstream from the proposed plant intake. Here the river is about 60 m wide and about 3 m deep. The current is swift and the water carries a high sediment load. The bottom is coarse sand. Both banks are steep and heavily wooded.

Stations 28 and 29 were added for the sampling of benthos from May through September, 1974. They are located about 100 m above and below the mouth of Dutchman Creek, respectively. Their characteristics are approximately the same as those for Stations 27 and 7.

Fish Inventory Station I-3 is located on Flat Swamp Creek at the Highway 47 crossing, where it begins to broaden into a main arm of High Rock Lake. The bottom is rocky, ranging from gravel to large layered sheets jutting from the bottom. At this station the creek is about 6 m wide and averages less than 0.3 m in depth. The stream remains relatively clear, even after heavy rains.

Fish Inventory Station I-4 is on Panther Creek where it is crossed by Bringle Ferry Road. Here the creek is about 10 m wide, but less than 0.5 m deep. The bottom is primarily a patch work of large rocks and mud. Both banks are wooded and numerous fallen trees, stumps, and submerged logs are present.

6.1.1.2. Sampling Stations: Year II

Fourteen sampling stations have been established on the Yadkin River System for the second year study. Although fewer stations are being sampled they are in closer proximity to the proposed plant and are sampled more intensively than during the first year. The stations are numbered according to an established Duke Power Company format that facilitates data storage and retrieval. The following text relates the Year II stations to those sampled during Year I, and characterizes new stations. The station descriptions apply to the river during late summer, low flow conditions. Station locations are plotted in Figures 6.1.1-1 and 6.1.1-2. In the decimal notation of stations, the digits to the left of the decimal denote the sampling area, and the digits to the right denote sampling strategy. Thus XXX.0 is a sample from mid-stream at sampling location XXX, XXX.1 is from near the left bank, XXX.2 from near the right bank, and XXX.3 is a composite.

Station 427 corresponds to Station 11 of the Year I program and is described in Subdivision 6.1.1.1.

Station 430 corresponds to Station 13 of the Year I program and is described in Subdivision 6.1.1.1.

Station 432 corresponds to Station 12 of the Year I program and is described in Subdivision 6.1.1.1.

Station 434 corresponds to Station 8 of the Year I program and is described in Subdivision 6.1.1.1.

Station 435 is on the Yadkin River 300 m above the mouth of Reedy Creek. The river at this point is approximately 50 m wide with a sandy substrate. A rock outcrop is present on the left bank; the right bank is forested.

Station 436 corresponds to Station 7 of the Year I program and is described in Subdivision 6.1.1.1.

Station 438 is on Dutchman Creek 40 m upstream from its confluence with the Yadkin River. At low flow Dutchman Creek is approximately 5-10 m wide at this point and both banks drop sharply about 2 m to the water surface. The bottom is composed of coarse sand.

Station 440 is on the Yadkin River immediately above the confluence of Dutchman Creek. The depth is less than 2 m and the substrate varies from sand in mid-channel to fine silt near the banks. Both banks drop sharply to the water surface.

Station 442 is on the Yadkin River immediately below the proposed discharge of Perkins. This station is located approximately 50 m below the head of a well-defined riffle where the water depth is less than 1 m and the substrate in mid-channel is bedrock. Near the banks the substrate is composed of sandy silt.

Station 444 is on the Yadkin River approximately 50 m upstream from the proposed plant intake. Here the river is approximately 60 m wide and about 2 m deep. This station is slightly upstream of Station 27 of the Year I study.

Station 445 is located in the riffle area on the Yadkin River 200 m above the proposed intake. The river is about 60 m wide, less than 1 m deep, and has a rocky substrate.

Station 446 is on the Yadkin River approximately 50 m downstream of the riffle below the confluence of Gobble Creek. At this point the river is approximately 40 m wide, 1.5 m deep, and has a sandy substrate and moderate current.

Station 447 is on Carter Creek, which enters on the right bank of the Yadkin
3 River approximately nine river miles upstream of the proposed location of the Perkins Intake Structure. Monthly sampling for fish, benthos and water quality measurements was begun here in January, 1975. There are two sub-stations. Station 447.0 is located just downstream of the Highway 801 crossing,

approximately 200 yards from the Yadkin River. At this point the creek is 15-20 feet wide, with an estimated average flow of about 10 cfs. Just below the crossing there is a riffle area created by rock dumped in the creek when the old 801 bridge was dismantled. Below this riffle there is a mid-channel sand bar, approximated 50 ft long. From there to the Yadkin mid-channel depth varies from 2-4 feet over a sand and silty sand bottom.
3 Both banks are steep, but cattle can reach the creek in the vicinity of the bridge; evidence of their presence (feces and hoofmarks) is extensive both upstream and downstream of that point. The second substation (447.5) is located just downstream of the State Road 1617 crossing, approximately 2 miles above 447.0. Here the creek is about 6-8 feet wide and has a mid-channel depth of 1-2 feet. The banks drop sharply to the waters edge, and are cluttered with brush and fallen branches. The bottom is hard-packed sand.

Station 448 corresponds to Station 2 of the Year I program and is described in Subdivision 6.1.1.1.

Station 449 corresponds to Station 1 of the Year I program and is described in Subdivision 6.1.1.1.

Table 6.1.1-5 is a listing of the field operations schedule for water quality and biological sampling for Year II. All samples taken at each station, as well as sampling frequency, are indicated in the appropriate column, as are collection methods for benthos and fish. Conditions permitting, all monthly samples are collected during the first full week of each month.

6.1.1.3 Hydrological Methodology

6.1.1.3.1 Bedform Survey

Bedform surveys were made prior to selection of sampling stations by traversing the river in a jonboat equipped with a recording echo sounder and manual sounding equipment. Bed material was sampled during the traverse to determine substrate conditions. Aerial photography and U.S.G.S. maps were used as a base for mapping channel bedforms. Initial field mapping was done at a scale of 1:24,000 and emphasized identification of point bars, pools, riffles, and anomalous forms.

6.1.1.3.2 Field Streamflow Measurements

During each sampling period measurements are taken at selected stations to permit accurate estimation of streamflow. A list of these selected stations is given in section 2.5.3.2. The thalweg at these stations has been determined by channel cross-section surveys, and both the stage and current velocity at the thalweg are measured. The stage is related to an arbitrary datum such as a mark on a bridge, and the velocity measurements are made with a Price Type AA current meter using standard U.S.G.S. procedures (Carter and Davidson, 1968).

6.1.1.3.3 Stage Discharge Determinations

Meaningful application of field flow measurements requires 1) knowledge of the channel cross-section at each station, 2) establishment of stage-discharge relationships at each station, and 3) correlation of field measurements with U.S.G.S. gaging station records.

Details of the channel cross-section and actual field measurement of streamflow are obtained by gaging the stream according to standard U.S.G.S. methodology. At each field station the width of the stream is divided into 20 to 30 equal segments to provide an accurate channel profile. Current velocity is measured in each segment. If the depth at the midpoint of each segment exceeds one meter the current velocity is measured near the water surface and channel bottom. On the basis of many such velocity-depth measurements in streams of various sizes, it has been determined that the mean velocity in the vertical section is closely represented by the average of the velocities occurring at points 20 and 80 percent of the depth below the water surface (Pierce, 1941). At points where the water is less than one meter deep the velocity is measured just below the midpoint (60 percent of total depth). The cross-sectional area of each segment is computed from its width and the observed depth at the measurement point, using the mid-section technique for analysis. Water transport through each channel subdivision is calculated by multiplying the mean-in-vertical current velocity (meters per second) by the area of the segment (square meters). River discharge at each gaging point is the sum (in cubic meters per second) of the transport through all of the segments at that point.

Stage-discharge rating curves are derived from field gaging survey data using computer analysis to apply the general equation:

$$Q = kd^n$$

where k and n apply to the variability of the channel profile, d is the depth with respect to gage height, and Q is discharge in cfs.

The predicted discharge rating curves will be checked against field flow measurements obtained from the gaging surveys. Additionally, several stations are located at sites of U.S.G.S. gages, and all field measurements and rating curves will be correlated to recorded U.S.G.S. flow data for identical time periods to ensure the validity of gaging procedures.

6.1.1.3.4 Estimation of Flow Data

For ungaged sampling stations, estimates of discharge will be obtained by interpolation of data from the nearest upstream and downstream gaged stations. This interpolation will be accomplished by application of the general continuity equation to the stream reach under study such that:

$$AS = I - 0$$

where I is inflow at the upstream station, 0 is outflow at the downstream station, and AS the change in storage for the stream reach for a given time period. Discharge at the ungaged sampling station (Qss) during the time period of interest can then be calculated from the equation:

$$Qss = I + AS/t$$

where t is proportionality estimate based on linear stream distances between sampling stations and influences such as the location of impoundments or major tributaries.

6.1.1.3.5 Suspended Sediment Measurements

During each sampling period suspended sediment samples are collected at selected river stations. All samples are collected with a depth-integrating US DH-59 hand line sampler. Operation of the sampler is in accordance with
2 procedures prescribed by the U.S.G.S. (Guy and Norman, 1970).[2] Suspended - sediment concentration is determined using the U.S.G.S. filtration method employing a Gooch crucible, glass fiber filter paper, and vacuum filtration
2 (Guy, 1969).[3] All results are reported in milligrams per liter.

6.1.1.4 Materials and Methods: Water Quality

6.1.1.4.1 Field Procedures: Year I

Water samples were taken in accordance with the schedules in Tables 6.1.1-1, 6.1.1-2 and 6.1.1-3. Procedures for sampling differed slightly according to the type of sample and the characteristics of the station being sampled. Samples for each type of analysis were taken in separate containers. Each container was labeled according to sampling period, site, station, and parameter to be measured. The date and person doing the sampling were also recorded. These labels (see Figure 6.1.1-3) provided a record of collection, transport and disposition.

Nutrient samples were taken in one liter Pyrex glass Erlenmeyer flasks and capped with plastic caps with teflon liners. Each flask and its cap were rinsed once with deionized water before sampling and twice more with quantities of the sample water before the final sample was taken. Metal samples were collected in acid washed one liter polyethylene bottles which contained 1 ml of 1% HNO_3.

Coliform samples were collected in preautoclaved glass bottles. Nutrient and coliform samples were placed on ice for transportation to the Belle Baruch Laboratories of Columbia, South Carolina for analyses. Whole water samples for settled phytoplankton collections were taken at the same time as other water samples.

Alpha, Van Dorn, or Kemmerer water sampling bottles were used for river stations accessible from bridges and for bottom and mid-depth lake station samples. Where possible, river stations were sampled at 0.3 m deep by wading into the stream. Surface lake stations were sampled at 0.3 m from a boat. Surface samples were taken at all stations, with additional samples at mid-depth or the bottom in lake areas where the possibility of stratification existed. River samples were taken in midstream except where safety considerations precluded wading. Care was taken to sample upstream from boats. Water samples for metals analyses were collected directly in one liter Erlenmeyer flasks to avoid possible loss of acid from the metals-sample container.

6.1.1.4.2 Laboratory Procedures: Year I

Details of sampling schedules and techniques have been described in 6.1.1 and 6.1.1.4.1, respectively. Table 6.1.1-6 is a summary of all analytical methods, references, and lower detection limits. Figures 6.1.1-4 through 6.1.1-6 are flow diagrams showing the manipulation and analyses of water collected in one liter borosilicate Erlenmeyer flasks, 500 ml polyproplene bottles, and sterile cultire bottles, respectively. Most analyses were performed by the Belle Baruch Laboratories at Columbia, South Carolina. Mercury was determined by Environmental Controls for Pollution Inc. of Sante Fe, New Mexico.

6.1.1.4.3 Field Procedures: Year II

Temperature, DO, pH, and conductivity are measured monthly in situ at 11 stations on the Yadkin River (Table 6.1.1-5) using a Hydrolab 6D. When the Hydrolab unit is unavailable, measurements are made in situ using a mercury thermometer, azide modified Winkler DO determination and sample preservation (ice) until readings of pH and conductivity can be determined later the same day at the laboratory. Immediately prior to each day's sampling the Hydrolab is calibrated for each parameter as follows:

Temperature:	internal calibration (internal calibration itself checked periodically with an NBS mercury thermometer)
Dissolved Oxygen:	azide modified Winkler run with Hach dry chemicals
pH:	buffer solutions of appropriate values, 4-9
Conductivity:	internal calibration (internal calibration itself checked periodically with standard solutions)

Manufacturer's indicated accuracies (i.e. overall meter reading) for the Hydrolab 6D for these measurements are:

Temperature:	$\pm$ 0.2 C for temperature range of -5 C - 25 C $\pm$ 0.4 C for temperature range of 25 C - 45 C
Dissolved Oxygen:	$\pm$ 2% of reading $\pm$ 0.5% of range (0-10 ppm or 0-20 ppm)
pH:	$\pm$ 0.1 pH unit
Conductivity:	$\pm$ 0.5% of range (0-100 or 0-1000 μmhos) $\pm$ 2.5% of reading when internal calibration used, or $\pm$ 1.5% of reading when standard solution used for calibration

Nutrient samples are taken in 500 ml polypropylene bottles. Prior to sample collection, nutrient sample bottles are washed with Fisher FL-70 detergent which contains no chromates, phosphates, or silicates. Then washed with 10% HCl, and finally two rinses with distilled deionized water. Bottles are also rinsed twice with sample water immediately prior to sample collection. Samples for BOD determinations are collected in one liter linear polyethylene bottles which are cleaned in the same manner as the nutrient bottles. Samples for metal analyses are collected in 60 ml polypropylene bottles which have been washed with Fisher FL-70 and water, concentrated chromic acid, a 1:1 nitric acid solution, and finally rinsed three times with distilled, deionized water.

Surface (0.3 m) samples for BOD and nutrients are generally obtained by submerging the sample bottle by hand. Kemmerer water sampling bottles made of PVC are used for sampling stations at depths greater than 0.3 m. Metal samples are obtained in the field by decanting from the BOD or nutrient bottles. Surface samples at Muddy Creek, Station 448.0, are collected from the NC 1485 bridge with a sewage sampler. Nutrient and BOD samples are returned to the laboratory on ice. Metal samples are preserved by addition of 0.2 ml of concentrated nitric acid to the sample bottle in the laboratory, prior to collection of samples.

6.1.1.4.4 Laboratory Procedures: Year II

Water samples returned to the laboratory are analyzed for 21 parameters. These parameters, including the analytical methodology, references, preservation techniques, detection limits, and reporting units for each are summarized in Table 6.1.1-7.

Analytical procedures that entail highly automated instrumentation are employed in the laboratory. The detection limits of an analytical method are governed by the sensitivity of the instrumentation and the technical competence of the test administrator. These values are more a product of the laboratory than the instrument manufacturer and consequently more meaningful in interpreting the importance the laboratory places in the significant digits it reports. Therefore, Table 6.1.1-7 reports detection limits rather than sensitivity, which is strictly a function of the instrument.

Except for alkalinity and biochemical oxygen demand, standards are run for each parameter during each set of samples analyzed. Biochemical oxygen demand is run in duplicate and the average reported. For all other parameters every fifth analysis is repeated. From this data, Cumulative-Summation Quality Control charts are constructed[1]. All subsequent replicate data for a given analysis may then be compared to the average differences from which the chart was constructed to determine whether the new data is "out of control". Reference standards are also obtained from the Environmental Protection Agency and run on a semi-annual basis or whenever new batches of test materials are obtained.

6.1.1.5 Materials and Methods: Benthos

The benthos consists of those aquatic organisms which burrow in, attach to, or crawl on the substrate. Each bottom type requires a sampler suited to it and, since each device has an inherent sampling bias, comparisons between samples gathered by different means are difficult to interpret. In flowing waters the problems are compounded. River beds are often highly variable patchworks of substrates, each supporting its own faunal assemblage. This situation makes the replication of samples difficult.

6.1.1.5.1 Field Procedures: Year I

Benthic organisms were sampled during the Year I study according to the program outlined in Table 6.1.1-1 and 6.1.1-3. Four sampling devices were used; a detailed description of each may be found in Edmondson and Winberg[19]. Two modifications of the Ekman grab were employed in soft substrates: a 23 cm (9 in) model for deep water and a 15 cm (6 in) pole-mounted version in shallow water. The heavier Ponar grab was used on hard-packed sand and during fast flow conditions. Shallow riffles were sampled with a Surber square foot sampler. The equipment used and the number of replicates taken at each site are presented with the date in Table 2.7.2-15.

Samples obtained by the Surber net were removed and preserved in 70% ethanol. Grab samples were washed through a Model 190 wash bucket (Wildlife Supply Company) with a 0.516 mm mesh. Water and materials which passed through the wash bucket were retained and sieved a second time. The concentrated samples were preserved in 70% ethanol.

6.1.1.5.2 Laboratory Procedures: Year I

In the laboratory, preserved field samples were transferred to trays and the larger organisms in them removed. Smaller animals were floated using the sugar-floatation method described by Anderson[18]. The organisms were then sorted to major taxa and stored in 70% ethanol in labeled vials. Initially, some samples were kept in isopropanol, but this practice damaged fine structures, such as oligochaete setae, and was discontinued.

Biomass was estimated by weighing blot-dried preserved specimens which had been rehydrated in water.

Identifications were made with standard taxonomic keys[8,20]. The firm of Midwest Aquatic Enterprises checked several samples to confirm or revise the identifications made by Environment Consultants, Inc.

6.1.1.5.3 Field Procedures: Year II

Benthic studies on the Yadkin River System were implemented by Duke Power Company biologists in September, 1974.

Benthos is sampled at the following stations, which are considered necessary for a valid evaluation of the benthic communities in the vicinity of Perkins:

<u>438.0</u> is located in Dutchman Creek, 40 m above the mouth, in midstream.

440.0 and 440.2 are located in the Yadkin River, 10 m above confluence with Dutchman Creek, in midstream and 2 m off the right bank, respectively.

442.0 and 442.2 are located 100 m below the proposed location of the Perkins discharge, in midstream and 2 m off the right bank, respectively. (Note: this is the closest location to the proposed location of the discharge where substrate permits grab samples to be taken . From this location upstream to the discharge, still considered Station 442.0, the substrate consists of boulders and bedrock. The bedrock is sampled by Surber Sampler, 50 m below discharge and approximately in midstream).

445.0 is located in the riffle area 200 m above Perkins intake. Some drift samples were taken here (e.g. diurnal, October 10-11, 1974) but this station is not sampled routinely.

Both shore and mid-channel stations at 440, 442, and 444 were sampled to establish differences in the benthic communities attributable to differences in sediment on the same transect in the river.

A modified Petersen grab with a bite of 258 cm^2 (40 in^2) was equipped with additional lead weights for use in the Yadkin River. Three replicates of grab samples are taken monthly at all stations. Samples are sieved in No. 30 mesh Wildco wash buckets and stored in 32 oz wide-mouth jars. Temperature of sediments and surface water, and depth of grab samples, are recorded at all stations. A fourth grab is collected at each station for laboratory analysis of total organic carbon and particle size of the sediments.

A 1.0 ft^2 Surber-type sampler with a 1050 μ mesh bag is used to sample the bedrock/riffle immediately below the proposed location of the Perkins discharge. Three replicate samples are taken. This station (442.0) is sampled monthly when conditions are favorable. At times of high flow, when the Surber sampler cannot be used, some type of qualitative sampling such as sweepnetting or kick sampling is attempted.

In an attempt to characterize variations in the Yadkin River drift, a diurnal study was conducted at Station 445.0 on October 10 and 11, 1974. Duplicate plexiglas drift frames were used, each of which had a 0.01 m^2 mouth tapered back to 0.1 m^2, where 471 μ mesh bags 1.0 m in length were attached. The frames were bolted to a heavy steel base, which permitted prolonged exposure in swift currents with no problem of backwash or clogging of nets. Twenty-three paired samples were taken for approximately 50-minute periods from sunrise to sunrise. About 10-minutes of each hour were required to remove and preserve samples, record flow measurements, and reposition the nets in the river.

Invertebrate drift is sampled monthly at Stations 442.0 and 444.0 at a depth of 0.7 m. Two replicate samples are taken at each site using a 0.1 m^2 Nitex net, 1.0 m in length, with a mesh of 471 μ. Samples are timed (usually 10 minutes) and flow is measured with a General Oceanics flowmeter, permitting calculation of the total volume of water sampled.

Samples are preserved in the field with 70% ethanol containing 0.25 g/l Rose Bengal stain.

6.1.1.5.4 Laboratory Procedures: Year II

In the laboratory invertebrates are hand picked from field samples under a 2X magnifying lens, identified to the lowest practicable taxonomic category, and counted. Blotted, wet weights are determined for major groups and for the total to the nearest 0.5 mg. Chironomids are cleared for two days in 5% KOH, neutralized, dehydrated, and mounted in Euparol.

References used in taxomonic determinations include, but are not limited to, those cited in the bibliography. Unknowns are identified, and reference specimens verified, by an outside group of professional taxonomists, Midwest Aquatic Enterprises. All specimens, including sample label, are stored in 2 dram vials and preserved in 70% ethanol.

Results from grab and Surber samples are presented as estimated number and biomass per m^2, based on three replicates. Results of drift samples are presented as number and biomass per 100 m^3. Diurnal drift samples are plotted vs. time. Aquatic and terrestrial drift organisms are considered separately, and their relative importance compared.

A subsample of the sediment from each grab station is dried, pulverized, and replicates analyzed for total organic carbon (TOC) with an Oceanography International Total Carbon System. Results are presented as milligrams of carbon per kilogram of sediment and as percent carbon.

The remainders of the sediment samples are sent to Duke Power Company's Soils Lab where they are analyzed for grain size according to ASTM procedures.

6.1.1.6 Materials and Methods: Phytoplankton

6.1.1.6.1 Field Procedures: Year I

Phytoplankton samples were obtained in whole water samples by three standard methods. One liter polyethylene bottles were filled directly for surface samples (0.3 m depth). Deep water stations were reached by boat while shallow water stations were reached by wading (Subdivision 6.1.1.1). Alpha bottles were used to obtain surface water samples at stations accessible from bridges. Mid-depth and bottom water samples were taken with Kemmerer bottles. Both Alpha and Kemmerer bottle samples were transferred immediately to one liter polyethylene bottles. All whole water samples were kept on ice until they reached the laboratory.

6.1.1.6.2 Laboratory Procedures: Year 1

In the laboratory, 5 ml of Lugol's solution was added to each whole water sample[1]. All samples were then allowed to settle undisturbed in their polyethlene containers for at least three days. Once the sample had settled, all but the bottom 2 cm of the water was drawn off by aspiration. The sides of each bottle were then rinsed with approximately 10 ml of water, which was left in the sample bottle[2].

The Sedgewick-Rafter cell was used routinely for counting algae[3,4]. When identifications became difficult or densities were extremely high, either a haemocytometer was used for counts or the sample was diluted with a known volume of filtered water before counting on the Sedgewick-Rafter cell[5].

Algal counts were made on thirty random fields in a Sedgewick-Rafter cell containing 1 ml of subsample. Whole mounts were made of problem species, which were stored and identified at a latter date[5]. Taxonomic references used in identification were Patrick and Reimer[6], Whitford and Schumacher[7], Tiffany and Britton[8], Weber[9], Prescott[10], and Smith[11].

Identification and counting of diatoms was accomplished after clearing the frustules by acidification and mounting them on permanent slides. To prepare these slides, a 5 ml sample of the concentrated phytoplankton was digested in a 15 ml centrifuge tube with 2 ml of concentrated sulfuric acid. The mixture was further oxidized with a 5% $KMnO_4$, and then cleared by slowly adding several milliliters of 10% oxalic acid. Each tube was then filled with water and centrifuged for 10 minutes at 1600 rpm. The water was then drawn off and each sample rinsed twice with 15 ml of water to prevent the formation of crystalline residues on the slides. After the final rinse and centrifugation the sample was drawn down to approximately 1 ml.

Each sample was agitated and 2 to 3 drops placed in the center of a clean 22 mm diameter glass cover slip, which was air dried in a dust-proof box overnight. The diameter of each dried sample drop was measured to permit back calculation of the original number of organisms per milliliter. One drop of Hyrax mounting medium was placed on the dried sample, which was then heated. A labeled glass slide was then applied and the entire slide was reheated. Air bubbles were gently expressed, and the cover slip was sealed in place with fingernail polish. Species counts were made under 1000X in thirty random fields. Densities were calculated in numbers per milliliter based on initial volume of the sample, volume of concentrate used, dilution volume after clearing, spot diameter, microscope power, and field size.

6.1.1.6.3 Field Procedures: Year II

Phytoplankton sampling for Year II began September, 1974, and all stations are sampled monthly (Table 6.1.1-5). Three procedures for obtaining whole water samples are described below with station listings where that procudure is followed. Duplicate samples are taken concurrently at each station on a sampling date. At Stations 436.3, 440.3, and 446.3 (Table 6.1.1-5) whole water samples are collected 0.3 m below the surface using a horizontal Van Dorn bottle. These samples are taken at three points along a transect perpendicular to the river channel. One sample point is located at mid-channel, and the remaining two sample points are located on either side of the mid-channel sample point, approximately one-fourth the distance of the river width out from each bank. One liter samples from each of the three sampling points are composited in a common two gallon nalgene carboy, mixed, and a 950 ml aliquot subsampled. This subsample is preserved, in the field, with 15 ml of a merthiolate preservative[12].

At the proposed intake and discharge areas (Stations 444 and 442, respectively) duplicate samples are taken 0.3 m below the surface at each station. Left bank Stations 444.1 and 442.1 are located approximately one-fourth the distance of the river width from the left bank. Right bank Stations 444.2 and 442.2 are located approximately the same distance from the right bank. Three one-liter samples are taken and composited at each of the four stations and processed in the same manner as the composited samples described above. This procedure provides a sample that compensates for lateral variation.

Due to the narrowness of Dutchman Creek, Station 438 is sampled at mid-channel only. Three one-liter samples are composited and processed in the same manner described above. Duplicate composite samples are likewise obtained.

6.1.1.6.4 Laboratory Procedures: Year II

Phytoplankton Sample Concentration: The 950 ml whole water preserved samples are allowed to settle in subdued light in the laboratory at the rate of 4 hours/cm of container height[2]. After settling the supernatant is aspirated from the sample and the remaining precipitate transferred to a smaller bottle. The original sample bottle is rinsed thoroughly with distilled water to insure the transfer of all cells into the smaller bottle. The settling and aspirating process is repeated until the sample is concentrated to a volume of from 5-50 ml, depending upon the concentration of suspended solids.

Phytoplankton Population Density: The phytoplankton organisms are identified and counted in transects on a Palmer-Maloney counting cell with a magnification of 500X (brightfield and phase contrast). The phytoplankton organisms are recorded in the following units:

Type	Units/ml
1. Non-diatom	
A. Unicellular	each cell
B. Colony	counted as colonies; number of cells per colony estimated for each of the first five colonies
C. Filamentous	one count per small Whipple square (18μ)

II. Diatoms

A. Unicellular — each cell

B. Colonies — each cell

Population data is reported as numbers per milliliter.

A partial list of the taxonomic references used include Cocke[13], Drouet[14], Bourrelly[15], Gojdics[16], Whitford and Schumacher[7], Uherkovich[17], Hustedt[18], Prescott[10], Smith[11], Patrick and Reimer[6], and Skuja[19].

Dr. Lawrence A. Whitford, a noted phycologist at North Carolina State University and co-author of A Manual of Freshwater Algae[7], serves as a consultant in algal identification problems.

The phylogenic system used to compile the Year II species list is based upon a modification of G. W. Prescott[10].

Permanent Hyrax diatom mounts are made from each phytoplankton composite sample using the incineration method described in Standard Methods[20]. These mounts are necessary to provide positive diatom identification since accurate identification to species of most diatoms is impossible using the Palmer-Maloney counting cell. The permanent mounts provide a proportional analysis of the diatom population.

Population Biovolume: The values obtained in computing the population density do not always represent a true estimate of the resident biomass. This is due to the extreme variations in size of the organisms. Therefore, a number of individuals of a species are measured to determine the cellular dimensions using a Whipple ocular micrometer. Using the mean cellular dimensions of a species and the volume formulae of an appropriate geometric solid, the species mean biovolume is computed. To obtain the biovolume per milliliter, the mean biovolume for each species is multiplied by its respective numerical density[2].

6.1.1.7 Materials and Methods: Zooplankton

6.1.1.7.1 Field Procedures: Year I

Zooplankton samples were taken using net tows. River stations, as listed in Table 6.1.1-1, were sampled with a Wisconsin style plankton net with a 12 cm mouth and a number 20 mesh (76 μ) net. All river tows were taken beneath the water surface to avoid skimming surface film and floating debris.

Lake stations were sampled using a Clarke-Bumpus net. Mesh sizes used were number 6 (239 μ), number 10 (158 μ), and number 20 (76 μ) in accordance with the schedule outlined in Tables 6.1.1-1 and 6.1.1-2. Tow speeds ranged from 1-2 m per second. "Surface" samples were taken at a depth of 0.2 m while deep tows were 1-3 m off the bottom.

Net samples were rinsed into a 158 ml (4 oz) collection vial and four drops of neosynephrine were added as a relaxant. After a two minute waiting period, the zooplankters were preserved with formalin. Initially, 70% ethanol was used as a sample fixative, but this was abandoned in favor of larger amounts of formalin in order to reduce dehydration of rotifers and cladocerans.

6.1.1.7.2 Laboratory Procedures: Year I

Zooplankton density was calculated from data on the length and speed of the tow and the diameter of the net. Total numbers were obtained from strip counts, as recommended by Standard Methods[1]. The large Crustacea (copepods and cladocerans) were counted in two 1 ml subsamples in a Sedgewick-Rafter cell under 20X magnification. If the count was low, a total of 8 ml was counted[2].

Rotifers, nauplii, and other small zooplankters were counted in strips across the Sedgewick-Rafter cell under 80X. If any organisms were abundant, two strips were counted. If both counts were low, six more strips were counted.

Species identifications were made by removing the organisms from the sample with a capillary tube and examining them under a compound microscope. For taxonomic confirmation, several samples were sent to Dr. Dewey Bunting, Zoology Department of the University of Tennessee, Knoxville. Dr. Bunting has been retained by Duke Power Company as a special consultant on zooplankton and statistics.

Dr. Bunting established a procedure for debris-laden samples. Samples were diluted to a known volume, then stirred with a magnetic stirrer. Five 5 ml subsamples were removed with a Hensen-Stempel pipette and every organism in each subsample was identified and counted.

6.1.1.7.3 Field Procedures: Year II

In September, 1974, a second year of data collection was begun in the vicinity of the proposed Perkins Nuclear Station. Sampling stations are located on the Yadkin River and Dutchman Creek. A description of the stations is given in Subdivision 6.1.1.2 and the sampling schedule is given in Table 6.1.1-5. Depending upon the station, either discrete or composite samples are taken. A discrete sample consists of a sample taken from either the left, mid, or right channel area of the water course and it is retained throughout further processing as a sample from that distinct area. Composite samples are taken transversely at left, mid, and right channel areas and these samples are combined in further processing to create a cross-channel composite sample. Duplicate samples, designated as A and B, are taken at all stations, processed separately, and combined only in numerical analyses.

In September, 1974, in order to determine the more efficient sampling method, samples were taken with both a Homelite gasoline powered pump and a number 20 mesh (76 μ) net.

All pumped samples were obtained by pumping 566 l (20 ft^3) of water through a number 20 mesh (76 μ) net partially submerged in the water to minimize mechanical damage to the organisms. Volume was calculated by means of an in-line flowmeter. Due to the low volume/long sampling time ratio of this method, it was discontinued after the September samples.

The 0.5 m oceanographic style net presently in use is weighted, immersed in the water, and held below the surface for a specific time, usually 10 seconds. The volume of water passing through the net is calculated by means of a General Oceanics flowmeter installed in the mouth of the net. At Dutchman Creek a relatively low flow is sometimes encountered and the sample is obtained by either of two methods. In the first, a short (10 sec) motor tow with the net held just below the surface is employed. In the second, the net is held between two people, lowered into the water, and retrieved. The former is the method preferred when the creek channel is navigable. All three of the above methods allow a volume approaching 1000 l to be sampled. Sampling a larger volume of water is not possible due to clogging of the net by the high sediment load usually carried by the Yadkin River System.

The organisms sampled are rinsed into a 250 ml vial and preserved in 10% (final concentration) formalin. Live samples are taken at various times and stations to aid in species identification.

6.1.1.7.4 Laboratory Procedures: Year II

In the laboratory the samples are stained with Rose Bengal, which facilitates location and identification of the zooplankton in the highly silted concentrated samples. For samples obtained in September, 1974, and part of October, 1974, the following procedure was used. The volume of each duplicate sample was measured. Samples to be composited from each station were rinsed into an Erlenmeyer flask and diluted to a volume that allowed the zooplankton to be identified in the presence of large amounts of silt. Discrete samples were processed in the same manner as composites with the exception of their retention as discrete samples.

After the dilution the flask was placed on a magnetic stirring apparatus and stirred one minute to assure homogeneity. Triplicate 5 ml subsamples were withdrawn into channeled plastic counting chambers and examined using a binocular dissecting microscope at 40X. Individual zooplankton were withdrawn, placed on depression slides, and identified to species with a compound microscope.

After consultation with Dr. Bunting regarding this method, it was decided to change the laboratory technique in order to count larger subsample volumes containing at least 50 organisms. This new method was instituted in mid-October, 1974, and it is anticipated that it will be retained throughout the remainder of the Year II collections.

This new procedure consists of the following techniques. Each sample is stained with Rose Bengal and diluted to 25 ml. For the cross-channel composite samples the three vials from the left, mid, and right channel areas are shaken thoroughly and 2 ml subsamples withdrawn from each vial. These 2 ml subsamples are placed in a plastic culture dish upon which a grid has been etched to facilitate counting. This 6 ml composite subsample is diluted to an arbitrary volume such that the zooplankters can be seen in the silt, and the entire contents of the dish counted. This procedure is repeated for the duplicate subsample. The discrete samples are also diluted to 250 ml, mixed thoroughly, and a subsample of 5 ml is withdrawn. This subsample is placed in the gridded culture dish, diluted, and the entire contents are counted. This procedure is repeated for the duplicate subsample.

Subsample volumes are varied to ensure that in each subsample at least 50 organisms are counted. After counting, densities are computed as number per cubic meter for each discrete and composite sample. Duplicate A and B samples are averaged to provide a final density estimation for the station. Biomass data are not calculated because the appropriate conversion factors in the literature are not accurate enough, or do not exist at all, for those zooplankton found in the Yadkin River system (Hall, et al.[3]). Therefore, data obtained by these methods would not be meaningful.

Suitable taxonomic references used to identify the organisms indlude, but are not limited to, Ahlstrom[4,5], Yeatman[6], Voigt[7], Brooks[8], Bartos[9], and Edmondson[10].

6.1.1.8 Materials and Methods: Periphyton

6.1.1.8.1 Field Procedures: Year I

Artificial substrate samplers similar to those developed by Kuznecov[1] were placed at each periphyton station; these samplers consisted of 2.5 x 7.6 cm (1 in x 3 in) glass slides imbedded in weighted rubber stoppers. Each sampler held four slides and two samplers were placed at each periphyton station each month. Slides were removed at two and four week intervals so that every four weeks all slides were replaced. Collected slides were placed in plastic bags and fixed with FPA (formalin, propionic acid, and alcohol); the bags were sealed, labeled, and then returned to the laboratory for analyses.

Approximately three slides per sampling period at each station were lost due to natural disturbances and vandalism.

6.1.1.8.2 Laboratory Procedures: Year I

The extent of periphytic colonization on both sides of each slide received from the field was determined. Each slide was then placed in a clean porcelain pan and the periphyton removed by scraping with a razor blade. The storage bag which held the slide was rinsed several times to remove residual periphyton. All material was transferred to a storage bottle and the volume brought to 100 ml. A homogeneous aliquot of 2-5 ml from each bottle was used to prepare permanent diatom slides as described in Subdivision 6.1.1.6. Diatom identifications and counts were made from these slides using phase-contrast microscopes. Identification of genera other than diatoms was made using a Sedgwick-Rafter cell. Manuals used for identification of diatoms were Patrick and Reimer[2], Whitford and Schumacher[3], Tiffany and Britton[4], Weber[5], Needham and Needham[6], Prescott[7], Prescott[8], and Smith[9]. Cell density as cells per square centimeter was calculated by the following formula:

$$N_T = \frac{(N)(A_S)(F)}{(A_F)(A_c)(0.066\text{ml})}$$

N_T = cell density as cells/cm^2
N = number of cells counted
A_S = total spot area on slip
F = factor dependent on size of 2-5 ml aliquot
A_F = total area of "x" fields
A_c = total area of slide colonization

0.066 ml = two drops from Pasteur pipette

Twenty milliliters of the remaining periphyton sample was used for biomass estimation. Crucibles were acid cleaned, oven fired at 105 C, cooled in a dessicator, and weighed to 0.1 mg on a Sartorius analytical balance. Thoroughly mixed samples were poured into the crucibles and oven dried at 105 C for at least six hours. The crucibles were cooled in dessicators and weighed to obtain dry weights. Samples were then ashed at 500 C for two hours in a Thermolyne Model 1400 muffle furnace. Crucibles were cooled to room temperature in dessicators and weighted to obtain ash-free dry weights.

Weights and original volumes of samples were used to calculate biomass of periphyton on an areal basis (mg/cm^2).

6.1.1.8.3 Field Procedures: Year II

The artificial samplers used in the quantitative sampling employ glass microscope slides as the substrate. Eight slides are held in vertical orientation by a float assembly fabricated by Craftsman Designers and called a Periphytometer. This device is similar to the Catherwood diatometer described by Hohn and Hellerman[10] and is being tested by the Army Corps of Engineers and the United States Environmental Protection Agency.

Duplicate slides are exposed for four week periods and collected and preserved individually with formalin for population analysis. Additional replicates are gathered for biomass determination and stored in labeled slide racks.

6.1.1.8.4 Laboratory Procedures: Year II

Diatom Cleaning and Mount Preparation

In order to make a taxonomic analysis of the population, it is necessary to first "clean" the diatom material. All organic matter is removed leaving the silicious diatom frustules. The cleaning procedure used is described by Hohn and Hellerman[10].

A rubber policeman is used to carefully scrape periphyton material from both sides of a glass microscope slide into a 200 ml beaker. The sample is heated to evaporate most of the water and then boiled gently (120-150 C) in 50 ml of concentrated nitric acid (HNO_3). Two glass beads are added to reduce spattering of the solution. When the acid stops fuming, a pinch of potassium dichromate is added. The solution is allowed to boil about twenty minutes. The cleaned material is then allowed to cool. If all organic material is not digested, 50 ml of concentrated sulfuric acid (H_2SO_4) is added and the mixture heated again. After all organic matter is digested, the sample is removed from the heat and allowed to cool.

The cleaned material is then washed with distilled water by a series of water additions, and aspirations. The sample is allowed to settle for at least 6 hours before the supernate is aspirated. This washing cycle is repeated until a colorless supernate is attained. The cleaned material is transferred to a graduated cylinder and brought to a known volume (10 ml). The sample is then thoroughly mixed. No. 2, 22 X 22 mm coverslips are placed on a hot plate and distilled water is placed on each until a high meniscus forms and extends to the edge of the coverslip. A 50 μl aliquot is withdrawn with an Eppendorf pipette from the mixed sample. An aliquot is transferred to each coverslip and mixed with the distilled water already on the coverslip by repeatedly drawing up and discharging the mixture from a Pasteur pipette. The material is then allowed to dry very slowly over low heat. In this way the material is distributed uniformly over the coverslip. After drying, the coverslip is placed on a hot plate at 230 C (450 F) for 20 minutes. The coverslip is then inverted on a drop of Hyrax permanent mounting medium that has been placed on a microscope slide. Boiling the Hyrax evaporates the solvent and produces a permanent mount. It is necessary to apply moderate pressure to the coverslip as the Hyrax cools to produce as thin a mount as possible. After cooling, the slide is scraped free of excess Hyrax and permanently labeled.

Counting

Initially a floral list is prepared by scanning the slide. Then starting at the edge of the coverslip complete parallel transects made until at least 800 diatom valves are counted.[11] The cleaning process introduces a bias by separating some cells into the two component valves and leaving other cells whole. Therefore, it is necessary to count valves to eliminate the bias.

Major taxonomic works used in the identifications include Husted[12], Patrick and Reimer[2], and Whitford and Schumacher[13]. Cell density is reported as cells/cm^2 and is calculated using the following formula. The formula for one transect at 1000X is:

$$\frac{1}{\text{slide area (two sides)}} \times \frac{\text{Total vol. clean material}}{\text{aliquot vol.}} \times \frac{\text{Total coverslip area}}{\text{area of one transect}} \times \text{cell number} =$$

$$\frac{1}{38.71\ cm^2} \times \frac{10\ ml}{.05\ ml} \times \frac{484\ mm^2}{3.96\ mm^2} \times \text{cell number} =$$

$$361.5/cm^2 \times \text{cell number} = \text{cells}/cm^2$$

Methods for Biomass Determinations

Replicate slides are air dried and broken to fit into individual 30 ml crucibles. The crucibles with their contents are placed in a drying oven and dried to a constant weight at 105 C. The crucibles are then removed and allowed to cool to room temperature in a dessicator. They are then weighed in a Mettler Model H51 analytical balance to the nearest 0.01 mg. The crucibles are then ashed in a muffle furnace at a temperature of 500 C. After cooling they are rewetted with distilled water (to reintroduce the water of hydration) and again dried to a constant weight at 105 C. After being cooled in a dessicator to room temperature, the crucibles are weighed to the nearest 0.01 mg. The organic weight determined by this method is converted and expressed as milligrams of organic accumulation per square meter per day.[14]

6.1.1.9 Aquatic Macrophytes

6.1.1.9.1 Field Sampling

Aquatic macrophytes (including mosses) were sampled qualitatively in the late fall and in the spring; quantitative samples were not taken. Several specimens were preserved for future reference.

6.1.1.9.2 Laboratory Procedures

No laboratory procedures were involved, except where species identifications required the use of a dissecting scope.

6.1.1.10 Materials and Methods: Fish

6.1.1.10.1 Field Procedures: Year I

The characteristics of each sampling station determine which sampling procedures are suitable. The selectivity of each method is partially offset by using a combination of two or more sampling devices at each station. Sampling methods are listed in Table 6.1.1-1. The nets used include 3.7 m (12 ft) and 4.6 m (15 ft) seines of .47 cm (3/16 in.) bar mesh and 4.6 m (15 ft) hoop nets of 5.08 cm (2 in.) mesh. Electrofishing was done with a portable 110 volt backpack unit and a boat mounted electrofishing unit. Samples were preserved in 10 percent formalin. The selectivity of the sampling gear means that care must be taken in comparing samples between stations. However, changes in biological parameters occurring at each station should be reflected in the data.

6.1.1.10.2 Laboratory Procedures: Year I

Fish were identified using standard keys[1,2,3,4,5], although original descriptions were consulted when necessary[6]. Numbers of each species at each station were recorded routinely. Dr. E. F. Menhinick of the University of North Carolina at Charlotte has validated some of the more difficult identifications.

6.1.1.10.3 Field Procedures: Year II

In August, 1974, a supplementary fish population sampling program was initiated. Fish are sampled at six stations on the Yadkin River near the proposed Perkins site, one station on Dutchman Creek near the proposed plant site, and at one station on Abbott Creek, a tributary of the Yadkin River near Lexington, North Carolina. Sampling stations are summarized and station numbers indicated in Table 6.1.1-5.

Fish population sampling is carried out using three methods. Electrofishing is the primary method of capture at the river stations and Dutchman Creek. Trotlines are used monthly at three river stations to better sample catfish species. Larval fish are sampled at four river stations and Abbott Creek with a towed ichthyoplankton net.

Stations

Sampling of Yadkin River fish populations was implemented in August, 1974. The collection of fishes on the Yadkin River requires that sampling areas be more extensive relative to those for other parameters such as water chemistry, phytoplankton or zooplankton. General station descriptions have been provided in Subdivision 6.1.1.2. A further description of fish sampling areas follows and includes the purpose for selecting each station and, when necessary, additional station characteristics relevant to fish population sampling.

427.0 is located on Abbott Creek at East Center Street in Lexington, North Carolina. Here, the stream is approximately 8-10 m wide and 0.25-0.5 m deep. There are several riffles and pools in this area. This station is sampled seasonally for larval fish and serves as a reference station in assessing fish spawning.

434.1 and 434.2 are located on the left and right shorelines of the Yadkin River about 75 m upstream from the confluence of the South Yadkin. The river here is approximately 70 m wide and up to 2 m deep. Current is swift and bottom type is coarse sand. This station serves as a downstream reference area for fish population sampling.

436.1 and 436.2 are located on the left and right shorelines of the Yadkin River just upstream of the North Carolina Wildlife Resources Commission access area. The river is about 55 m wide and up to 4 m deep at this point. Current is moderate and the bottom is primarily coarse sand. Station 436.2 serves as a downstream reference area for fish population sampling.

438.0, 438.1, and 438.2 begin at the mouth and extend approximately 100 m into Dutchman Creek. The stream is approximately 5-10 m wide in this area. The current is slow, the depth varies from 0.5-1 m, and the bottom is primarily sand. Dutchman Creek is the largest tributary in the vicinity of the proposed plant site. At Stations 438.1 and 438.2 fish populations are sampled to document use of this area as a spawning site. Station 438.0 is sampled intensively during spawning season for fish eggs and larvae.

440.1 and 440.2 are located on the left and right banks, respectively, of the Yadkin River immediately upstream from the confluence of Dutchman Creek. The river is about 50 m wide and 2 m deep at this point. The bottom is primarily sand and silt. Samples from this area will be used to evaluate the extent of any possible plant effects.

442.0, 442.1, and 442.2 are located at the proposed Perkins discharge site. At this location the river is about 50-60 m wide and is up to 2 m deep. Current ranges from moderate to swift. The banks of the river are primarily sand and silt while the main channel is bedrock. A well defined riffle extends all the way across the river at this location. This area of the river will directly receive the effluent from the Perkins Station. Stations 442.1 and 442.2 extend 200 m downstream from the riffle area, on left and right banks (respectively) of the river. At Station 442.2, surface runoff from adjacent agricultural land enters the river. Fish populations are sampled at monthly intervals at 442.1 and 442.2 and in the riffle area. Station 442.0 is at mid-channel 400 m downstream of the riffle and is sampled during spawning season for fish eggs and larvae. Any possible plant effects should be most evident at these stations in the immediate discharge area.

444.1 and 444.2 are located approximately 50 m upstream from the proposed intake site on left and right banks of the river, respectively. The river is approximately 60 m wide and ranges to 2 m deep. Current is moderate and bottom type is primarily sand. Each station extends 200 m upstream on either bank to a well defined riffle. Stations 444.1, 444.2, and the riffle areas adjacent are sampled monthly for fish population evaluation and during spawning season for eggs and larvae. Stations 444.1 and 444.2 serve as upstream reference areas for fish population sampling.

446.0, 446.1, and 446.2 are located on the Yadkin River approximately 50 m downstream from the confluence of Gobble Creek. Here, the river is approximately 40 m wide and about 1.5 m deep. Current is moderate and the bottom is primarily sand and gravel. A well defined riffle is located at the upstream limit of Stations 446.1 and 446.2 which extend 200 m downstream. Monthly fish population samples at these stations and the riffle areas provide an upstream reference area. Station 446.0 begins 400 m downstream from the riffle area. This station is sampled for fish eggs and larvae.

Electrofishing

Each monthly electrofishing sample is collected using a boat mounted electrode system. Pulsed direct current of 850 volts is delivered to the water from a Smith-Root Mark VI electrofisher and a 220 volt alternating current generator. In August and September, 1974, 400 volts alternating current was used in place of direct current. Electrofishing substations consist of 100 m sections of shoreline. The banks of the river are electrofished thoroughly, all fish netted, selected specimens retained, and all others returned to the river. Actual shocking time, the number of seconds current is applied to the water, is metered on the Smith-Root electrofisher. Total time is kept with a stop-watch and represents the time taken to cover a 100 m section of shoreline. After each 100 m section is sampled, all fish are identified, counted, and individual lengths recorded. Fish to be sacrificed for life history studies are placed on ice to retard digestion of stomach contents.

At Stations 442, 444, and 446, four 100 m sections of shoreline, two on each side of the river, are electrofished as replicate samples. In addition, duplicate samples at the riffle areas at each of these stations are taken when flow permits. Replication is not as strict in riffle areas due to variation in river flow characteristics. At Stations 434, 436, 438, and 440 sampling is replicated by electrofishing a 100 m section of shoreline on each bank of the river. No riffle areas exist in these sections of the Yadkin River and Dutchman Creek.

Trotlines

Two trotlines are currently set at Stations 436.2, 442.2, and 444.2 on the Yadkin River. Each trotline is 30 m long and consists of twenty-five 3/0 hooks. Each line is set parallel to and 2 to 5 m from the river bank. Hooks are baited with shrimp. Trotlines are run after approximately 24 hours. Fish caught are identified and length of each fish is recorded. Fish to be sacrificed for life history studies are placed on ice to prevent further digestion of stomach contents. All others are returned to the river.

As indicated in Table 2.7.2-20, the location of trotline stations has been changed since the original August sample was taken. Trotline stations are now located in areas which will provide information on plant effects (Stations 444.2 and 442.2), supply information from a reference area (Station 436.2), as well as provide life history data.

Ichthyoplankton

Larval fishes are collected using a 0.5 m diameter #0 (571μ) ichthyoplankton net. A General Oceanics digital flowmeter is mounted in the center of the net opening in order to calculate volumes of water filtered. The net is towed on the surface upstream for 2.5 minutes (when possible), the flowmeter readings are recorded, and the contents of the catch bucket preserved in 10 percent formalin for laboratory examination.

Seasonal larval samplings was completed in November, 1974. Larval fish sampling has been carried out twice monthly since September, 1974, at Stations 446.0, 444.1, 444.2, and 442.0 on the Yadkin River, Station 427.0 on Abbott Creek, and Station 438.0 on Dutchman Creek. Collection techniques vary slighly between stations depending on depth, flow rates and turbidity.

At Stations 446.0, 442.0, and 438.0, duplicate larval tows are made at mid-channel. At Station 427.0, on Abbott Creek, the net is held in the flow for two 5-minute replicate samples. At Stations 444.1 and 444.2, two pairs of replicate tows are taken during each sampling period. One set is taken to the right of the river channel (intake side), the other to the left of the river channel. Data will be collected in this manner to ascertain relative horizontal distribution of larval fishes in the river.

6.1.1.10.4 Laboratory Procedures: Year II

Fish are separated by station, total and standard length to the nearest millimeter and weight to the nearest 0.1 g are recorded for each. Pectoral spines from ictalurids (catfishes) and scales from other fishes are taken for age and growth determinations. Intestinal tracts and gonads are excised and preserved individually in 10% formalin, stored for approximately one week, washed, and placed in 40% isopropanol.

Taxonomic Considerations

Fishes collected in the Yadkin River are identified using standard references [1,7,8,9]. A reference collection is maintained to insure consistent identifications.

Life History Studies

Life history data, species length-weight relationships, age and growth, and food habits are derived from laboratory analyses of sacrificed fish.

Length-weight relationships for major fish species are established using regression analysis. This method allows the prediction of weight for given length for each species and calculation of biomass for each station.

Age of individual fishes is determined by the number of annuli on a scale or spine section. Scales are prepared for reading by making impressions on acetate slides with an Ann Arbor roller press. Impressions are examined under a standard magnification with a Baush and Lomb Micro-projector. Spines are prepared for examination by sectioning with a jewelers diamond saw. Sections are cleared with xylene and examined at a standard magnification under a dissecting microscope fitted with an ocular micrometer. Total scale or spine radius and radius to each annulus are recorded for each fish. Relationship between body length and scale or spine radius are determined. When this relationship is linear, back calculations of lengths at each age are made. In this manner mean length for each age class and growth increment (mm) for each year can be calculated. Data of this nature is useful in comparison of stations on the Yadkin River and in comparison of Yadkin River fish populations to other populations.

Stomach content analyses are necessary to establish trophic relationships. Each stomach is cut longitudinally and the contents washed into a petri dish. Stomach contents are analyzed using three methods. Total numbers of discrete food items are tabulated. Weights of all food items are determined to the nearest 0.001 g and frequency of occurrence or the percentage of fish in which an item occurs is tabulated. Identification of food organisms is carried to the lowest taxonomic unit practicable using standard references.[10,11]

6.1.1.11 Cooling Tower Blowdown Assessment

The major objective in assessing the effects of cooling tower blowdown water on aquatic algae will be to describe their growth response to different concentrations of the potentially toxic chemicals in blowdown water.

6.1.1.11.1 Field Procedures

On October 10, 1974, in connnection with the Year II field studies, a 20 l whole water sample was taken at Station 442.3, immediately below the proposed location of the Perkins discharge structure. The sample was composited in a 10% v/v HCl-washed 20 l carboy from ten 2.2 l Van Dorn samples. Temperature was measured with a mercury thermometer. A subsample for algal analysis was preserved with copper sulfate at an effective concentration of about 150 mg/l. Photosynthetically active radiation (PAR) was measured at the water surface with a quantum meter. A vertical profile of PAR was also taken. PAR represents radiation energy in the waveband 400 to 700 nm, most of which is actually used by algae, and therefore is inherently better than a non-energy measure such as foot-candles.

6.1.1.11.2 Laboratory Procedures

Upon return to the laboratory (about 1 1/2 hours) in vivo chlorophyll fluorescence is measured on the sample using a Turner Model 111 Fluorometer equipped with a Corning 5-60 primary filter and a Corning 2-60 secondary filter. The zero of this instrument is set with distilled water and all measurements are made using the 10X window. Distilled water dilutions are made when sample fluorescence exceeds 90 units. Justification for this method is as follows:

1) the filters are highly specific for chlorophyll-a excitation and emission wavelengths, 2) distilled water represents zero chlorophyll-a concentrations, 3) fluorometer response is not linear above 90 units on the 0-100 scale, and 4) window factors may change when measuring in vivo fluorescence on different natural samples if different windows are used.

Sample preparation consists of autoclaving the whole water sample at 121 C (15 psi) for 30 minutes. Because of the size of the autoclave, water must be autoclaved in 4 l quantities, which are then composited and cooled to room temperature overnight. The sample is autoclaved to kill all living material and to make all bound organic matter available for algal production. The warm autoclaved sample is filtered through Gelman glass fiber filters to remove large particles and then through Millipore 0.45 μm membrane filters for removal of smaller material.

Dry weight is determined by vacuum (up to 640 mm Hg) filtration of prepared sample through tared Millipore membrane filters (0.8 μm pore size, 25 mm diameter) set up on Millipore's microanalysis apparatus. The filtrate is collected in 10% v/v HCl-washed plastic cups and used in nutrient analysis. Filters are tared and weighed on a Mettler H51 balance to 0.01 mg. About 30 ml is filtered, depending on the quantity of membrane pore-clogging materials in the sample. Dry weights are reported as mg/l to the nearest 0.1 mg/l. The 0.8 μm pore size was chosen because no test algae are smaller than this, and it allows smaller particles such as bacteria and debris to pass through without clogging the filter.

Nutrient analyses are performed on the prepared sample as soon as possible, generally on the same day as collection. If analysis must be delayed, samples are stored in the refrigerator at 4 C or below. Analyses are performed for ammonia nitrogen, nitrate plus nitrite nitrogen, total phosphorus, filterable orthophosphate, and silicon according to the procedures described in Subdivision 6.1.1.4.

The sample preserved with $CuSO_4$ is analyzed for algal species composition and cell numbers. A whole-water count is made if cell concentration is sufficient; otherwise the sample is centrifuged (2000 Xg), the centrifugate withdrawn and the pellet resuspended and counted. Counts are made by filling the chamber of a Palmer-Maloney nannoplankton counting cell with sample and examining it at 400X using an Olympus EHT phase contrast microscope. A calibrated Whipple grid in one of the eyepieces allows a known volume to be counted. The 400X magnification is sufficient to enable identification of most algal species. All counts are reported as cells per milliliter.

The flasks used in the static assay are polycarbonate plastic. They are relatively inert to most chemicals, do not encourage the growth of attached algae as much as glass flasks, and are non-breakable. Each flask is scrubbed with a flask brush and Fisher FL-70 detergent, which contains no phosphorus. The flask is rinsed twice in tap water and is then washed in 10% v/v HCl. This is followed by two tap water rinses and four distilled water rinses. Each flask is then capped with aluminum foil until the sample is prepared. This cleaning procedure is carried out prior to sample collection.

The algae Nitzschia palea and Scenedesmus apiculatus, isolated from the Yadkin River in August, 1974, are used. Identical inocula of the test algae are added to triplicate flasks containing 100 ml of reference assay medium NAAM[1], i.e., the culture medium in which the algae are maintained and for which accurate growth curves and specific growth rates are known. This replicate acts as an external control (not connected with the assay of Yadkin River water) and thereby indicates if some condition of incubation (e.g., light, temperature) is out of specifications. Should this be the case, the entire assay will be scratched and repeated at later convenience.

The flasks are rinsed with 20 to 30 ml of the prepared sample and then filled with 100 ml of sample. An algal inoculum (less than 0.5 ml, volume dependent on cell density in stock culture) is introduced into each flask to give an initial cell density of 3000 cells/ml of Scenedesmus apiculatus and 5000 cells/ml of Nitzschia palea.

The test chemicals are then added to randomly selected flasks. For the October, 1974, assay, three tests were run in five dilutions, all in triplicate flasks. The volume of each spike was equal to or less than 1 ml. The first test was with Calgon CL-134 (a corrosion and deposit inhibitor) which consists of 10% of a short-chain polyacrylate polymer and aminomethylene phosphonate, equivalent to 8.6% PO_4. Product usage is expected at 30 mg/l. The second was with American Cyanimid's Cytox 2013 (an alternate non-oxidizing biocide) which contains dodecylguanidine hydrochloride as a 33% solution in 15% isopropanol. Product usage is expected to be 10 to 30 mg/l no more than twice a week. The third was a combination of CL-134 and Cytox 2013 to detect any synergistic or antagonistic effect. An internal control was run with autoclaved, filtered river water.

Calgon CL-134 was tested at concentrations of 30, 3, 0.3, 0.03, and 0.003 mg/l as PO_4-P. The Cytox 2013 series was evaluated at 30, 3, 0.3, 0.03, and 0.003 mg/l of dodecylguanidine hydrochloride. The dilution series for CL-134 plus Cytox 2013 were run by innoculating 30, 3, 0.3, 0.03, and 0.003 mg/l of each chemical. These dilutions bracket the expected discharge concentrations.

Once all chemicals have been added the flasks are transported to the incubator, located in another building 50 m away. During this period they are subjected to the ambient outdoor temperature and light conditions. The effect of this is unknown. The flasks are placed randomly in the incubator and kept under a light period PAR of 125 $\mu e/m^2/sec \pm 10\%$ and a temperature of 32.2 C $\pm$ 2 C (90 F). The PAR chosen is about 12% of normal incident PAR on a sunny day and near the saturation level, beyond which the rate of photosynthesis no longer increases with increasing light. The temperature chosen is the expected maximum discharge temperature. Lighting in the incubator is adjusted to simulate seasonal sunrise and sunset. For the assay reported in 2.7.2.7 this period was 13 hours light and 11 dark.

Beginning the third day after inoculation, chlorophyll fluorescence is determined on each flask in order to plot a growth rate curve and to determine the maximum specific growth rate, μ_{max}. The daily specific growth rate, μ, will be calculated for each flask from the equation

$$\mu = \frac{\ln (x_2/x_1)}{t_2-t_1} \ \text{day}^{-1}$$

where x_2 = chlorophyll fluorescence at end of selected time interval

x_1 = chlorophyll fluorescence at beginning of selected time interval

t_2-t_1 = elapsed time in days between selected fluorescence determinations

These parameters show growth patterns of the algae as a response to the particular environmental situation. They also show how rapidly the algae respond to environmental stress.

On the twelfth day after initiation, the October, 1974, assay was terminated. Chlorophyll fluorescence, dry weight, and cell counts were done on each flask in the assay. Replicates were composited for nutrient analysis. All procedures were in accordance with those previously described.

6.1.1.12 Adequacy of Sampling : Year I

Q 6.1.6

6.1.1.12.1 Purpose

A Duncan's multiple range test was conducted on data sets for phytoplankton, zooplankton and benthos to see if the location of sampling stations at Stations 4, 27 and 7 was sufficient to characterize those communities in the stretch of the Yadkin River which runs immediately past the plant. Where possible the test was run on data sets for numbers of species and numbers of organisms at Stations 4 (replicate a), 27, 7, 8 and 10, and for sampling periods 3 through 8. Missing data sets made this impossible for periods 3, 4 and 8 for zooplankton and Station 4 for benthos. The test is shown in detail for Numbers of phytoplankton species; thereafter only the results are shown.

6.1.1.12.2 Results

I. Duncan's Multiple Range Test for Numbers of Phytoplankton Species:

Station Number

	4a		27		7		8		10	
Period	X	X^2	X	X^2	X	X^2	X	X^2	X	X^2
3	15	225	24	576	34	1156	17	289	39	1521
4	15	225	7	49	13	169	23	529	27	729
5	11	121	12	144	15	225	14	196	15	225
6	9	81	21	441	16	256	16	256	10	100
7	12	144	17	289	25	625	18	324	12	144
8	16	256	25	625	22	484	20	400	13	169
Total:	78	1052	106	2124	125	2915	108	1994	116	2888
Mean:	13.0	175.3	17.6	354.0	20.8	485.8	18.0	332.3	193	481.3

Ranked means of number of species		4a	7	27	8	10
	Station:	4a	7	27	8	10
	Mean:	13.0	20.8	17.6	18.0	19.3

Part A. (1) $\frac{(X_{i}:)^2}{N} = \frac{(521)^2}{30} = 9469.6$

(2) $(X_{i}:)^2 = 10973$

(3) Subtract (2) - (1) = 1503.4

(4) Add each column of $X_{i}:$, square sums, add, divide by number of replicates in column:

$\underline{(78)^2 + (106)^2 + (125)^2 + (108)^2 + (116)^2} = 9677.5$

(5) Subtract (4) - (1) = 207.9

(6) Subtract (3) - (5) = 1295.5

(7) Divide (6) by C (4-1) = 51.82 (where C=5 columns and r= 6 rows)

(8) Divide (7) by r and take square root = 2.94

Part B. (1) Arrange means in ascending order - done above

(2) Tabulate number of means to compare, adjacent comparisons use value under 2; those removed from each other by 1, use value under 3; removed by 2, use value under 4; removed by 4, use value under 5.

	2	3	4	5
Tabulated From Table A8*	2.9105	3.065	3.145	3.215
	x 2.94	x 2.94	x 2.94	x 2.94
	8.557	9.011	9.246	9.452

(3) Subtract each pair of means, i.e. mean of Station 27 - mean of Station 4a, 8-27, 10-8, 7-10, 8-4, 10-27, 7-8, 10-4, 7-27, 7-4:

Station means subtracted

adjacent

10-4a = 17.3 - 13.0 = 4.3
27-10 = 17.6 - 17.3 = 0.3
8-27 = - 17.6 = 0.4

27-4a = 17.6 - 13.0 = 4.6
8-27 = 18.0 - 17.6 = 0.4
10- 8 = 19.3 - 18.0 = 1.3
7-10 = 20.8 - 19.3 = 1.5

* Steel and Torrey[1]

```
            ( 8 - 4a = 18.0 - 13.0 = 5.0
1 apart     (10 - 27 = 19.3 - 17.6 = 1.7
            ( 7 -  8 = 20.8 - 18.0 = 2.8

2 apart     (10 - 4a = 19.3 - 13.0 = 6.3
            ( 7 - 27 = 20.8 - 17.6 = 3.2

3 apart     (7.8 - 4a = 20.8 - 13.0 = 7.8
```

(4) If value after subtraction of means is greater than tabulated value for adjacent means (under 2), then there is significant difference between those two stations at = .05 for average number of phytoplankton species. Significance is shown by lack of underlining below means for stations (see directly above Part A, 1). Also significance is designated by * beside subtracted pairs of means.

(5) There were no significant differences among any stations tested, using time periods as replicates, for numbers of phytoplankton species.

II. Duncan's Multiple Range Test for Estimated Density (no./ml) of Phytoplankton:

	Station Number									
	4a		27		7		8		10	
Period	x	x^2	x	x^2	x	x^2	x	x^2	x	x^2
3	213	45369	392	153664	452	204304	121	14641	512	262144
4	150	22500	327	106929	136	18496	136	18496	236	55696
5	209	43681	391	152881	205	42025	226	51076	186	34596
6	162	26244	627	393129	468	219024	365	133225	156	24336
7	231	53361	408	166464	532	283024	607	368449	188	35344
8	557	310249	602	362404	490	240100	390	152100	162	26244
Total	1522	501,404	2747	1335471	2283	1006973	1845	737987	1440	438360
Mean	253.7	83567	457.8	222578.5	380.5	167828.8	307.5	122997.8	240	73060

Ranked means of total phytoplankters:						
	Station:	10	4a	8	7	27
	Mean:	240.0	253.7	307.5	380.5	460.8

adjacent
- Station means subtracted
- 4-10 = 253.7 - 240.0 = 13.7
- 8-4 = 307.5 - 253.7 = 53.8
- 7-8 = 380.5 - 307.5 = 73.0
- 27-7 = 457.8 - 380.5 = 77.3

1 apart
- 8-10 = 307.5 - 240.0 = 67.5
- 7-4 = 380.5 - 253.7 = 126.8
- 27-8 = 457.8 - 307.5 = 150.3

2 apart
- 7-10 = 380.5 - 240.0 = 140.5
- 27-4 = 457.8 - 253.7 = 204.1 *

3 apart
- 27-10 = 457.8 - 240.0 = 217.8 *

III. Duncan's Multiple Range Test for numbers of zooplankton taxa:

	Station Number									
	4a		27		7		8		10	
Period	x	x^2	x	x^2	x	x^2	x	x^2	x	x^2
5	5	25	7	49	5	25	6	36	8	64
6	7	49	10	100	9	81	5	25	2	4
7	13	169	4	16	4	16	14	196	17	289
Total:	25	243	21	165	18	122	25	257	27	357
Mean:	8.3	81	7	55	6	40.7	8.3	85.7	9	119

Ranked means of zooplankton taxa:						
	Station:	7	27	4a	8	10
	Mean:	6	7	8.3	8.3	9

	Station means subtracted
adjacent	27 - 7 = 7 - 6 = 1.0
	4 - 27 = 8.3 - 7 = 1.3
	8 4 = 8.3 - 8.3 = 0.0
	10 - 8 = 9 - 8.3 = 0.7
1 apart	4 - 7 = 8.3 - 6 = 2.3
	8 - 27 = 8.3 - 7 = 1.3
	10 - 4 = 9 - 8.3 = 0.7
2 apart	8 - 7 = 8.3 - 6 = 2.3
	10 - 27 = 9 - 7 = 2
3 apart	10 - 7 = 9 - 6 = 3

IV. Duncan's Multiple Range Test for total numbers of zooplankton organisms:

	Station Numbers									
	4a		27		7		8		10	
Period	x	x^2	x	x^2	x	x^2	x	x^2	x	x^2
5	305	93025	35	1225	101	10201	97	9409	109	11881
6	452	204304	681	463761	306	93636	36	1296	26	676
7	479	229441	501	251001	177	31329	1335	1782225	3346	11195716
Total:	1236	526770	1217	715987	584	135166	1468	1792930	3481	11208273
Mean:	412.0	175590.0	405.6	238661.3	194.6	45055.3	489.3	597643.3	1160.3	3736091.0

Ranked means of total zooplankters:						
	Station:	7	27	4a	8	10
	Mean:	194.6	405.6	412.0	489.3	1160.3

Station means subtracted

adjacent
- 27-7 = 405.6 - 194.6 = 211.0
- 4-27 = 412.0 - 405.6 = 6.4
- 8-4 = 489.3 - 412.0 = 77.3
- 10-8 = 1160.3 - 489.3 = 671.0

1 apart
- 4-7 = 412.0 - 194.6 = 217.4
- 8-27 = 489.3 - 405.6 = 83.7
- 10-4 = 1160.3 - 412.0 = 748.3

2 apart
- 8-7 = 489.3 - 194.6 = 294.7
- 10-27 = 1160.3 - 405.6 = 754.7

3 apart
- 10-7 = 1160.3 - 194.6 = 965.7

V. Duncan's Multiple Range Test for Numbers of Benthic Taxa:

Station Number

	27		7		8		10	
Period	X	X^2	X	X^2	X	X^2	X	X^2
3	3	9	1	1	1	1	2	4
4	2	4	1	1	1	1	1	1
5	2	4	3	9	1	1	1	1
6	3	9	1	1	1	1	3	9
7	1	1	3	9	3	9	4	16
8	2	4	3	9	2	4	2	4
Total	13	31	12	30	9	17	13	35
Mean	2.16	5.16	2.0	5.0	1.5	2.83	2.16	5.83

Ranked means of Benthic Taxa:					
	Station:	8	7	10	27
	Mean:	1.5	2.0	2.16	2.16

Station means subtracted

adjacent
- 7 - 8 = 2.0 - 1.5 = 0.5
- 10 - 7 = 2.16 - 2.0 = 0.16
- 27 - 10 = 2.16 - 2.16 = 0.0

1 apart
- 10 - 8 = 2.16 - 1.5 = 0.66
- 27 - 7 = 2.16 - 2.0 = 0.16

2 apart
- 27 - 10 = 2.16 - 1.5 = 0.66

VI. Duncan's Multiple Range Test for total numbers of benthic organisms:

Station Number

	27		7		8		10	
Period	x	x^2	x	x^2	x	x^2	x	x^2
3	393	154449	115	13225	29	841	38	1444
4	129	16641	17	289	345	119025	926	857516
5	297	88209	144	20736	345	119025	38	1444
6	603	363609	1129	1274641	325	105625	116	13456
7	19	361	269	72361	642	412164	408	166464
8	469	219961	393	154449	1024	1048576	1129	1274641
Total	1910	843230	206.7	1575701	2710	1805256	2255	2314965
Mean	318.3	140555.0	344.5	262616.8	451.8	300876.0	375.8	385827.5

Ranked means of total numbers of benthic organisms:					
	Station:	27	7	10	8
	Mean:	318.3	344.5	375.8	451.8

	Station means subtracted				
adjacent	7-27	=	344.5 - 318.3	=	26.2
	10-7	=	375.8 - 344.5	=	31.3
	8-10	=	451.8 - 375.8	=	76.0
1 apart	10-27	=	375.8 - 318.3	=	57.5
	8-7	=	451.8 - 344.5	=	107.3
2 apart	8-27	=	451.8 - 318.3	=	133.5 *

6.1.1.12.3 Conclusions

The numbers of taxa for all three groups of aquatic organisms (phytoplankton, zooplankton and benthos) were not significantly different among any of the river stations above High Rock Lake (4, 27, 7, 8 and 10) over the six sampling periods tested. On the same basis, phytoplankton densities were significantly different only between Stations 4 and 27 and between 27 and 10 (i.e. the vicinity of the intake/discharge structures differed significantly only between stations which were several river miles upstream and downstream of it).

The Duncan multiple range test requires that equal numbers of sets of data be evaluated. Missing data sets at various stations for both zooplankton and benthos prevent the use of all six sampling periods. The stations which were tested showed no significant differences in numbers of taxa or numerical densities, except for Station 27 and 8, which differed for density of benthos.

In June, 1974, Stations 28 and 29, above and below Dutchman Creek, respectively, were added for sampling benthos, and transects were taken at those stations and at 27 and 7.

The stations established for the Year II program (Figures 6.1.1-1 and 6.1.1-2) are centered in the site area. Samples are taken in both riffle and sand-bottom stretches of the river, and several transects have been established, as explained in Subsection 6.1.1.2.

6.1.2 GROUNDWATER

Groundwater levels at the site were determined by measurement at over 100 soil and rock borings after a 24-hour stabilization period. To provide long-term observations of groundwater elevations, many of the test borings were cased with slotted PVC pipe. After installation the pipe was bailed to insure inflow of groundwater. Groundwater variations with time are being periodically recorded in the cased test borings and continually recorded at two borings with a Leupold and Stevens Model F automatic recorder.

Chemical and physical tests were conducted on water from 8 wells located in the vicinity of the site and from 5 borings at the site. The results of these tests are given in Section 2.5.

6.1.3 AIR

6.1.3.1 Meteorology

Onsite meteorological equipment became operational on October 11, 1973. Meteorological measurements have been made for wind direction and speed, horizontal wind direction fluctuation, temperature and vertical temperature gradient, dew point and rainfall. Sensors, supporting towers and instrument shelter are shown in Figure 6.1.3-1. The instrument shelter is environmentally controlled; that is, it is heated and air conditioned. Relative positions of instruments with respect to station yard are noted in Figure 6.1.3-2. Relative elevations of both surface levels and instrument levels are depicted in Figure 6.1.3-3. The locations of both wind measuring systems, the resistence thermometers, and the dew point instrument are clearly indicated.

Present wind measurements are made with the Packard Bell Model W/S 101B Series Wind Direction - Speed System with starting thresholds of 0.7 and 0.6 miles per hour for direction and speed respectively. Temperature and delta temperature measurements are presently made with the Leeds and Northrup 8100 Series 100 Ohm Resistance Temperature Device with Packard Bell Model 327 Thermal Radiation Shields. Dew point is taken from the EG&G dew point hygrometer Model 110S-M; and rainfall is measured with the Belfort weighing rain gauge Model 5-780. Wind direction and speed are recorded in the instrument shelter on Esterline Angus Model A 601 C Strip Chart Recorders with a system accuracy of ± 5.4 degrees for direction and $\pm$ 0.45 miles per hour for speed. Temperature, delta temperature and dew point are recorded on the Leeds and Northrup Speedomax W Recorder with a system accuracy of $\pm$ 1 F for temperature at 30 foot level, of $\pm$ 0.5 F for delta temperature (130 foot level referenced to the 30 foot level) and of $\pm$ 1 F for dew point at 30 foot level. The accuracy of the delta temperature instruments available for the onsite measurements did not enable us to comply with the recommendations of Regulatory Guide 1.23. Delivery of instruments which do comply with Guide 1.23 is expected shortly. We will provide a comparison of relative concentration (χ/Q) values calculated using both systems simultaneously for one month. The results will appear in Section 6.2.4. Measured rainfall has an accuracy of $\pm$ 0.03 and $\pm$ 0.06 inch for first and second pen sweeps respectively. Q 6.1.:

Currently all data are reduced manually and keypunched for storage on magnetic tape. Procedures for data reduction are as follows:

Wind direction and speed are averaged over 30 minute intervals preceding each hour and logged on the hour. Wind range is measured during 30 minute intervals preceding each hour and logged on the hour. Wind direction and speed are averaged with a transparent straight edge making a visual integration by equal area apportionment. Wind range is measured by counting direction intervals between extreme directions, eliminating momentary peaking.

Temperature and delta temperature are averaged over one hour intervals, 30 minutes before and after each hour and logged on the hour. Temperature corresponds to absolute temperature trace. Delta temperature is the difference in the reading between the lowest and highest sensor (100 foot separation). Both temperature and delta temperature are averaged by the equal area technique employed in reduction of wind data.

Dew point is averaged over one hour intervals, 30 minutes before and after each hour and logged on the hour. Averaging again is made by the equal area technique.

Rainfall is noted for each hour (by taking the difference in total rainfall between successive hours) and logged on the hour.

The establishment of onsite and near vicinity characteristics of visibility with respect to fog will be determined for at least a period of one year prior to the operation of cooling towers. Evaluation of mechanical devices to sense visibility is currently under way with the expectation of a program to follow aimed at the simultaneous observation of visibility at locations projected to be influenced by cooling tower plumes, and other points of public interest. Observations before and after operation of the plant will be correlated to visibility observations at a control site beyond the influence of cooling tower plumes. These observations will account for fog variation due solely to regional influence in order to adequately assess the contribution from cooling tower sources.

Subsection 5.1.5 describes the methods used in prediction of local fogging, icing and drift deposition. A height representative of release of cooling tower effluent will be 130 ft for wind direction and speed considerations; the height representative of release of cooling tower effluents for humidity considerations will be taken as 30 ft. Q 6.1.1

A subsequent set of onsite measurements will be made at a permanent meteorological facility for assessment of diffusion prior to filing the Final Safety Analysis Report. These measurements will be initiated after site clearing and excavation have rendered the elevations and exposure representative of final plant conditions. The tentative plan for location of the permanent meteorological facility is northwest of the plant at a distance of approximately 1600 feet. These measurements will be initiated as soon as practical after site
3 clearing and excavation have rendered the elevations and exposure representative of final plant conditions. Duke will commit to taking at least one-year of meteorological data prior to filing FSAR; however, additional data will be taken if the sequence of permitting and construction activities allow. Data collection from all instrumentation will comply with Regulatory Guide 1.23 with regard to accuracies and sensitivities. Instrument heights will remain unchanged. The following system description represents our current thinking. Wind speed and direction sensors will be installed at the 30 foot and 130 foot level. Wind speed sensors are planned to be three cup anemometers with a starting threshold of 0.6 mph and an accuracy of ± 0.5 mph. Wind direction sensors Q 6.1.4 are planned to be damped vanes with a range of 0-540°, a starting threshold of 0.7 mph and an accuracy of ± 5°. The temperature gradient between the 30 and 130 foot levels will have an accuracy of ± 0.18° F, and the ambient temperature and dew point temperature sensors will have accuracies of ± 0.85° F. Finally, each sensor will be interrogated at a frequency to be determined later and the data will be recorded in real time on magnetic tape and processed by computer thus eliminating manual data reduction. A weighing rain gauge will also be installed at the site.

The joint frequency distribution of wind speed and direction by atmospheric stability class from data at the permanent facility will be compared with joint frequency distributions from data taken under the present program.

6.1.3.2 Models

6.1.3.2.1 Short Term (Accident) Diffusion Estimates

Hourly dilution factors are developed by computation from the widely accepted Pasquill-Gifford gaussian equation[1]:

$$X/Q = \frac{1}{\bar{u}\,\pi\left(\sigma_y \sigma_z + \frac{CA}{\pi}\right)} \qquad \text{Eqn. 2.3.4-1}$$

where X/Q = normalized concentration at plume centerline (sec/m^3)

$\bar{u}$ = mean wind speed through the vertical extend of the plume (m/sec)

σ_y = crosswind concentration distribution standard deviation (m)

σ_z = vertical concentration distribution standard deviation (m)

C = containment structure shape factor - 0.5

A = cross-sectional area of containment structure normal to the wind $=2696 m^2$

Crosswind and vertical standard deviations are those suggested by D B Turner.[2] The factor ($\sigma_y \sigma_z + \frac{CA}{\pi}$) is a measure of plume spread. This factor is restricted to be no greater than ($3\,\sigma_y \sigma_z$) as recommended in Regulatory Guide 1.42.

To provide the necessary wind and stability information, a joint stability-wind distribution is generated which displays the joint frequencies of wind direction and speed by atmospheric stability type.

The cumulative frequency distribution for hourly dispersion factors results from summation of percentage values from the joint stability-wind distribution in decreasing order of normalized concentration for selected wind speed class intervals and stability categories.

Stability categories are determined by vertical temperature gradient according to the following schedule:

Stability Class	Vertical Temperature Gradient
G	greater than +2.2° F in 100 ft
F	+0.9 to +2.2° F in 100 ft
E	-0.3 to +0.8° F in 100 ft
D	-0.8 to -0.4° F in 100 ft
* B-C	-1.0 to -0.9° F in 100 ft
A	less than -1.0° F in 100 ft

*The small range of temperature gradient defining stability categories B and C precludes a differentiation of these stabilities from the field data. In all such cases, the plume spread parameters for C stability (less unstable than B) are used.

Estimates of diffusion for longer time periods up to 30 days after an accident are developed from dilution factors for 0-8 hours, 8-24 hours, 1-4 days, and 4-30 days following an accident. These dilution factors result from a gaussian diffusion model which stores and accumulates successive hourly X/Q values at angular intervals of five degrees at the low population zone boundary. Successive hourly values are calculated to crosswind distances of ± 20 degrees from observed wind directions. Points beyond ± 20 degrees for any one hour are assumed at zero concentration for that hour. Computation therefore is from:

$$X/Q = \frac{1}{\bar{u}\,\pi\left(\sigma_y \sigma_z + \frac{CA}{\pi}\right)} \quad \times \ \exp\left[-1/2 \ \frac{y^2}{\left(\sigma_y^2 + \frac{CA}{\pi}\right)}\right] \qquad \text{Eqn. 2.3.4-2}$$

Where y = crosswind distance from plume centerline (m).

The building wake factor, C times A, is included in the exponential term as suggested by Davidson[1]. Dispersion parameters, selection criteria and plume spread relationships are identical to those used for hourly estimates in Eqn. 2.3.4-1. Again, the plume spread factor is limited to be no greater than 3 times the value assumed for a ground level point source. Calm hours are included in the averages by assuming persistence in the wind direction last observed. The hourly concentrations are then combined to form cumulative frequency distributions of X/Q for the required averaging times; that is, 8 hours, 16 hours, 72 hours (3 days), and 624 hours (26 days). Successive averaging times overlap except for the first Δ H hours of one average and the final Δ H hours of the next. For example, the midnight to 8 am average and the overlapping 2 am to 10 am average are considered independent members of the 8-hour average frequency distribution with Δ H equal to 2 hours. The value of Δ H can increase with increasing averaging time without significantly altering the resultant frequency distributions. We have chosen Δ H values of 2 hours, 2 hours, 6 hours, and 24 hours for averaging times of 8 hours, 16 hours, 72 hours, and 624 hours respectively.

6.1.3.2.2 Long Term (Routine) Diffusion Estimates

Average dispersion factors are computed, covering the stated period of record, for angular intervals of five degrees at ten distance (to 50 miles), utilizing a computer program to store and accumulate successive hourly values. Q 6.1.3

The model for annual averages is identical to the model described for intermediate averages. Successive hourly values are calculated to crosswind distances of ± 20 degrees from observed wind directions. Points in the computational grid beyond ± 20 degrees for any one hour are assumed at zero relative concentration for that hour. A gaussian form is assumed with computation from:

$$X/Q = \frac{1}{\bar{u}\pi\left(\sigma_y \sigma_z + \frac{CA}{\pi}\right)} \times \exp\left[-1/2 \quad \frac{y^2}{\left(\sigma_y^2 + \frac{CA}{\pi}\right)}\right] \quad \text{Eqn. 2.3.4-2}$$

Where y = crosswind distance from plume centerline (m).

Dispersion parameters, selection criteria and plume spread relationships are identical to those used for short term estimates.

The diffusion model used for these annual average dilution factor estimates differs from the recommendations of Regulatory Guide 1.42, Appendix B. The 2 principal differences between the Guide 1.42 recommendations and the use of Equation 2.3.4-2 are as follows:

a) X/Q values are calculated at 5° intervals instead of averaged over 16 22.5° sectors; and

b) X/Q values are accumulated from a chronological record of meteorological data instead of employing the joint frequency distribution developed from the meteorological data.

Because the onsite winds are recorded to the nearest 5° direction, the model effectively assumes that the plume centerline is impacting some radial line of receptors at every hour. This assumption is slightly more conservative than the sector average approach. The use of a time series of meteorological data would be no different from the use of the frequency distribution meteorological data.

Two variations of the long term model described above are also used for special purposes. A value for Man-X/Q is calculated as a population weighted annual average X/Q within a 50 mile radius of the site. Annual average X/Q values used for radioiodine dosage calculations consider depletion of the plume by dry deposition. Each hourly X/Q value from Equation 2.3.4-2 is modified by a depletion factor which is a function of wind speed, stability and deposition velocity. The method emplyed is that presented by Van der Hoven[1] with a deposition velocity of 0.015 meters per second as suggested in Regulatory Guide 1.42.

6.1.4 LAND

6.1.4.1 Geology and Soils

Geological and soils studies were made at the site to determine the nature of subsurface conditions. A description of the investigative methods used to evaluate the soil and rock materials is presented in PSAR Appendix 2D, Chapter 2. Studies at the site have included test borings, test pits, insitu permeability tests, refraction profiling, in-hole wave velocity measurement, static and dynamic laboratory tests, and analyses of bearing capacity and settlement.

6.1.4.2 Land Use and Demographic Surveys

Methods used in land use and demographic studies are fully described in Section 2.2.

6.1.4.3 Terrestrial Ecology

A survey of plants and animals of the terrestrial communities at the Perkins site was initiated in the fall of 1973. A schedule of the survey work is presented in Table 6.1.4-2. Locations of all community stand replicates and census areas are shown in Figure 6.1.4-2. Q 6.1.8

6.1.4.3.1 Vegetation Study Methods

The goals of the vegetation survey were to construct accurate and detailed vegetation maps and to characterize the composition, structure and function of the major plant communities found on the site.

6.1.4.3.1.1 Vegetation Mapping

The major vegetation communities have been mapped using black and white aerial
3 photography (1:1000, 1:2000 or 1:20,000 scale) and color infra-red aerial photography (1:6,000 scale). Standard photogrammetric techniques[1] were used and an initial forest community type identificiation was based on tree size and shape, shadows, texture and pattern. On-site inspection was used to correlate the aerial survey with existing conditions. The vegetation was mapped at a
3 scale of 1:400 or 1:1000.

6.1.4.3.1.2 Community Analysis

Vegetation surveys were initiated at the Perkins site in November, 1973 and were concluded in mid-December, 1973. Initial survey objectives were to identify the major plant communities present in the site area and to catalog the dominant species in each community.

Three replicates of each community type were selected for detailed study. Permanent sampling stations for each replicate stand were established, marked and mapped (Figure 6.1.4-2). A belt transect 20 feet wide and Q 2.7.
150 feet long was established at each station within the stand. Due to Q 2.7.
past disturbances by man at the site (e.g. clearcutting for cultivation, logging, etc.), care was taken to place the sampling transect so as to maximize sampling of a particular community and minimize the edge effect of ecotonal areas. An initial plant species list was compiled by observation along the transects. All species encountered along the transect were classified as canopy, subcanopy, shrub, vine or herb.

Four sampling points, 50 feet apart, were set up along the center of the 150-foot belt transect. At each sampling point, basal area of tree species was determined by the Bitterlich Variable Radius technique.[2,3,4,5]

Within the 20' by 150' belt transect, the dominance class for each species present was estimated using a dominance scale (Table 6.1.4-1) devised by Poulton.[6] Q 2.7.

Frequency of occurrence of individual species between replicates and between community types was calculated as a basis for system constancy indices. If similar samples are taken from a series of stands belonging to one association, or community, a constancy value for each species can be calculated. Two types of constancy data were determined: inside system constancy and outside system constancy. Inside system constancy is the percent occurrence of a given species in several replicate stands of the same community:

$$\text{Inside system constancy} = \frac{\text{Number of stands of a community in which a species was observed}}{\text{Total number of stands of the community sampled}} \times 100$$

Outside system constancy of a given species is its percent occurrence in stands of other communities.

$$\text{Outside system constancy} = \frac{\text{Number of stands in other communities in which a species was observed}}{\text{Total number of stands sampled from other communities}} \times 100$$

Several synthetic concepts concerned with the grouping of stands into associations and communities have been proposed in the literature. Data collected on plant communities at the Perkins site can be used to characterize the communities in terms of constancy indices[7,8], similarity indices[9,10] fidelity[9], releve' methods[7,11] or other methods.[12,13]

6.1.4.3.1.3 Quadrat Sampling

A representative stand of each community type was characterized by detailed quadrat analysis.

Nested quadrats were laid out at 10-meter intervals along the belt-transect line established for the preliminary identification and description of major communities. The following quadrat sizes were used: 10 x 10 meters (100 m^2) for the tree layer, 4 x 4 meters ($16m^2$) for the shrub-sapling layer, and 1 x 1 meters (1 m^2) for the herbs and tree seedlings. Vines were sampled by using the 4 x 4 meter quadrat.[14] These quadrat sizes have been used by others in sampling the Eastern Deciduous Forest.[15,16,17] The concentric arrangement of the smaller quadrats within the 10 x 10 meter quadrat is shown in Figure 6.1.4-1.

A total count of all individuals was made for all species present within the nested quadrats. In order to be included in the count, the trunk, shoot or roots of a particular plant must be at least 50 percent within the quadrat. Clumps of grasses and sedges were considered as individuals and their percent cover was visually estimated. The number of nested quadrats required to characterize the vegetation was determined using a species area curve.[18] When a 5 percent increase in sample size did not give a corresponding 5 percent increase in new species, the sample was considered adequate.

Plants were classified as trees, saplings, shrubs, seedlings, vines and herbs, defined as follows: a tree is any tall, woody perennial plant, usually with a single trunk, and a height greater than 3 meters. Saplings are trees between 1 and 3 meters in height. Shrubs, having a height between 1 and 3 meters, are much-branched woody perennial plants without a single trunk. Tree seedlings have a height between 0 and 1 meter. Herbs (0-1 meter) are usually low, soft, or coarse plants with annual above-ground stems. A vine is an elongated, weak-stemmed annual or perennial plant with herbaceous or woody texture.

For all species, density, frequency, dominance, relative density, relative frequency, relative dominance, density-frequency-dominance (dfd index) values, and importance values were determined.

Basal area, as measured by a standard dbh (diameter breast high) tape, was determined for all woody species whose trunks measured 30 cm or more in circumference 1 meter above the ground. Cover was estimated using the combined cover-abundance scale of Braun-Blanquet [7]:

Percent	Cover Class	Description
1%	X	sparsely and very sparsely present, cover very small
5%	1	plentiful but of small cover value
10%	2	very numerous, and covering at least 1/20 of the area
37%	3	any number of individuals covering 1/4 to 1/2 of the area
62%	4	any number of individuals covering 1/2 to 3/4 of the area
87%	5	covering more than 3/4 of the area

Individual species data were generated using the following formulae:

$$\text{Density} = \frac{\text{number of individuals}}{\text{area of sample}}$$

$$\text{Frequency} = \frac{\text{number of quadrats in which species occurs}}{\text{number of quadrats sampled}}$$

$$\text{Dominance (canopy and subcanopy)} = \frac{\text{total basal area}}{\text{total area sampled}}$$

Dominance (shrubs, seedlings, saplings, vines and herbs) =

$$\frac{\text{sum of cover estimates for an individual species}}{\text{number of quadrats sampled}}$$

$$\text{Relative density} = \frac{\text{density of a given species}}{\text{total density of all species}} \times 100$$

$$\text{Relative frequency} = \frac{\text{frequency of a given species}}{\text{total frequency of all species}} \times 100$$

$$\text{Relative dominance} = \frac{\text{dominance of a given species}}{\text{total dominance of all species}} \times 100$$

dfd index = density + frequency + dominance

Importance value = relative density + relative frequency + relative dominance.

The importance value is a measure of the total importance of a species within a community and is considered a relevant indication of dominance.

6.1.4.3.1.4 Litter Production and Decomposition

Four leaf-litter traps were placed at 50-foot intervals along belt transects established in representative stands of each plant community at the site. The litter trap is a wire-mesh basket that samples a 0.5 m^2 area. Leaf-litter accumulated in the traps was removed quarterly in order to obtain a wet weight-dry weight measurement of the litter biomass. However, due to the heavy leaf fall in autumn, leaf litter was gathered monthly during that quarter.

The litter was weighed (wet weight) and the various components (twigs, fruits, leaves) were separated. In order to obtain measurements of each individual species' contribution to the litter sample, the groups were further separated into sub-samples by species. These subsamples were dried for 24 hours at 105° C then reweighed to determine dry weight (19). The annual production of leaf litter was determined by summing the dry weights obtained from each collection. Individual species contributions were determined for each species present in the community litter sample.

Leaf-litter standing crops were sampled in representative stands of each community type. A litter sample was taken 5 meters away from each leaf-litter trap along the belt-transects. Four samples per community were collected, each sampling an area of 0.5 m^2. The litter was weighed (wet weight), dried for 24 hours at 105 C and reweighed to determine dry weight. The samples were separated into sub-samples of deciduous litter and evergreen litter. These subsamples were further separated into leaves, twigs and fruits. Individual dry weights of the deciduous and evergreen components were obtained. The sample components were then re-mixed.

Representative samples of this leaf litter, 20% of the total dry weight of the standing crop from the 0.5 m^2 area sampled, were put into fiberglass-coated plastic screen litter bags measuring 22.4 cm on a side and sewn with nylon thread. The bag construction and size is similar to those described by Wiegert.[20] The filled bags were sealed with stainless steel safety pins and marked. In order to insure that decomposition would begin as soon as possible, the bags were soaked in water for 24 hours. They were then placed on the forest floor adjacent to their respective litter sample plots and attached to marked wooden stakes in order to guard against removal.

The litter in the bags was removed in August 1974, weighed (wet weight), dried and reweighed (dry weight). Litter decomposition rates were then determined for the major plant communities.

6.1.4.3.1.5 Floristics

Floristics is an observational and descriptive methodology that deals with the taking of a floral inventory of a geographical area.

The vegetation survey of the entire site was used to construct a presence list for dominant species at the site. The timing of the survey insured that most herbaceous species were recorded. Dates during which the floristic survey was conducted are shown in Table 6.1.4-2. Species samples were classified as to presence, range, habitat, community type, life form, diaspore type, duration and phenology.

Ranges are based on distribution of the species in the Carolinas. Source maps are contained in the Manual of the Vascular Flora of the Carolinas.[21]

Habitat classifications are descriptive of the location where the particular plant is found within the site area, such as road side ditch, abandoned field, marsh, etc.

One of the primary objective of this survey was to locate and identify endangered or rare species. Species that occur in five or fewer counties of North Carolina were considered rare. A species' regional occurrence was based on county distribution maps found in Radford, Ahles and Bell.[21]

Since habitat destruction is equivalent to species destruction, the occurrence of unique, uncommon or disjunct habitats in the site area was investigated.

Differences in duration[23] (life span), life (morphological) form, diaspore (seed dispersal) type,[23] and phenology are species adaptations to environmental demands.[23] They in part determine the degree of success or failure of a species in utilizing a particular type of habitat. These adaptations, by conferring a measure of competitive advantage, aid a plant in coping with a multiplicity of environmental factors. As such, they provide a basis for evaluating and comparing the adaptive structures and functions present in a plant community. Stability of the community can also be evaluated.

6.1.4.3.2 Animal Census Techniques

Determination of the abundance of animal species at the site will allow interpretation of impacts of construction and plant operation on animal populations. Analysis of occurrence of species by habitat type permits estimation of the intensity of use of habitats by different species. The sensitivity of species to proposed habitat alterations may then be assessed. The dates on which animal censuses were conducted are presented in Table 6.1.4-2.

6.1.4.3.2.1 Mammals

A mark-recapture method [24] was used to census mammals that can be readily captured in live traps (raccoons, opposums, rabbits, etc.). The basic method entails marking (with paint, ear tags, etc.) of all animals caught in live traps during a sampling period. As the marking of animals proceeds, the proportion of marked animals in the population will increase. The population is estimated by the formula:

$$P = \frac{\Sigma wx^2}{\Sigma wxy}$$

Where P = population,
w = number of marked and unmarked animals caught each time,
x = number of animals marked and released,
y = proportion of animals marked.

The trapping technique for the census method involves setting eight 18-inch box-type traps along a 450-foot transect line within a community. Traps are checked, mammals marked and released, and sprung traps reset daily during a sampling period. The traplines are run for a period of time sufficient to allow for a good probability of marked animal recaptures, thereby allowing population estimation.

The removal method [24,25] was used where possible to census small mammals (rodents, shrews, etc.). In this technique, animals are removed from the population as they are captured in snap traps. Therefore, the population of animals is depleted with each successive trapping of animals. To determine a population estimate, the number of animals caught during each trapping was regressed against the total number of animals previously captured. The point at which the regression line intersects the X-axis (Y=0) was the population estimate for the area being sampled by the trap configuration. This area was estimated by assuming that an individual of a given species whose home range intersects or is tangential to the trap line has a high probability of being captured. The area estimate is therefore based on a knowledge of the average home range size of each species as given in the literature.[27,28,29,30,31,32]

Three "museum special" snap traps were set out at each of 20 stations along a 450-foot transect line within a community. The trap lines were run for a period of time adequate to show a trend in population reduction assuming reasonable trapping success, thereby allowing estimation of population size. Traps were checked, mammals removed, and sprung traps reset once each day during the sampling period. If no trend of population reduction is apparent due to insufficient numbers of captures, a population density estimate may be made by dividing the number of animals trapped by the area sampled by the trap line.

The abundances of the larger mammals which cannot be easily captured (deer, bobcat, fox, etc.) were determined by road censuses and observation of "signs". The road census method involves driving the back roads and highways in the immediate vicinity of the site at twilight and dusk to detect the presence of these animals. "Signs" (tracks, scats, etc.) were also recorded when they were observed in conjunction with field sampling activities. Mist nets were set to capture bats in August, 1974.

Presence and abundance of aquatic mammals, such as otter, beaver, muskrat, etc., were estimated by field observation of signs (lodges, tracks, felled trees, etc.) as well as by sight records of the animals.

6.1.4.3.2.1 Birds

The relative abundance of bird species was determined on a seasonal (quarterly) basis. The technique employed entailed noting all birds seen along a 450-foot transect near each vegetation community analysis stand during daily one hour observation periods. The number of observation periods in which a species was sighted in a given community type was divided by the total number of observation periods within that community type. This fraction multiplied by 100 gives a percentage of occurrence which is a measure of relative abundance of bird species within each community type.[26] Species were then ranked in order of relative abundance for each quarter (fall, winter, spring, summer). Standard terms were used to designate relative abundance. These terms, with their frequency of occurrence rating definitions, are:

abundant	- 90% to 100%
common	- 65% to 89%
moderately common	- 31% to 64%
uncommon	- 10% to 30%
rare	- 1% to 9%

In addition to relative abundance data, one-acre study plots were established in one representative stand of each vegetation community present at the site to estimate breeding bird density.[26] Each plot was visited three times during the breeding season. Singing territorial males, territorial defense, courtship activity, nest construction and feeding of young were noted. The number of breeding pairs of each species in each community plot was recorded along with the locations of the breeding territories on a plot map so that comparisons could be made between visits.

6.1.4.3.2.3 Amphibians and Reptiles

Population densities of reptiles and amphibians were estimated on the basis of equal effort observations. One hour was spent censusing a one-acre plot in a representative stand of each major vegetation community at the site. Plots were thoroughly surveyed by tearing apart logs, searching under wood or rocks in contact with the soil, searching in and under litter and cruising each stand while carefully watching for reptiles and amphibians.

Animals were captured, identified, counted, and released in the same plot. Estimates of abundance for aquatic reptiles and amphibians were based on records and captures incidental to other sampling pursuits. Censuses were conducted during the spring and summer quarters (Table 6.1.4-2).

6.1.5 PRE-OPERATIONAL RADIOLOGICAL MONITORING PROGRAM (RADIOLOGICAL SURVEY)

The pre-operational phase of the Radiological Monitoring Program for the Cherokee Nuclear Station provides data on the existing environmental radioactivity levels for the site and vicinity. This phase provides data which can be used to evaluate whether increases in environmental radioactivity levels in the vicinity of the station after it becomes operational are attributable to station operations.

This monitoring program includes the guidance of the Environmental Protection Agency, as established in their "Environmental Radioactivity Surveillance Guide", ORP/SID 72-2, in selecting the choice of samples, sampling locations, and, somewhat indirectly, laboratory instrumentation. This program provides surveillance of all likely critical exposure pathways to man, and satisfies legitimate interests of the Company, of the public, and of state and federal agencies concerned with the environment. These agencies include the N. C. Division of Health Services, Survey and Consultation Section (Radiological Health); the Environmental Protection Agency; and the U. S. Department of Interior, Fish and Wildlife Service. Requirements of AEC Regulatory Guides have also been included in the design of the program.

The pre-operational phase of the Radiological Monitoring Program is outlined in Table 6.1.5-1. This table lists the type sample or measurement to be made, the criteria for selecting sampling locations, and the frequence of collection. Table 6.1.5-2 lists the type sample or measurement to be made, and the frequency of collection. Figure 6.1.5-1 maps the sampling locations, specifically denoting the well water sampling locations, the nearest dairy and the discharge point on the Broad River. A control dairy will be added. Table 6.1.5-2A lists the distance and direction from the station of all sampling points.

The Radiological Monitoring Program goes into effect two years prior to the operation of Unit 1, with monitoring of aquatic vegetation, plankton, and bottom organisms; terrestrial vegetation and crops; and fish. The remainder of the program goes into effect one year before operation.

Radioactive materials from station gaseous and liquid waste releases, if they can be detected at all beyond the Exclusion Area, are most likely to be found in samples of air and water from locations where these materials are dispersed by stream flow and wind. The Environmental Protection Agency, in Radiological Data and Reports, in the section on Air and Deposition, states that "Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission-product radioactivity". Precipitation and settled-dust samples, in conjunction with air-particulate samples, provide a basis for determining the fission-product radioactivity in the environment resulting from station-operation, and/or fallout from nuclear weapons and other sources. Therefore, air and water samples receive primary emphasis, both in the number of samples collected and in the frequency of collection. These samples ordinarily are counted for gross alpha and beta activity, to establish a "baseline" for evaluating increases in radioactivity in the vicinity of the station after it becomes operational. If, during this preoperational phase, the gross activity of an air or water sample exceeds twice the effective maximum permissible concentration (mpc) allowed, then the sample will be gamma-scanned. Gamma analyses are also made on representative composite samples. Radiochemical analyses are performed for strontium 89 and 90. Water samples are also analyzed for tritium. Q 6.2.1.3

The air particulate monitoring program will sample onsite at two or three points of "ground level maximum concentration" and offsite at one or two points of "ground level maximum concentration"; at Mocksville, the community within a ten-mile radius of the station; and a control location. The program will begin one year prior to operation. Preoperationally, air filters and charcoal cartridges will be collected monthly; samplers will be cycled to accumulate seven days' "on-time." Q 6.2.1.6

Samples of secondary importance in regard to numbers of samples and frequency of collection include river-bottom sediment, terrestrial and aquatic vegetation and plankton, fish, and milk. Fish samples include game fish, forage fish, and bottom feeders. River-bottom sediment and terrestrial and aquatic vegetation and plankton are counted for gross alpha and gross beta activity. If the gross activity exceeds a predetermined small fraction of any effective mpc limit (such as one percent of the mpc's for air and water in an unrestricted area, listed in 10CFR20 Appendix B), additional analyses will be made by use of a multichannel gamma analyzer and by radiochemical means. Gamma analyses are also made on representative composite samples. Fish are counted for gross beta activity; both fish and milk are subjected to gamma analysis as well as radiochemical analyses for Potassium 40, Strontium 89 and 90. Milk is also analyzed for tritium.

Measurements of gamma dose and dose rate are made. Thermoluminescent dosimeters are located in the prevailing wind directions and elsewhere and immersed in water downstream of the liquid effluent release point.

The sensitivity of these analyses and the size of samples taken permits absolute measurement of existing pre-operational radioactivity levels to be made.

The instrumentation and detection capabilities of counting systems are constantly being improved, so it is not feasible to commit to specific systems at this time. The generic instrumentation used for environmental surveillance is likely to include:

1. A thin-window, low-background, gas-flow proportional counter (bgd $\leq$ 1.0 cpm beta, $\leq$ 0.05 cpm alpha) used for gross alpha and gross beta activity measurements;

2. A dual-channel liquid scintillation counter for the measurement of tritium and gross beta activities;

3. A one-to-four-thousand-channel gamma spectrometer with a 4 x 4-inch right-cylinder NaI (Tl) crystal (7% resolution) and an 8-10 percent efficiency Ge(Li) detector (2.5 keV resolution) used for identification and measurement of gamma-emitting radionuclides; and Q 6.2.1.4

4. A thermoluminescent dosimeter reader and associated equipment used for measurement of radiation dose and exposure.

The sensitivity of the analyses for various radionuclides in representative samples is typically as follows:

	Gross Beta	Gross Alpha	Cs^{137}	Sr^{90}	Sr^{89}	I^{131}	Co^{60}
Air Particulates and Iodine, pCi/m3	$3x10^{-3}$	$1x10^{-3}$	$1x10^{-2}$	$1x10^{-3}$	$5x10^{-3}$	$1x10^{-2}$	-
All Water Samples and Milk, pCi/l	0.03	0.03	10	1	5	1	10
Fish and Animals, pCi/kg	-	-	80	5	25	-	-
Vegetation and Crops pCi/kg	-	-	80	5	25	-	-

Additional sensitivities are as follows:

K^{40} in fish and animals, 1.2 pCi/g

H^3 in water and milk, $3 \times 10^{-6}\mu Ci/ml$ by liquid scintillation counting and as low as $2 \times 10^{-9}\mu Ci/ml$ by electrolytic enrichment and gas counting.

The sensitivity of the radiation exposure measurements, (gross gamma) is approximately 10 mR for a three month integrated dose, and 0.005 mR/hr, for a dose rate measurement.

The environmental radioactivity sampling methods, analytical procedures, and sensitivities are essentially those proposed by the Environmental Protection Agency in their "Environmental Radioactivity Surveillance Guide", ORP/SID72-2. This "Guide" is supplemented as necessary with procedures from other sources including those of the American Public Health Association as described in their publication "Standard Methods for the Examination of Water and Wastewater" and those of the U. S. Public Health Service in their "Radioassay Procedures for Environmental Samples", 999-RH-27. Applicable procedures from AEC Regulatory Guides have also been used. In some cases, procedures not from the above sources are used which are in agreement with the EPA "Guide" in that the levels of accuracy and precision are equivalent to the recommended methods. Analyses to be performed on each type sample are listed in Table 6.1.5-3.

Analytical results from the monitoring are reported once as a summary of the pre-operational monitoring program. The report format is a computerized tabulation, by the type of sample, of the sample parameters recommended in Regulatory Guide 4.1. A range and mean is determined for sample results of the reporting period; a simple sign test is performed to determine an individual result's variation from the mean. Q 6.2.1.5

6.2 APPLICANT'S PROPOSED OPERATIONAL MONITORING PROGRAMS

The baseline studies discussed in Section 6.1 are providing initial data necessary to determine the physical, chemical, and biological variables which are likely to be affected by station construction and operation.

The proposed monitoring program to be used during station operation is outlined in this Section. As station construction and operation approach, the detailed information now being gathered will be used to more fully perfect the operational monitoring program.

6.2.1 OPERATIONAL RADIOLOGICAL MONITORING PROGRAM (ENVIRONMENTAL RADIOLOGICAL MONITORING)

The Operational Radiological Monitoring Program provides surveillance and backup support of detailed effluent monitoring which is necessary to evaluate individual and population exposures and the ecological significance, if any, of the contributions to the existing environmental radioactivity levels that result from station operation.

During operation of Perkins Nuclear Station, the only contributions of radioactive materials to the environment are from releases of low-level gaseous and liquid wastes, made in accordance with AEC regulations. The design and operation of the radioactive waste systems maintain the quantities of radioactive materials released as low as practicable within the regulatory limits. The objective of the Radiological Monitoring Program is to assure that the contribution of radioactivity to the environment is indeed negligible.

This monitoring program includes the guidance of the Environmental Protection Agency as established in their "Environmental Radioactivity Surveillance Guide," ORP/SID 72-2, in selecting the choice of samples, sampling locations, sampling methods, frequency of sampling, analytical procedures, and somewhat indirectly, laboratory instrumentation. This program provides surveillance of all likely critical exposure pathways to man and satisfies legitimate interests of the company, of the public, and of state and federal agencies concerned with the environment. These agencies include the N. C. Division of Health Services, Survey and Consultation Section (Radiological Health); the Environmental Protection Agency; and the U. S. Department of Interior, Fish and Wildlife Service. Requirements of AEC Regulatory Guides have also been included in the design of the program.

The operational phase of the Radiological Monitoring Program is outlined in Table 6.2.1-1. This table lists the type sample or measurement to be made, the criteria for selecting sampling locations, and the frequency of collection. Table 6.2.1-2 lists by actual sampling location the type sample or measurement to be made and the frequency of collection. Figure 6.1.5-1 maps the sampling locations, specifically denoting the well-water sampling locations, the nearest dairy, and the discharge point on the Broad River. A control dairy is being added. Table 6.1.5-2A lists the distance and direction from the station of all sampling points. Q6.2.1.2

The operational and pre-operational phases of the Radiological Monitoring Program are similar in design with increased analyses for iodine in the operational phase. Additional modifications will be incorporated as necessary to reflect any changes required as a result of pre-operational experience, local population growth, operational data from the Perkins Nuclear Station and similar stations, and appropriate regulations.

Radioactive materials from station gaseous and liquid waste releases will exist in extremely low concentrations in the environment. If they can be detected at all beyond the Exclusion Area, they are most likely to be found in samples of air and water from locations where these materials are dispersed by stream flow and wind. The Environmental Protection Agency, in Radiological Data and Reports, in the section on Air and Deposition, states that Q 6.2.1.1

"Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission-product radioactivity". Precipitation and settled-dust samples, in conjunction with air-particulate samples, provide a basis for determining the fission-product radioactivity in the environment resulting from station-operation, and/or fallout from nuclear weapons and other sources. Therefore, air and water samples receive primary emphasis, both in the number of samples collected and in the frequency of collection. These samples ordinarily are counted for gross alpha and beta activity. If, during the operational phase, the gross activity of an air or water sample exceeds the "baseline" activity (established by pre-operational monitoring) by 10 percent of the effective mpc allowed, the sample will be gamma scanned. Gamma analyses are also made on representative composite samples. Radiochemical analyses are performed for Strontium 89 and 90. Water samples are also analyzed for tritium.

Q 6.2.1.1

Q 6.2.1.3

The air particulate monitoring program will sample onsite at two or three points of "ground level maximum concentration" and offsite at one or two points of "ground level maximum concentration"; at Mocksville, the community within a ten-mile radius of the station; and a control location. The program will begin one year prior to operation. Operationally, the air filters will run continuously, and will be collected on a weekly (seven-day) basis. Operationally, analyses for iodine will be performed weekly; gross alpha and gross beta counting and gamma analyses will be performed monthly.

Q 6.2.1.6

Samples of secondary importance in regard to numbers of samples and frequency of collection include river bottom sediment, terrestrial and aquatic vegetation and plankton, fish and milk. Fish samples include game fish, forage and bottom feeders. River bottom sediment, terrestrial and aquatic vegetation and plankton are counted for gross alpha and gross beta activity. If the gross activity exceeds a predetermined small fraction of any effective mpc limit (such as one percent of the mpc's for air and water in an unrestricted area, listed in 10CFR20 Appendix B), additional analyses will be made by use of a multichannel gamma analyzer and by radiochemical means. Gamma analyses are also made on representative composite samples. Fish are counted for gross beta activity; both fish and milk are subjected to gamma analysis as well as radiochemical analyses for potassium 40, strontium 89 and 90. Milk is also analyzed for tritium.

Measurements of gamma dose and dose rate are made. Thermoluminescent dosimeters located in the prevailing wind directions and elsewhere and immersed in water downstream of the liquid effluent release point measure the direct dose effects of gaseous and liquid activity releases during the operating period.

Since concentration of radioactivity can occur in the environment, particular attention is devoted to evaluating the significance of any buildup of activity in these samples. Estimates of dose to man will be made if the above analyses show that significant amounts of radioactivity from station releases are accumulating in environmental samples (i.e., amounts that could possibly result in doses in excess of one percent of 10CFR20 limits). The sampling program is designed to permit these dose estimates to be made, if necessary. Analysis and concentrations of specific radionuclides in environmental samples are correlated with known station releases of the same nuclide. Although the preoperational monitoring results may serve as a base line for comparison with operational levels, such comparisons have been complicated in the past by fallout from nuclear testing and spatial and time variations in naturally occurring radioactive materials and radiation. Therefore, to assist further in evaluating the effect of the station releases on the environment during the operating period, the station's contribution of activity is differentiated from existing environmental levels by comparing levels found in similar samples collected at the same time in different locations. This is done by collecting samples both within and beyond the Exclusion Area, upstream and downstream, upwind and downwind from the station and in control locations sufficiently far removed from the station to be beyond its influence.

The sensitivity of these analyses and the size of samples taken permit absolute measurement of existing preoperational and operational radioactivity levels to be made even though they may be far below permissible levels.

The instrumentation and detection capabilities of counting systems are constantly being improved, so it is not feasible to commit to specific systems at this time. The generic instrumentation used for environmental surveillance is likely to include:

1) A thin-window, low-background, gas-flow proportional counter used for gross alpha and gross beta activity measurements; Q 6.2.1.4

2) A dual-channel liquid scintillation counter for the measurement of tritium and gross beta activity;

3) A one-to-four-thousand-channel gamma spectrometer with a 4 x 4 inch right-cylinder crystal and an 8-10 percent efficiency detector used for identification and measurement of gamma-emmitting radionuclides; and

4) A thermoluminescent dosimeter reader and associated equipment used for measurement of radiation dose and exposure.

The sensitivity of the analyses for various radionuclides in representative samples is typically as follows:

	Gross Beta	Gross Alpha	Cs^{137}	Sr^{90}	Sr^{89}	I^{131}	Co^{60}
Air Particulates and Iodine, pCi/m^3	3×10^{-3}	1×10^{-3}	1×10^{-2}	1×10^{-3}	5×10^{-3}	1×10^{-2}	-
All Water Samples and Milk, pCi/l	0.03	0.03	10	1	5	1	10
Fish and Animals, pCi/kg	-	-	80	5	25	-	-
Vegetation & Crops, pCi/kg	-	-	80	5	25	-	-

Additional sensitivities are as follows:

K^{40} in fish and animals, 1.2 pCi/g

H^3 in water and milk, 3×10^{-6} μCi/ml by liquid scintillation counting and as low as 2×10^{-9} μCi/ml by electrolytic enrichment and gas counting.

The sensitivity of the radiation exposure measurements, (gross gamma) is approximately 10 mR for a three month integrated dose, and 0.005 mR/hr, for a dose rate measurement.

When Appendix 1 was first proposed, the "as low as practicable" (ALAP) dose to the thyroid, resulting from I131 in milk, was defined as 5 mrems per year. To confidently determine a dose of 5 mrems per year, an analytical sensitivity of 0.5 pCi/l of I131 in milk was necessary. Dr. John Matuszek, who developed the procedure for analyzing milk for iodine - which was adopted with modifications for the Regulatory Guide - indicated, at a recent ANS meeting, statistical difficulties in obtaining the analytical sensitivity of 0.5 pCi/l ±25 percent error. These difficulties and the change of the ALAP definition from 5 mrems to 15 mrems per year indicate a more reasonable analytical sensitivity, such as 1.0-1.5 pCi/l ±25 percent error of I131 which is still a significantly small fraction of the 15-mrems-per-year thyroid dose. 15 mrems is the ALAP dose, not a radiation-protection standard. There is no regulatory requirement to remain ALAP within ALAP.

Q 6.2.1.7

The environmental radioactivity sampling methods, analytical procedures and sensitivities are essentially those proposed by the Environmental Protection Agency in their, "Environmental Radioactivity Surveillance Guide," ORP/SID72-2. This "Guide" is supplemented as necessary with procedures from other sources including those of the American Public Health Association as described in their publication, "Standard Methods for the Examination of Water and Wastewater" and those of the U. S. Public Health Service in their, "Radioassay Procedures for Environmental Samples," 999-RH-27. Applicable procedures from AEC Regulatory Guides have also been used. In some cases, procedures not from the above sources are used which are in agreement with the EPA "Guide" in that the levels of accuracy and precision are equivalent to the recommended methods. Analyses to be performed on each type sample are listed Table 6.2.1-3 .

The sensitivity of these procedures are more than adequate to provide surveillance for the small amounts of various radionuclides from waste releases at Perkins Nuclear Station that may be found in environmental samples. This insures the capability to determine that any resulting doses to the public from these materials will be well within the dose limits permitted by applicable AEC regulations and are as low as practicable. However, in most cases, since the actual releases are so low, it is not likely that radioactive materials released during normal operations and under design conditions can actually be detected in the off-site environment and that attributable to Perkins Nuclear Station actually distinguished.

This is due to the fact that concentrations in environmental samples are a very small fraction of existing background levels. Primary reliance in determining population doses depends, therefore, on effluent data. The program provides surveillance adequate to provide reasonable confirmation of calculations based on effluent release data.

Examples of the analytical sensitivity of the program versus concentrations in the environment and concentrations associated with applicable regulations for various radionuclides of concern may be found in Table 6.2.1-4.

Analytical results from the monitoring program are reported once as a summary of the pre-operational monitoring program, and semi-annually thereafter for the life of the station (in accordance with Tec Spec requirements) as part of the operating report for the nuclear station. Q 6.2.1.5

The report format is a computerized tabulation, by the type of sample, of the sample parameters recommended in Regulatory Guide 4.1. A range and mean is determined for sample results of the reporting period; a simple sign test is performed to determine an individual result's variation from the mean. Figure 6.2.1-1 is a copy of the semi-annual report form.

6.2.2 CHEMICAL EFFLUENT MONITORING

The chemical effluent monitoring program will be established to comply with requirements of the National Pollutant Discharge Elimination System (NPDES) permit which will be issued by the Environmental Protection Agency or by the State of North Carolina if the State program is approved at the time of issue. As a minimum, the sampling program will include:

Sampling Point	Frequency	Analysis	Sensitivity
Waste Water Treatment System Discharge	Daily	pH	± 0.1
	Daily	Conductivity	± 0.01 mmho
	Daily	Settleable Solids	± 0.1 ml/l

3

6.2.3 THERMAL EFFLUENT MONITORING

The thermal effluent monitoring program will include, as a minimum, continuous monitoring in the discharge canal of any blowdown discharged to the river. The complete monitoring program will be established to comply with the requirements of the NPDES Permit which will be issued for the station.

6.2.4 METEOROLOGICAL MONITORING

6.2.4.1 Meteorology

Onsite meteorological measurements have been made for wind direction and speed, horizontal wind direction fluctuation, temperature and vertical temperature gradient, dew point and rainfall. Sensors, supporting towers and instrument shelter (environmentally controlled, ie with heating, air conditioning) are shown in Figure 6.1.3-1. Relative positions of instruments with respect to station yard are noted in Figure 6.1.3-2. Relative elevations of both surface levels and instrument levels are depicted in Figure 6.1.3-3. A subsequent set of measurements (at a permanent meteorological facility) will be made for assessment of diffusion prior to filing the Final Safety Analysis Report which will be initiated after site clearing and excavation have rendered a topographic and relief form representative of final plant conditions (plant elevation and exposure). Prior to plant operation wind and temperature records will be housed in the reactor control room. Data collection from all
1 instrumentation will comply with Regulatory Guide 1.23 with regard to required accuracies and senstivities.

Present wind measurements are made with the Packard Bell Model W/S 101B Series Wind Direction - Speed System with starting thresholds of 0.7 and 0.6 miles per hour for direction and speed respectively. Temperature and delta temperature measurements are presently made with the Leeds and Northrup 8100 Series 100 Ohm Resistance Temperature Device with Packard Bell Model 327 Thermal Radiation Shields. Dew point is taken from the EG&G dew point hygrometer Model 110S-M; and rainfall is measured with the Belfort weighing rain gage Model 5-780. Wind direction and speed are recorded in the instrument shelter on Esterline Angus Model A 601 C Strip Chart Recorders with a system accuracy of $\pm$5.4 degrees for direction and $\pm$0.45 miles per hour for speed.

Temperature, delta temperature and dew point are recorded on the Leeds and Northrup Speedomax W Recorder with a system accuracy of $\pm$1 F for temperature (at 30 foot level), of $\pm$0.5 F for delta temperature (130 foot level referenced to the 30 foot level) and of $\pm$1 F for dew point (at 30 foot level). Measured rainfall has an accuracy of $\pm$0.03 and $\pm$0.06 inch for first and second pen sweeps respectively.

All data are reduced manually and keypunched for storage on magnetic tape. Procedures for data reduction are as follows:

Wind direction and speed are to be averaged over 30 minute intervals preceding each hour and logged on the hour. Wind range is to be measured during 30 minute intervals preceding each hour and logged on the hour. Wind direction and speed are to be averaged with a transparent straight edge making a visual integration by equal area apportionment. Wind range is to be measured by
2 counting direction intervals between extreme directions, eliminating momentary

peaking.

Temperature and delta temperature are to be averaged over one hour intervals, 30 minutes before and after each hour and logged on the hour. Temperature corresponds to absolute temperature trace. Delta temperature is delta reading between the lowest and highest sensor (100 foot separation). Both temperature and delta temperature are to be averaged by equal area technique employed in reduction of wind data.

1 Dew point is to be averaged over one hour intervals, 30 minutes before and after each hour and logged on the hour. Averaging again is to be made by equal area technique.

Rainfall is to be noted for each hour (by taking the difference in total rainfall between successive hours) and logged on the hour.

The establishment of onsite and near vicinity characteristics of visibility with respect to fog will be determined for at least a period of one year prior to the operation of cooling towers. Evaluation of mechanical devices to sense visibility is currently under way with the expectation of a program to follow aimed at the simultaneous observation of visibility at locations projected to be influenced by cooling tower plumes, and other points of public interest. Observations before and after operation of the plant will be correlated to visibility observations at a control site (beyond the influence of cooling tower plumes) for the purpose of accounting for fog variation due solely to regional influence in order to adequately assess the contribution from cooling tower sources. A height representative of release of cooling tower effluent will be 130 ft for wind direction considerations and 30 ft for humidity considerations; the heights representative of release of cooling tower effluents for wind speed considerations, will be taken as 30 ft in the case of mechanical draft towers and 130 ft in the case of natural draft towers.

Data collection has been completed for the period November 28, 1974 - December 29, 1974, for the purpose of ascertaining the relative influence of old and new delta-T systems on the distribution of hourly X/Q values. The effect on long term averages of X/Q is also demonstrated.

3 As stated in Subdivision 6.1.3.1, the old system of temperature and temperature difference consisted of Leeds and Northrup 8100 Series 100 Ohm Resistance devices with a system accuracy of ± 1° F for temperature at the 30 foot level, and of ± 0.5° F for delta-T (130 foot level referenced to the 30 foot level). The new system consisted of 100 Ohm Resistance devices made expressly for Duke Power Company by Leeds and Northrup with an accuracy of ± 0.5° F for temperature at the 30 foot level, and of ± 0.18° F for delta-T. The systems had otherwise identical hardware as described in Subdivision 6.1.3.1. The new instruments were mounted approximately one foot from the old instruments at the same elevations.

Table 6.2.4-1 (Sheets 1-7) shows the joint frequency of wind and stability for the period of record with stability deduced from temperature measurements from the old system. Similarly, Table 6.2.4-2 (Sheets 1-7) displays the joint frequency of wind and stability with stability deduced from the new temperature system. Figure 6.2.4-1 depicts the distribution of the difference in delta-T measurements as indicated by the old and new systems.

Hourly X/Q distributions developed from methods outlined in Subsection 2.6.2
show no discernable difference at the 95 percentile level and a six percent
difference at the 50 percentile level (1.8×10^{-4} sec/m^3 and 1.7×10^{-4}
sec/m^3 for the old and new systems respectively). The percentage difference
3 is measured with respect to the new system. The X/Q values, then, at the
95 and 50 percentile levels are essentially unaltered by utilization of the
more refined delta-T measurement.

The effect of the refined delta-T measurement on long term averages of X/Q is not significant in the near field (to distances of 4-5 miles). For example, average X/Q values calculated per Section 2.6.3 for the period of record are identical to two significant figures for the highest value at the Exclusion Area Boundary.

6.2.5 ECOLOGICAL MONITORING

A study yielding one year of ecological baseline data was completed in September, 1974. The sampling program, and the field and laboratory procedures followed, are described in Subsection 6.1.1. In August 1974, a second one year baseline study was begun by Duke Power Company's Environmental Sciences Unit following a monthly sampling program described in Subsection 6.1.1. This study will be continued until September 1975, when quarterly sampling for water chemistry will be implemented until one year prior to start-up of the first unit. At this time monthly sampling for water chemistry, fish, phytoplankton, zooplankton, periphyton and benthos will be resumed.

ER Table 6.1.1-1

Perkins Nuclear Station
Routine Monthly Aquatic Sampling Schedule,
Yadkin River System (Revised 27 Nov 1974)

Station	Physical meas.	Phyto-* plankton	Zoo- plankton	Peri- phyton	Nutri-* ents	Sedi-* ments	Metals*	Coli-* form	Heavy Metals	Benthos* Dendy	Benthos* Other	Nekton
1	S	S	S		S	+	S	S				
2	S	S	S		S	+	S	S		+	Ponar	
3	S	S	S	+	S	+	S	S		+	Surber	E/seine
4 *	S	S	S	+	S	+	S	S	S	+	Surber	E/seine
5	S	S	S	+	S	+	S	S		+	Surber	E/seine
6	S	S	S	+	S	+	S	S	S	+	Ponar	E/seine
7	S	S	S	+	S	+	S	S	S	+	Ponar	E/seine/fy
8	S	S	S		S	+	S	S			Ponar	
9	S	S	S	+	S	+	S	S			Ponar	E/trammel
10	S/B	S/B	S		S/B	+	S/B	S/B			Ponar	
11	S	S	S		S	+	S	S		+	Surber	
12	S/B	S/B	S	+	S/B		S/B	S/B	S		Ponar	E/trammel
13	S/B	S/B	S	+	S/B		S/B	S/B			Ponar	
14	S/B	S/B	S/B		S/B		S/B	S/B			Ekman	
15	S/B	S/B	S/B		S/B		S/B	S/B			Ekman	E/trammel
16	S/M/B	S/B	S		S/B		S/B	S/B				
17	S/M/B	S/B	S/B		S/B		S/B	S/B			Ekman	
18	S/M/B	S/B	S		S/B		S/B	S/B			Ekman	
19	S/M/B	S/B	S		S/B		S/B	S/B				
20	S/M/B	S/B	S		S/B		S/B	S/B			Ekman	
21 *	S/M/B	S/M/B	S/M/B		S/M/B		S/M/B	S/M/B	S/B		Ekman	E/trammel
22	S/M/B	S/B	S/B		S/B		S/B	S/B			Ekman	
23	S/B	S/B	S		S/B	+	S/B	S/B		+	Ekman	E/seine
24 *	S	S	S	+	S	+	S	S		+	Surber	E/seine
25	S	S	S		S	+	S	S				
26	S	S	S		S	+	S	S		+		
27	S	S	S	+	S	+	S	-		+		E/seine

* Statistical station -- samples triplicated, for benthos - Surbers doubled (ie 6 replicates), Ponar & Ekman samples triplicated (normally consist of 2 replicates)
S Surface of water column.
M Mid-depth of water column.
B Bottom of water column.
E Electrofishing
\+ Depth integrated or otherwise mixed sample

ER Table 6.1.1-2

Perkins Nuclear Station
Routine Bimonthly Aquatic Sampling Schedule,
Yadkin River System

Station	Physical measurement	Phyto-plankton*	Peri-phyton	Nutrients*	Sediment*
1					
2					
3	S	S	+	S	+
4 *	S	S	+	S	+
5	S	S	+	S	+
6	S	S	+	S	+
7	S	S	+	S	+
8	S	S		S	+
9	S	S	+	S	+
10	S	S		S	
11					
12	S/B	S/B	+	S/B	
13	S/B	S/B	+	S/B	
14	S/M/B	S/B		S/B	
15	S/M/B	S/B		S/B	
16					
17	S/M/B	S/B		S/B	
18					
19					
20					
21 *	S/M/B	S/B		S/M/B	
22	S/M/B	S/B		S/B	
23					
24 *	S	S	+	S	+
25					
26					
27	S	S	+	S	+

* Statistical station - samples triplicated.
S Surface of water column.
M Mid-depth of water column.
B Bottom of water column.
\+ Depth-integrated or otherwise mixed sample.

ER Table 6.1.1-3

Perkins Nuclear Station

Annual Sampling Schedule

Short Schedule Sampling Yadkin River	Full Schedule Sampling Yadkin River
1-5 Oct 73	15-19 Oct 73
29 Oct - 2 Nov 73	12-16 Nov 73
26-30 Nov 73	10-15 Dec 73
24-28 Dec 73	7-11 Jan 74
21-25 Jan 74	4-9 Feb 74
18-22 Feb 74	4-9 Mar 74
18-22 Mar 74	1-6 April 74
15-19 April 74	29 April - 4 May 74
13-17 April 74	27 April - 1 June 74
10-14 June 74	24-29 June 74
8-12 July 74	22-27 July 74
5-9 Aug 74	19-24 Aug 74
2-6 Sept 74	16-21 Sept 74

ER Table 6.1.1-4

Perkins Nuclear Station

Routine Stations to be Sampled for Full and Short Schedules after Revision of Sampling Prior to Period 9.

Station Number	Sampling Schedule
1	Delete
2	Delete
3	Retain all sampling
4	Retain all sampling
5	Retain all sampling
6	Retain all sampling
7	Retain all sampling
8	Sample water quality only
9	Retain all sampling
10	Delete
11	Delete
12	Retain all sampling
13	Retain all sampling
14	Retain all sampling
15	Sample water quality only
16	Sample water quality only
17	Retain all sampling
18	Sample water quality only
19	Sample water quality only
20	Sample water quality only
21	Retain all sampling
22	Delete
23	Delete
24	Retain all sampling
25	Delete
26	Delete
27	Retain all sampling
28	Added for benthos
29	Added for benthos

ER Table 6.1.1-5

Perkins Nuclear Station

Non-Radiological Environmental Sampling Program, Year II

Location	Water Chemistry (Refer to Table 6.1.1-7)	Phytoplankton: Whole Water	Phytoplankton: Chlorophyll	Zooplankton	Periphyton	Benthos: Dredge	Benthos: Surber	Benthos: Drift	Fish: Electro-fish	Fish: Trot-Line	Fish: Larvae
427											S[e]
430	M[e]										
432	M[e]										
434	M[e]								M[a]		
435	M[e]										
436	M[e]	M[d]	M[d]	M[d]	M[a]				M[a]	M[b]	
438	M[e]	M	M	M		M[b]			M[a]		S[e]
440	M[e]	M[d]	M[d]	M[d]		M[c]			M[a]		
442		M[a]	M[a]	M[a]	M[a]	M[c]	M[e]	M[e]	M[a]	M[b]	S[e]
444	M[e]	M[a]	M[a]	M[a]	M[f]	M[c]		M[e]	M[a]	M[b]	S[a]
445								I			
446	M[e]	M[d]	M[d]	M[d]					M[a]		S[e]
448	M[e]										
449	M[e]										

M = monthly

I = infrequently

S = during spawning season (spring and summer)

a = right (XXX.2) and left (XXX.1) bank

b = right (XXX.2) bank only

c = shore and midchannel (XXX.0) sample

d = composite (XXX.3)

e = midchannel

f = right (XXX.2) and left (XXX.1) bank and midchannel (XXX.0)

ER Table 6.1.1-6

Perkins Nuclear Station

Summary of Analytical Techniques for Year 1

Parameter	Technique	Lower Detection Limit (mg/1)
Total P	Reduction to molybdenum complex; colorimetric measurement[a,b]	0.01
Turbidity	Hellige Turbidimeter (nephelometric technique); expressed as ppm SiO_2 Method 163A[c]	0.5
Total N	Oxidation and reduction of nitrogen compounds to nitrite; diazotization; colorimetric measurement Method 111.3.11[d]	0.01
Alkalinity	Potentiometric titration of aliquot to bicarbonate and carbonic acid equivalence points and titration of a second aliquot to phenolphthalein endpoint. Total of these gives alkalinity Method 102[c]	0.5
Chlorophyll _a_	Extraction with acetone; Turner fluorometric measurement Method IV.3.1[d]	0.1
DOC	Oxidation to carbon dioxide; non-dispersive infrared spectrometric measurement Method 111.4[d]	0.001
Ammonia	Formation of indolphenol; colorimetric measuremtnt Method 11.9[d]	0.01
Chloride	Specific (selective) ion electrode[e]	0.02
Sulfate	Production of free chloranilic acid; colorimetric measurement[f]	0.05
Nitrate	Reduction to nitrite; diazotization; colorimetric measurement Method 11.6[d]	0.005
Nitrite	Diazotization; colorimetric measurement Method 11.7[d]	0.005
Orthophosphate	Formation of blue phosphomolybdate complex; colorimetric measurement[a]	0.01
Boron	Formation of colored complex; colorimetric measurement[b]	0.1

ER Table 6.1.1-6 (cont'd)

Perkins Nuclear Station

Summary of Analytical Techniques for Year I

Parameter	Technique	Lower Detection Limit (mg/l)
Silica	Formation of colored complex; colorimetric measurement[b]	0.1
Cadmium	Atomic absorption spectrophotometric measurement[b]	0.02
Calcium	Atomic absorption spectrophotometric measurement[b]	0.05
Chromium	Atomic absorption spectrophotometric measurement[b]	0.05
Copper	Atomic absorption spectrophotometric measurement[b]	0.05
Iron	Atomic absorption spectrophotometric measurement[b]	0.01
Magnesium	Atomic absorption spectrophotometric measurement[b]	0.05
Manganese	Atomic absorption spectrophotometric measurement[b]	0.01
Potassium	Atomic absorption spectrophotometric measurement[b]	0.05
Sodium	Atomic absorption spectrophotometric measurement[b]	0.01
Zinc	Atomic absorption spectrophotometric measurement[b]	0.001
Mercury	Reduction to mercury metal and mercury vapor; detection by flameless (cold-vapor) atomic absorption[b]	0.1
Total Coliform	Membrane filter[c]	0 (organism/ 100 ml)
Fecal Coliform	Membrane filter[c]	0 (organisms/ 100 ml)

Perkins Nuclear Station

References - Analytical Methods

a Murphy, J. and J. P. Riley, 1962. A modified Single Solution Method for the Determination of Phosphate in Natural Waters. Anal. Chem. Acta 27: 31-36.

b American Soc. Testing and Materials, 1973. Annual Book of Standards, Part 23. ASTM, Philadelphia, Pa. 1108 pp.

c American Public Health Association, 1971. Standard Methods for the Examination of Water and Wastewater. 13th Ed. Amer. Public Health Assn., Washington, D. C. 874 pp.

d Strickland, J. D. H. and T. R. Parsons, 1968. A Practical Handbook of Seawater Analysis. Bull. 167, Fisheries Research Board of Canada, Ottawa, Can. 311 pp.

e Riseman, J. M., 1969. Measurement of Inorganic Water Pollutants by Specific Ion Electrode. American Laboratory 1:32.

f Environmental Protection Agency, Water Quality Office, Analytical Quality Control Laboratory, 1971. Methods for Chemical Analysis of Water and Wastes. Cincinnati, Ohio. 312 pp.

ER Table 6.1.1-7 (Sheet 1 of 3)
Perkins Nuclear Station
Chemical Parameters and Analytical Methods for Year II
(References Listed at End of Table)

Parameter	Method and Reference	Preservation Techniques	Detection Limits
	In Situ Analysis (monthly)		
Temperature	Thermistor-Thermometer[c]		0.25 C
Dissolved Oxygen	Polarographic Cell[c]		0.1 mg/l
pH	Glass Electrode[c]		0.1 pH unit
Conductivity	Temperature Compensated Nickel Electrode[c]		1 μmhos/cm
	Laboratory Analysis (monthly)		
Iron, total	Acid Digestion, Atomic Absorption,[e] DA GF	0.5% HNO_3	0.01 mg/l 0.03 μg/l
Manganese	AA, DA[e] GF	0.5% HNO_3	0.01 mg/l 0.01 μg/l
Turbidity	Monitek Turbidimeter		1 JTU
Alkalinity	Method 102[a]	4 C	1 mg/l as $CaCO_3$
Ammonia-N	Berthelot Reaction automated[f]	4 C	0.005 mg/l-N
Nitrate-Nitrite-N	Copper-Cadmium Reduction[f,g]	Filtration 4 C	0.01 mg/l-N
Orthophosphate, soluble	Ascorbic Acid Method[d]	Filtration 4 C	0.005 mg/l-P
Phosphorus, total	Persulfate Digestion Ascorbic Acid Method[d]	4 C	0.005 mg/l-P
Silicon, soluble	Automated Molybdosilicate 151B[a]	Filtration 4 C	0.02 mg/l-Si

Note: DA - Direct Aspiration GF - Graphite Furnace

ER Table 6.1.1-7 (Sheet 2 of 3)

Perkins Nuclear Station
Chemical Parameters and Analytical Methods for Year II
(References Listed at End of Table)

Parameter	Method and Reference	Preservation Techniques	Detection Limits
Calcium	Atomic Absorption[e] DA	0.5% HNO_3	0.01 mg/l-Ca
Magnesium	Atomic Absorption[e] DA	0.5% HNO_3	0.01 mg/l-Mg
Chloride	Specific Ion Electrode[b]	4 C	0.01 mg/l-Cl
BOD	Method 102[a]	BOD, water sealed bottle	0.05 mg/l
	Laboratory Analysis (quarterly)		
Aluminum	Atomic Absorption[e] DA GF	0.5% HNO_3	20 μg/l-Al 0.03 μg/l-Al
Cadmium	Atomic Absorption[e] GF	0.5% HNO_3	0.1 μg/l-Cd
Chromium	Atomic Absorption[e] DA GF	0.5% HNO_3	3 μg/l-Cr 0.5 μg/l-Cr
Copper	Atomic Absorption[e] DA GF	0.5% HNO_3	1 μg/l-Cu 0.01 μg/l-Cu
Nickel	Atomic Absorption[e] GF	0.5% HNO_3	10 μg/l-Ni
Zinc	Atomic Absorption[e] GF	0.5% HNO_3	10 μg/l-Zn
Potassium	Flame Emmission DA	0.5% HNO_3	4 μg/l-K
Sodium	Flame Emmission DA	0.5% HNO_3	0.2 μg/l-Na

ER Table 6.1.1-7 (Sheet 3 of 3)
Perkins Nuclear Station
Chemical Parameters and Analytical Methods for Year II
(References)

a American Public Health Association. 1971. Standard Methods for the Examination of Water and Wastewater. 13th ed. A.P.H.A. Washington, D.C. 874 p.

b Orion Research. 1972. Analytical Methods Guide. 4th Ed.

c Hydrolab Surveyor Model GD; multi-parameter in situ water analysis instrument.

d Murphy, J., and Riley, J. P. 1962. A Modified Single Solution for the Determination of Phosphate in Natural Waters, Anal. Chem. Acta, 27, p. 30.

e Atomic Absorption Spectrophotometer, P-E 306, HGA 2000 Graphite Furnace.

f Armstrong, F. A. J., Sterma, C. R. and Strickland, J. D. H. 1967. Deep Sea Res., 14, pp. 381-389, "The Measurement of Upwelling and Subsequent Biological Processes by Means of the Technicon Auto Analyzer and Associated Equipment."

g Grasshoff, K., Technicon International Congress, June 1969.

ER Table 6.1.4-1

Perkins Nuclear Station
Definition of Dominance Ratings

Dominance rating	Definition
5	The species which dominates the aspect of the layer. It is dominant in the sense of its impact on the microenvironment beneath its canopy. Some stands may not have a species which clearly rates a 5. In such cases this class would not be used.
4	The species which is/are codominant in the aspect of the layer. This is the species which shares dominance with another or which is subordinate only to the layer dominant which rates a 5. A layer may thus have one or more species rating a 4. In stands lacking an outstanding dominant, the two (or rarely more) most important species (ecologically) may be assigned a 4-dominance rating if they are approximately equal in their apparent impact on the microenvironment.
3	The species which are easily seen by standing in one place and looking casually around.
2	The species which can be seen only by moving around in the stand or by looking intently while standing in one place. Species occurring in patches encountered only by moving about would be rated 2-dominance although within the patch the species may rate a higher dominance value.
1	Species which can be seen only by searching for a time in and around other plants. Species which occur in extremely wide-scattered and isolated patches would rate a 1-dominance provided they did not represent an inclusion of a different plant community.
X	Found in the community but not in stand data.

ER Table 6.1.4-2
Perkins Nuclear Station
Terrestrial Environmental Survey Schedule

Season	Fall 1973	Winter 1974	Spring 1974	Summer 1974
Woody Vegetation	11/26 - 12/16	-	5/10 - 29	-
Herbaceous Vegetation	11/26 - 12/16	-	5/10 - 29	7/12-20, 8/26-30
Mammals	12/2 - 7	-	3/31 - 4/6	8/14 - 16
Birds	10/22-27, 11/26-27, 12/15-17	2/24-3/1	3/25-26,5/1-3,5/13-16	7/15-19,8/14-16
Breeding Birds	-	-	3/25-26, 5/1-3,5/13-16	-
Reptiles and Amphibians	-	-	5/13-16	7/12-20,8/14-16

Amendment 2
(New)

ER Table 6.1.5-1

The Pre-Operational Radiological Monitoring Program for the Perkins Nuclear Station

TYPE SAMPLE OR MEASUREMENT	CRITERIA FOR SELECTION OF SAMPLING LOCATIONS	COLLECTION FREQUENCY
1. Water	For comparison purposes water samples are collected: a. Upstream, well beyond Site and Exclusion Area, (Yadkin River) b. Within 500 ft. of point where liquid effluent enters Yadkin River. c. Downstream, well beyond Site and Exclusion Area (Yadkin River) d. Salisbury Water Supply e. Well water samples near liquid waste discharge area and elsewhere within Low Population Zone	Monthly; sample b will be collected continuously during operation; sample e will be collected quarterly
2. Airborne Particulates (including iodine) Rain and Settled Dust	Comparison of on-site vs off-site locations at distances up to 10 miles near towns and populated areas; and in prevailing wind directions and control location.	Monthly, sample collected continuously
3. Radiation Dose and Dose Rate	Comparison of on-site vs off-site locations near towns and populated areas; at distances up to 10 miles and in prevailing wind directions; also within 500 ft of point where liquid effluent enters Yadkin River; and control locations.	Dose: Quarterly, Integrated total, duplicate sampes at each location Dose Rate: Quarterly Single Measurement

ER Table 6.1.5-1

The Pre-Operational Radiological Monitoring Program for the Perkins Nuclear Station

TYPE SAMPLE OF MEASUREMENT	CRITERIA FOR SELECTION OF SAMPLING LOCATIONS	COLLECTION FREQUENCY
4. Bottom and Shoreline Sediment (including bottom organisms)	For comparison purposes, sediment samples are collected:	
	a. Upstream, well beyond Site and Exclusion Area (Yadkin River, control location)	Quarterly
	b. Within 500 ft of point where liquid effluent enters Yadkin River	Quarterly
	c. Downstream well beyond Site and Exclusion Area (Yadkin River)	Quarterly
5. Aquatic Vegetation and/or Plankton	For comparison purposes, samples are collected:	
	a. Upstream, well beyond Site and Exclusion Area (Yadkin River control location)	Quarterly (as available)
	b. Within 500 ft of point where liquid effluent enters Yadkin River	Quarterly (as available)
	c. Downstream, well beyond Site and Exclusion Area (Yadkin River)	Quarterly (as available)
6. Terrestrial Vegetation (Pasture grass) and Crops (corn, beans, leafy green vegetables)	Comparison of nearby upwind and downwind directions in Low Population Zone and in control locations.	Quarterly (as available)
7. Milk	From nearby farms in prevailing wind directions and from control locations.	Monthly

The Pre-Operational Radiological Monitoring Program for the Perkins Nuclear Station

TYPE SAMPLE OF MEASUREMENT	CRITERIA FOR SELECTION OF SAMPLING LOCATIONS	COLLECTION FREQUENCY
8. Fish	Fish samples will include both game, forage and bottom feeders, collected: a. Upstream, well beyond Site and Exclusion Area (Yadkin River, control location) b. Within Discharge Area where liquid effluent enters Yadkin River c. Downstream well beyond Site and Exclusion Area (Yadkin River)	Quarterly (as available)
9. Miscellaneous	Investigation of special situations found as a result of the monitoring program and/or station operations, to provide extended coverage; also as may be required due to nuclear testing or unusual fallout conditions not associated with the Perkins Nuclear Station.	As Necessary

ER TABLE 6.1.5-2

THE OFFSITE RADIOLOGICAL MONITORING PROGRAM FOR THE PERKINS NUCLEAR STATION

CODE

M - MONTHLY

Q - QUARTERLY

LOCATION	Well-Water Residence, Other	Finished Water Water Supply	Raw Water Water Supply	Surface Water	Rain, Settled Dust	Air Particulates	Vegetation-Pasture grass, forage	Vegetation-Crops (corn, beans, leafy gr.)	Vegetation-Aquatic Plankton	River Bottom & Shoreline Sediment	Radiation Dose & Dose Rate	Fish	Milk
SITE													
400.1 Within Exclusion Area	Q												
400.2 Restricted Area Boundary											Q		
400.3 Point of Maximum Concentration in Prevailing Wind Directions					M	M					Q		
YADKIN RIVER													
401.1 Upstream (Control)				M	M				Q	Q	Q	Q	
401.2 Point 500 ft from Liquid Effluent Discharge				M					Q	Q	Q	Q	
401.3 Horseshoe Neck Wildlife Access Area				M					Q	Q	Q		
401.4 Boone's Cave State Park	Q								Q	Q	Q	Q	
401.5 Homes on River near Discharge	Q							Q					
401.6 Salisbury Water Supply Intake		M	M										
402 SALISBURY											Q		
403 COOLEEMEE					M		Q	Q			Q		
404 MOCKSVILLE											Q		
405 FORKS CHURCH											Q		
406 YADKIN COLLEGE					M		Q				Q		
407 TYRO					M						Q		
408 CHURCHLAND					M						Q		
409 QUADRANT DAIRY (MILES FROM SITE)													Q
410 FARMS AND GARDENS WITHIN 2-MILE RADIUS OF SITE							Q	Q					Q
411 POINT OF HIGHEST GROUND CONCENTRATION IN MOST PREVALENT WIND DIRECTION						M					Q		

NOTE: Sampling locations subject to changes based on completion of one year's period of record for onsite meteorological data

ER Table 6.1.5-2A
Perkins Nuclear Station
Sampling Locations

SAMPLING LOCATION		DISTANCE FROM SITE IN MILES	DIRECTION
401.1	Upstream Control (Hwy 158 bridge on Yadkin River)	12.0	NNE
401.2	Point 500 ft from liquid effluent discharge	0.1	SSE
401.3	Horseshoe Neck Wildlife Access Area	1.3	W
401.4	Boone's Cave State Park	5.5	S
401.5	Homes on river, near discharge	1-1.5	SSW-SSE
401.6	Salisbury water intake	6.5	S
402	Salisbury	10.0	S
403	Cooleemee	5.5	WSW
404	Mocksville	6.8	WNW
405	Forks Church	2.2	NNE
406	Yadkin College	4.0	NE
407	Tyro	5.0	ESE
408	Churchland	4.5	SSE
409	Nearest dairy	2.5	W
410	Farms/Gardens within 2 mi of site	2.0	?
411	Point of highest ground concentration		

ER Table 6.1.5-3
Perkins Nuclear Station

THE PRE-OPERATIONAL RADIOLOGICAL MONITORING PROGRAM

	Schedule	Gross Alpha	Gross Beta	Gamma Analysis	Specific Nuclides
		Analyses			
1. Water	Monthly	x	x		^{89}Sr, ^{90}Sr, ^{3}H
	Quarterly	x	x	x	
2. Airborne Particulates (including Iodine, rain, and settled dust)	Monthly	x	x	x	^{131}I
3. Radiation Dose and Dose Rate	Quarterly				
4. Bottom and Shoreline Sediment including benthos	Quarterly	x	x	x	^{60}Co
5. Aquatic Vegetation and/or Plankton	Quarterly (as available)	x	x	x	^{137}Cs, ^{40}K
6. Terrestrial Vegetation, pasture grass, and crops (corn, beans, leafy green vegetables)	Quarterly (as available)	x	x	x	^{137}Cs, ^{40}K
7. Milk	Monthly			x	^{89}Sr, ^{90}Sr, ^{137}Cs, ^{40}K, ^{3}H, ^{131}I
8. Fish	Quarterly		x	x	^{89}Sr, ^{90}Sr, ^{137}Cs, ^{40}K

The Operational Radiological Monitoring Program for the Perkins Nuclear Station

TYPE SAMPLE OR MEASUREMENT	CRITERIA FOR SELECTION OF SAMPLING LOCATIONS	COLLECTION FREQUENCY
1. Water	For comparison purposes water samples are collected: a. Upstream, well beyond Site and Exclusion Area, (Yadkin River, control location) b. Within 500 ft of point where liquid effluent enters Yadkin River c. Downstream, well beyond Site and Exclusion Area (Yadkin River) d. Salisbury Water Supply e. Well water samples near liquid waste discharge area and elsewhere within Low Population Zone	Monthly; sample b will be collected continuously during operation; sample e will be collected quarterly
2. Airborne Particulates (including iodine)	Comparison of on-site vs off-site locations at distances up to 10 miles near towns and populated areas; and in prevailing wind directions and control location.	Monthly, sample collected continuously Weekly, for iodine
3. Radiation Dose and Dose Rate	Comparison of on-site vs off-site locations near towns and populated areas; at distances up to 10 miles and in prevailing wind directions; also within 500 ft of point where liquid effluent enters Yadkin River; and control locations.	Dose: Quarterly, Integrated total, duplicate samples at each location Dose Rate: Quarterly Single Measurement

The Operational Radiological Monitoring Program for the Perkins Nuclear Station

TYPE SAMPLE OF MEASUREMENT	CRITERIA FOR SELECTION OF SAMPLING LOCATIONS	COLLECTION FREQUENCY
4. Bottom and Shoreline Sediment (including bottom organisms)	For comparison purposes, sediment samples are collected:	
	a. Upstream, well beyond Site and Exclusion Area (Yadkin River, control location)	Quarterly
	b. Within 500 ft of point where liquid effluent enters Yadkin River	Quarterly
	c. Downstream well beyond Site and Exclusion Area (Yadkin River)	Quarterly
5. Aquatic Vegetation and/or Plankton	For comparison purposes, samples are collected:	
	a. Upstream, well beyond Site and Exclusion Area (Yadkin River, control location)	Quarterly (as available)
	b. Within 500 ft of point where liquid effluent enters Yadkin River	Quarterly (as available)
	c. Downstream, well beyond Site and Exclusion Area (Yadkin River)	Quarterly (as available)
6. Terrestrial Vegetation (pasture grass) and Crops (corn, beans, leafy green vegetables)	Comparison of nearby upwind and downwind directions in Low Population Zone and in control locations.	Quarterly (as available)
7. Milk	From nearby farms in prevailing wind directions and from control locations.	Monthly Weekly for iodine

The Operational Radiological Monitoring Program for the Perkins Nuclear Station

TYPE SAMPLE OF MEASUREMENT	CRITERIA FOR SELECTION OF SAMPLING LOCATIONS	COLLECTION FREQUENCY
8. Fish	Fish samples will include both game, forage and bottom feeders, collected: a. Upstream, well beyond Site and Exclusion Area (Yadkin River, control location) b. Within Discharge Area where liquid effluent enters Yadkin River c. Downstream well beyond Site and Exclusion Area (Yadkin River)	Quarterly (as available)
9. Miscellaneous	Investigation of special situations found as a result of the monitoring program and/or station operations, to provide extended coverage; also as may be required due to nuclear testing or unusual fallout conditions not associated with the Perkins Nuclear Station.	As necessary

ER TABLE 6.2.1-2

THE OFFSITE RADIOLOGICAL MONITORING PROGRAM FOR THE PERKINS NUCLEAR STATION

CODE
M - MONTHLY
Q - QUARTERLY

LOCATION	Well-Water Residence, Other	Finished Water Water Supply	Raw Water Water Supply	Surface Water	Rain, Settled Dust	Air Particulates	Vegetation-Pasture grass, forage	Vegetation-Crops (corn, beans, leafy gr.)	Vegetation-Aquatic Plankton	River Bottom & Shoreline Sediment	Radiation Dose & Dose Rate	Fish	Milk
SITE													
400.1 Within Exclusion Area	Q												
400.2 Restricted Area Boundary											Q		
400.3 Point of Maximum Concentration in Prevailing Wind Directions					M	M					Q		
YADKIN RIVER													
401.1 Upstream (Control)				M	M				Q	Q	Q	Q	
401.2 Point 500 ft from Liquid Effluent Discharge				M					Q	Q	Q	Q	
401.3 Horseshoe Neck Wildlife Access Area				M					Q	Q	Q		
401.4 ~~Boone's Cave State Park~~	Q								Q	Q	Q	Q	
401.5 Homes on River near Discharge	Q							Q					
401.6 Salisbury Water Supply Intake		M	M										
402 SALISBURY											Q		
403 COOLEEMEE					M		Q	Q			Q		
404 MOCKSVILLE											Q		
405 FORKS CHURCH											Q		
406 YADKIN COLLEGE					M		Q				Q		
407 TYRO					M						Q		
408 CHURCHLAND					M						Q		
409 QUADRANT DAIRY (MILES FROM SITE)													Q
410 FARMS AND GARDENS WITHIN 2-MILE RADIUS OF SITE							Q	Q					Q
411 POINT OF HIGHEST GROUND CONCENTRATION IN MOST PREVALENT WIND DIRECTION						M					Q		

NOTE: Sampling locations subject to changes based on completion of one year's period of record for onsite meteorological data

ER Table 6.2.1-3

Perkins Nuclear Station

THE OPERATIONAL RADIOLOGICAL MONITORING PROGRAM

		Analyses			
	Schedule	Gross Alpha	Gross Beta	Gamma Analysis	Specific Nuclides
1. Water	Monthly	x	x		
	Quarterly	x	x	x	^{89}Sr, ^{90}Sr, ^{3}H
2. Airborne Particulates (including iodine, rain and settled dust)	Weekly				^{131}I
	Monthly	x	x	x	
3. Radiation Dose and Dose Rate	Quarterly				
4. Bottom and Shoreline Sediment including benthos	Quarterly	x	x	x	^{60}Co
5. Aquatic Vegetation and/or Plankton	Quarterly (as available)	x	x	x	^{137}Cs, ^{40}K
6. Terrestrial Vegetation, pasture grass and crops (corn, beans, leafy green vegetables)	Quarterly (as available)	x	x	x	^{137}Cs, ^{40}K
7. Milk	Weekly			x	^{131}I
	Monthly			x	^{89}Sr, ^{90}Sr, ^{137}Cs, ^{40}K, ^{3}H, ^{131}I
8. Fish	Quarterly		x	x	^{89}Sr, ^{90}Sr, ^{137}Cs, ^{40}K

ER Table 6.2.1-4

Perkins Nuclear Station

Examples of Analytical Sensitivity Versus Permissible and Discharge Canal Concentrations

A. Releases into Water

Radionuclides	Discharge Canal Concentrations µCi/ml	Concentration Permitted by AEC Regulations µCi/ml	Sensitivity of Analysis µCi/ml
Tritium		3×10^{-3}	2×10^{-9}
Sr^{90}		3×10^{-7}	1×10^{-9}
Cs^{137}		2×10^{-5}	1×10^{-9}
Co^{60}		5×10^{-5}	1×10^{-8}
I^{131}		3×10^{-7}	1×10^{-8}

B. Releases into Air

Radionuclide		
I^{131}	1×10^{-10}	1×10^{-14}

ER Table 6.2.4-1
Perkins Nuclear Station (Sheet 1 of 7)

PERKINS LOW LEVEL - OLD SYSTEM
SUMMARY OF PASQUILL A

FOR PERIOD OF 11287401-12297424
WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR,PERCENT)

DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	3	0	1	1	1	0	0	0	0	0	0
-N-	PCT	0.41	0.00	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	0	0	0	0	0	0	0	0	0	0	0
-NNE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.0	NO	0	0	0	0	0	0	0	0	0	0	0
-NE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67.5	NO	0	0	0	0	0	0	0	0	0	0	0
-ENE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90.0	NO	0	0	0	0	0	0	0	0	0	0	0
-E-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
112.5	NO	1	0	1	0	0	0	0	0	0	0	0
-ESE-	PCT	0.14	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	0	0	0	0	0	0	0	0	0	0	0
-SE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	0	0	0	0	0	0	0	0	0	0	0
-SSE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	0	0	0	0	0	0	0	0	0	0	0
-S-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	0	0	0	0	0	0	0	0	0	0	0
-SSW-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
225.0	NO	0	0	0	0	0	0	0	0	0	0	0
-SW-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
247.5	NO	2	0	1	0	1	0	0	0	0	0	0
-WSW-	PCT	0.28	0.00	0.14	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00
270.0	NO	1	1	0	0	0	0	0	0	0	0	0
-W-	PCT	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
292.5	NO	9	1	0	0	1	4	3	0	0	0	0
-WNW-	PCT	1.24	0.14	0.00	0.00	0.14	0.55	0.41	0.00	0.00	0.00	0.00
315.0	NO	3	1	0	1	0	1	0	0	0	0	0
-NW-	PCT	0.41	0.14	0.00	0.14	0.00	0.14	0.00	0.00	0.00	0.00	0.00
337.5	NO	6	0	0	0	2	2	2	0	0	0	0
-NNW-	PCT	0.83	0.00	0.00	0.00	0.27	0.27	0.27	0.00	0.00	0.00	0.00
CALM	NO	0										
	PCT	0.00	------	------	------	------	------	------	------	------	------	------
TOTAL	NO	25	3	3	2	5	7	5	0	0	0	0
	PCT	3.44	0.41	0.41	0.27	0.69	0.96	0.69	0.00	0.00	0.00	0.00

AVERAGE WIND SPEED 8.79 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 768

Amendment 3
(New)

PERKINS LOW LEVEL - OLD SYSTEM
SUMMARY OF PASQUILL C

FOR PERIOD OF 11237401-12297424
WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR,PERCENT)
DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	WIND SPEED CLASS 1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	2	0	2	0	0	0	0	0	0	0	0
-N-	PCT	0.28	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	0	0	0	0	0	0	0	0	0	0	0
-NNE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.0	NO	1	1	0	0	0	0	0	0	0	0	0
-NE-	PCT	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67.5	NO	1	0	0	1	0	0	0	0	0	0	0
-ENE-	PCT	0.14	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90.0	NO	3	0	2	1	0	0	0	0	0	0	0
-E-	PCT	0.41	0.00	0.27	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
112.5	NO	0	0	0	0	0	0	0	0	0	0	0
-ESE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	0	0	0	0	0	0	0	0	0	0	0
-SE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	2	2	0	0	0	0	0	0	0	0	0
-SSE-	PCT	0.28	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	0	0	0	0	0	0	0	0	0	0	0
-S-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	3	1	1	1	0	0	0	0	0	0	0
-SSW-	PCT	0.41	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
225.0	NO	11	1	4	0	2	0	4	0	0	0	0
-SW-	PCT	1.51	0.14	0.55	0.00	0.27	0.00	0.55	0.00	0.00	0.00	0.00
247.5	NO	10	0	3	5	2	0	0	0	0	0	0
-WSW-	PCT	1.38	0.00	0.41	0.69	0.27	0.00	0.00	0.00	0.00	0.00	0.00
270.0	NO	9	1	2	4	2	0	0	0	0	0	0
-W-	PCT	1.24	0.14	0.27	0.55	0.27	0.00	0.00	0.00	0.00	0.00	0.00
292.5	NO	7	0	4	1	0	2	0	0	0	0	0
-WNW-	PCT	0.96	0.00	0.55	0.14	0.00	0.27	0.00	0.00	0.00	0.00	0.00
315.0	NO	3	1	2	0	0	0	0	0	0	0	0
-NW-	PCT	0.41	0.14	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
337.5	NO	5	0	2	2	1	0	0	0	0	0	0
-NNW-	PCT	0.69	0.00	0.27	0.27	0.14	0.00	0.00	0.00	0.00	0.00	0.00
CALM	NO	0										
	PCT	0.00	------	------	------	------	------	------	------	------	------	------
TOTAL	NO	57	7	22	15	7	2	4	0	0	0	0
	PCT	7.84	0.96	3.03	2.05	0.96	0.27	0.55	0.00	0.00	0.00	0.00

AVERAGE WIND SPEED 6.06 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 768

ER Table 6.2.4-1
Perkins Nuclear Station (Sheet 3 of 7)

PERKINS LOW LEVEL - OLD SYSTEM FOR PERIOD OF 11287401-12297424
SUMMARY OF PASQUILL D WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR,PERCENT)
DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	WIND SPEED CLASS 1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	8	4	1	2	1	0	0	0	0	0	0
-N-	PCT	1.10	0.55	0.14	0.27	0.14	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	5	2	2	1	0	0	0	0	0	0	0
-NNE-	PCT	0.69	0.27	0.27	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.0	NO	14	3	5	4	1	1	0	0	0	0	0
-NE-	PCT	1.93	0.41	0.69	0.55	0.14	0.14	0.00	0.00	0.00	0.00	0.00
67.5	NO	10	2	4	1	3	0	0	0	0	0	0
-ENE-	PCT	1.38	0.27	0.55	0.14	0.41	0.00	0.00	0.00	0.00	0.00	0.00
90.0	NO	6	2	2	1	1	0	0	0	0	0	0
-E-	PCT	0.83	0.27	0.27	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00
112.5	NO	4	2	2	0	0	0	0	0	0	0	0
-ESE-	PCT	0.55	0.27	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	5	3	2	0	0	0	0	0	0	0	0
-SE-	PCT	0.69	0.41	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	2	2	0	0	0	0	0	0	0	0	0
-SSE-	PCT	0.28	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	10	6	3	1	0	0	0	0	0	0	0
-S-	PCT	1.38	0.82	0.41	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	24	1	8	10	4	1	0	0	0	0	0
-SSW-	PCT	3.30	0.14	1.10	1.37	0.55	0.14	0.00	0.00	0.00	0.00	0.00
225.0	NO	30	7	4	12	4	3	0	0	0	0	0
-SW-	PCT	4.13	0.96	0.55	1.65	0.55	0.41	0.00	0.00	0.00	0.00	0.00
247.5	NO	18	1	7	5	3	2	0	0	0	0	0
-WSW-	PCT	2.48	0.14	0.96	0.69	0.41	0.27	0.00	0.00	0.00	0.00	0.00
270.0	NO	9	3	5	1	0	0	0	0	0	0	0
-W-	PCT	1.24	0.41	0.69	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
292.5	NO	6	4	1	1	0	0	0	0	0	0	0
-WNW-	PCT	0.83	0.55	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
315.0	NO	9	4	3	2	0	0	0	0	0	0	0
-NW-	PCT	1.24	0.55	0.41	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
337.5	NO	5	4	1	0	0	0	0	0	0	0	0
-NNW-	PCT	0.69	0.55	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CALM	NO	0										
	PCT	0.00	------	------	------	------	------	------	------	------	------	------
TOTAL	NO	165	50	50	41	17	7	0	0	0	0	0
	PCT	22.70	6.88	6.88	5.64	2.34	0.96	0.00	0.00	0.00	0.00	0.00

AVERAGE WIND SPEED 4.95 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 768

Amendment 3
(New)

ER Table 6.2.4-1
Perkins Nuclear Station

(Sheet 4 of 7)

PERKINS LOW LEVEL - OLD SYSTEM
SUMMARY OF PASQUILL E

FOR PERIOD OF 11287401-12297424
WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR,PERCENT)
DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	WIND SPEED CLASS 1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	11	3	5	3	0	0	0	0	0	0	0
-N-	PCT	1.51	0.41	0.69	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	12	3	4	4	0	1	0	0	0	0	0
-NNE-	PCT	1.65	0.41	0.55	0.55	0.00	0.14	0.00	0.00	0.00	0.00	0.00
45.0	NO	12	3	6	3	0	0	0	0	0	0	0
-NE-	PCT	1.65	0.41	0.82	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67.5	NO	20	4	7	2	1	3	0	0	3	0	0
-ENE-	PCT	2.75	0.55	0.96	0.27	0.14	0.41	0.00	0.00	0.41	0.00	0.00
90.0	NO	7	6	0	0	0	0	0	1	0	0	0
-E-	PCT	0.96	0.82	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00
112.5	NO	5	3	2	0	0	0	0	0	0	0	0
-ESE-	PCT	0.69	0.41	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	7	6	1	0	0	0	0	0	0	0	0
-SE-	PCT	0.96	0.82	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	3	3	0	0	0	0	0	0	0	0	0
-SSE-	PCT	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	11	3	4	4	0	0	0	0	0	0	0
-S-	PCT	1.51	0.41	0.55	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	13	4	5	2	2	0	0	0	0	0	0
-SSW-	PCT	1.79	0.55	0.69	0.27	0.27	0.00	0.00	0.00	0.00	0.00	0.00
225.0	NO	38	3	14	14	6	1	0	0	0	0	0
-SW-	PCT	5.23	0.41	1.93	1.93	0.82	0.14	0.00	0.00	0.00	0.00	0.00
247.5	NO	18	3	7	6	2	0	0	0	0	0	0
-WSW-	PCT	2.48	0.41	0.96	0.82	0.27	0.00	0.00	0.00	0.00	0.00	0.00
270.0	NO	24	10	3	6	4	1	0	0	0	0	0
-W-	PCT	3.30	1.37	0.41	0.82	0.55	0.14	0.00	0.00	0.00	0.00	0.00
292.5	NO	11	2	2	3	1	1	2	0	0	0	0
-WNW-	PCT	1.51	0.27	0.27	0.41	0.14	0.14	0.27	0.00	0.00	0.00	0.00
315.0	NO	19	6	3	6	4	0	0	0	0	0	0
-NW-	PCT	2.61	0.82	0.41	0.82	0.55	0.00	0.00	0.00	0.00	0.00	0.00
337.5	NO	8	1	1	1	2	2	1	0	0	0	0
-NNW-	PCT	1.10	0.14	0.14	0.14	0.27	0.27	0.14	0.00	0.00	0.00	0.00
CALM	NO	1										
	PCT	0.14	------	------	------	------	------	------	------	------	------	------
TOTAL	NO	219	63	64	54	22	9	3	1	3	0	0
	PCT	30.12	8.67	8.80	7.43	3.03	1.24	0.41	0.14	0.41	0.00	0.00

AVERAGE WIND SPEED 5.37 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 768

Amendment 3
(New)

ER Table 6.2.4-1
Perkins Nuclear Station (Sheet 5 of 7)

PERKINS LOW LEVEL - OLD SYSTEM FOR PERIOD OF 11287401-12297424
SUMMARY OF PASQUILL F WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR,PERCENT)
DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	WIND SPEED CLASS 1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	5	0	4	1	0	0	0	0	0	0	0
-N-	PCT	0.69	0.00	0.55	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	2	0	2	0	0	0	0	0	0	0	0
-NNE-	PCT	0.28	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.0	NO	4	3	1	0	0	0	0	0	0	0	0
-NE-	PCT	0.55	0.41	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67.5	NO	4	3	1	0	0	0	0	0	0	0	0
-ENE-	PCT	0.55	0.41	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90.0	NO	3	1	2	0	0	0	0	0	0	0	0
-E-	PCT	0.41	0.14	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
112.5	NO	1	0	1	0	0	0	0	0	0	0	0
-ESE-	PCT	0.14	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	3	2	1	0	0	0	0	0	0	0	0
-SE-	PCT	0.41	0.27	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	4	3	1	0	0	0	0	0	0	0	0
-SSE-	PCT	0.55	0.41	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	3	3	0	0	0	0	0	0	0	0	0
-S-	PCT	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	5	3	2	0	0	0	0	0	0	0	0
-SSW-	PCT	0.69	0.41	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
225.0	NO	6	5	1	0	0	0	0	0	0	0	0
-SW-	PCT	0.83	0.69	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
247.5	NO	3	1	0	2	0	0	0	0	0	0	0
-WSW-	PCT	0.41	0.14	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
270.0	NO	9	4	3	2	0	0	0	0	0	0	0
-W-	PCT	1.24	0.55	0.41	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
292.5	NO	5	3	2	0	0	0	0	0	0	0	0
-WNW-	PCT	0.69	0.41	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
315.0	NO	4	2	2	0	0	0	0	0	0	0	0
-NW-	PCT	0.55	0.27	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
337.5	NO	1	0	1	0	0	0	0	0	0	0	0
-NNW-	PCT	0.14	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CALM	NO	1										
	PCT	0.14	------	------	------	------	------	------	------	------	------	------
TOTAL	NO	62	33	24	5	0	0	0	0	0	0	0
	PCT	8.53	4.54	3.30	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00

AVERAGE WIND SPEED 3.21 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 763

Amendment 3
(New)

PERKINS LOW LEVEL - OLD SYSTEM FOR PERIOD OF 11287401-12297424
SUMMARY OF PASQUILL G WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR.,PERCENT)
DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	WIND SPEED CLASS 1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	12	11	1	0	0	0	0	0	0	0	0
-N-	PCT	1.65	1.51	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	9	9	0	0	0	0	0	0	0	0	0
-NNE-	PCT	1.24	1.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.0	NO	14	13	1	0	0	0	0	0	0	0	0
-NE-	PCT	1.93	1.79	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67.5	NO	25	25	0	0	0	0	0	0	0	0	0
-ENE-	PCT	3.44	3.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90.0	NO	33	33	0	0	0	0	0	0	0	0	0
-E-	PCT	4.54	4.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
112.5	NO	24	24	0	0	0	0	0	0	0	0	0
-ESE-	PCT	3.30	3.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	16	16	0	0	0	0	0	0	0	0	0
-SE-	PCT	2.20	2.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	5	4	1	0	0	0	0	0	0	0	0
-SSE-	PCT	0.69	0.55	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	2	1	1	0	0	0	0	0	0	0	0
-S-	PCT	0.28	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	0	0	0	0	0	0	0	0	0	0	0
-SSW-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
225.0	NO	1	1	0	0	0	0	0	0	0	0	0
-SW-	PCT	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
247.5	NO	4	4	0	0	0	0	0	0	0	0	0
-WSW-	PCT	0.55	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
270.0	NO	6	5	1	0	0	0	0	0	0	0	0
-W-	PCT	0.83	0.69	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
292.5	NO	11	11	0	0	0	0	0	0	0	0	0
-WNW-	PCT	1.51	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
315.0	NO	5	4	1	0	0	0	0	0	0	0	0
-NW-	PCT	0.69	0.55	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
337.5	NO	2	2	0	0	0	0	0	0	0	0	0
-NNW-	PCT	0.28	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CALM	NO	28										
	PCT	3.85	------	------	------	------	------	------	------	------	------	------
TOTAL	NO	169	163	6	0	0	0	0	0	0	0	0
	PCT	23.25	22.42	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

AVERAGE WIND SPEED 1.66 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 768

Amendment 3
(New)

PERKINS LOW LEVEL - OLD SYSTEM
SUMMARY OF PASQUILL A+C+D+E+F+G

FOR PERIOD OF 11287401-12297424
WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR,PERCENT)

DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	WIND SPEED CLASS 1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	41	18	14	7	2	0	0	0	0	0	0
-N-	PCT	5.64	2.47	1.93	0.96	0.27	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	28	14	8	5	0	1	0	0	0	0	0
-NNE-	PCT	3.85	1.93	1.10	0.69	0.00	0.14	0.00	0.00	0.00	0.00	0.00
45.0	NO	45	23	13	7	1	1	0	0	0	0	0
-NE-	PCT	6.19	3.16	1.79	0.96	0.14	0.14	0.00	0.00	0.00	0.00	0.00
67.5	NO	60	34	12	4	4	3	0	0	3	0	0
-ENE-	PCT	8.25	4.68	1.65	0.55	0.55	0.41	0.00	0.00	0.41	0.00	0.00
90.0	NO	52	42	6	2	1	0	0	1	0	0	0
-E-	PCT	7.15	5.78	0.82	0.27	0.14	0.00	0.00	0.14	0.00	0.00	0.00
112.5	NO	35	29	6	0	0	0	0	0	0	0	0
-ESE-	PCT	4.81	3.99	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	31	27	4	0	0	0	0	0	0	0	0
-SE-	PCT	4.26	3.71	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	16	14	2	0	0	0	0	0	0	0	0
-SSE-	PCT	2.20	1.93	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	26	13	8	5	0	0	0	0	0	0	0
-S-	PCT	3.58	1.79	1.10	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	45	9	16	13	6	1	0	0	0	0	0
-SSW-	PCT	6.19	1.24	2.20	1.79	0.82	0.14	0.00	0.00	0.00	0.00	0.00
225.0	NO	86	17	23	26	12	4	4	0	0	0	0
-SW-	PCT	11.83	2.34	3.16	3.58	1.65	0.55	0.55	0.00	0.00	0.00	0.00
247.5	NO	55	9	18	18	8	2	0	0	0	0	0
-WSW-	PCT	7.57	1.24	2.47	2.47	1.10	0.27	0.00	0.00	0.00	0.00	0.00
270.0	NO	58	24	14	13	6	1	0	0	0	0	0
-W-	PCT	7.98	3.30	1.93	1.79	0.82	0.14	0.00	0.00	0.00	0.00	0.00
292.5	NO	49	21	9	5	2	7	5	0	0	0	0
-WNW-	PCT	6.74	2.89	1.24	0.69	0.27	0.96	0.69	0.00	0.00	0.00	0.00
315.0	NO	43	18	11	9	4	1	0	0	0	0	0
-NW-	PCT	5.91	2.47	1.51	1.24	0.55	0.14	0.00	0.00	0.00	0.00	0.00
337.5	NO	27	7	5	3	5	4	3	0	0	0	0
-NNW-	PCT	3.71	0.96	0.69	0.41	0.69	0.55	0.41	0.00	0.00	0.00	0.00
CALM	NO	30										
	PCT	4.13										
TOTAL	NO	697	319	169	117	51	25	12	1	3	0	0
	PCT	95.87	43.88	23.25	16.09	7.01	3.44	1.65	0.14	0.41	0.00	0.00

AVERAGE WIND SPEED 4.25 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 768

Amendment 3
(New)

ER Table 6.2.4-2
Perkins Nuclear Station (Sheet 1 of 7)

PERKINS LOW LEVEL - NEW SYSTEM FOR PERIOD OF 11287401-12297424

SUMMARY OF PASQUILL A WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR,PERCENT)

DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	4	0	1	1	2	0	0	0	0	0	0
-N-	PCT	0.55	0.00	0.14	0.14	0.27	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	0	0	0	0	0	0	0	0	0	0	0
-NNE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.0	NO	1	1	0	0	0	0	0	0	0	0	0
-NE-	PCT	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67.5	NO	0	0	0	0	0	0	0	0	0	0	0
-ENE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90.0	NO	1	0	0	1	0	0	0	0	0	0	0
-E-	PCT	0.14	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
112.5	NO	0	0	0	0	0	0	0	0	0	0	0
-ESE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	0	0	0	0	0	0	0	0	0	0	0
-SE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	0	0	0	0	0	0	0	0	0	0	0
-SSE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	0	0	0	0	0	0	0	0	0	0	0
-S-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	1	0	0	1	0	0	0	0	0	0	0
-SSW-	PCT	0.14	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
225.0	NO	3	1	1	1	0	0	0	0	0	0	0
-SW-	PCT	0.41	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
247.5	NO	7	1	1	3	2	0	0	0	0	0	0
-WSW-	PCT	0.96	0.14	0.14	0.41	0.27	0.00	0.00	0.00	0.00	0.00	0.00
270.0	NO	5	1	1	1	2	0	0	0	0	0	0
-W-	PCT	0.69	0.14	0.14	0.14	0.27	0.00	0.00	0.00	0.00	0.00	0.00
292.5	NO	10	1	0	1	1	4	3	0	0	0	0
-WNW-	PCT	1.38	0.14	0.00	0.14	0.14	0.55	0.41	0.00	0.00	0.00	0.00
315.0	NO	1	0	0	0	0	1	0	0	0	0	0
-NW-	PCT	0.14	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00
337.5	NO	8	0	0	1	3	2	2	0	0	0	0
-NNW-	PCT	1.10	0.00	0.00	0.14	0.41	0.27	0.27	0.00	0.00	0.00	0.00
CALM	NO	0										
	PCT	0.00	------	------	------	------	------	------	------	------	------	------
TOTAL	NO	41	5	4	10	10	7	5	0	0	0	0
	PCT	5.64	0.69	0.55	1.37	1.37	0.96	0.69	0.00	0.00	0.00	0.00

AVERAGE WIND SPEED 7.82 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 768

Amendment 3
(New)

PERKINS LOW LEVEL - NEW SYSTEM FOR PERIOD OF 11287401-12297424

SUMMARY OF PASQUILL C WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR, PERCENT)

DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	1	0	1	0	0	0	0	0	0	0	0
-N-	PCT	0.14	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	0	0	0	0	0	0	0	0	0	0	0
-NNE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.0	NO	0	0	0	0	0	0	0	0	0	0	0
-NE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67.5	NO	0	0	0	0	0	0	0	0	0	0	0
-ENE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90.0	NO	1	1	0	0	0	0	0	0	0	0	0
-E-	PCT	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
112.5	NO	1	0	1	0	0	0	0	0	0	0	0
-ESE-	PCT	0.14	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	0	0	0	0	0	0	0	0	0	0	0
-SE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	0	0	0	0	0	0	0	0	0	0	0
-SSE-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	0	0	0	0	0	0	0	0	0	0	0
-S-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	0	0	0	0	0	0	0	0	0	0	0
-SSW-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
225.0	NO	5	0	1	1	1	0	2	0	0	0	0
-SW-	PCT	0.69	0.00	0.14	0.14	0.14	0.00	0.27	0.00	0.00	0.00	0.00
247.5	NO	2	0	1	1	0	0	0	0	0	0	0
-WSW-	PCT	0.28	0.00	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
270.0	NO	3	1	0	2	0	0	0	0	0	0	0
-W-	PCT	0.41	0.14	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
292.5	NO	2	0	1	0	0	1	0	0	0	0	0
-WNW-	PCT	0.28	0.00	0.14	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00
315.0	NO	2	1	1	0	0	0	0	0	0	0	0
-NW-	PCT	0.28	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
337.5	NO	0	0	0	0	0	0	0	0	0	0	0
-NNW-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CALM	NO	0										
	PCT	0.00	------	------	------	------	------	------	------	------	------	------
TOTAL	NO	17	3	6	4	1	1	2	0	0	0	0
	PCT	2.34	0.41	0.82	0.55	0.14	0.14	0.27	0.00	0.00	0.00	0.00

AVERAGE WIND SPEED 6.29 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 768

ER Table 6.2.4-2
Perkins Nuclear Station (Sheet 3 of 7)

PERKINS LOW LEVEL - NEW SYSTEM FOR PERIOD OF 11287401-12297424
SUMMARY OF PASQUILL D WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR, PERCENT)
DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	10	4	3	3	0	0	0	0	0	0	0
-N-	PCT	1.38	0.55	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	8	2	4	2	0	0	0	0	0	0	0
-NNE-	PCT	1.10	0.27	0.55	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.0	NO	20	3	8	7	1	1	0	0	0	0	0
-NE-	PCT	2.75	0.41	1.10	0.96	0.14	0.14	0.00	0.00	0.00	0.00	0.00
67.5	NO	20	3	6	3	4	1	0	0	3	0	0
-ENE-	PCT	2.75	0.41	0.82	0.41	0.55	0.14	0.00	0.00	0.41	0.00	0.00
90.0	NO	10	3	4	1	1	0	0	1	0	0	0
-E-	PCT	1.38	0.41	0.55	0.14	0.14	0.00	0.00	0.14	0.00	0.00	0.00
112.5	NO	6	3	3	0	0	0	0	0	0	0	0
-ESE-	PCT	0.83	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	4	2	2	0	0	0	0	0	0	0	0
-SE-	PCT	0.55	0.27	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	4	4	0	0	0	0	0	0	0	0	0
-SSE-	PCT	0.55	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	11	6	3	2	0	0	0	0	0	0	0
-S-	PCT	1.51	0.82	0.41	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	27	2	11	10	3	1	0	0	0	0	0
-SSW-	PCT	3.71	0.27	1.51	1.37	0.41	0.14	0.00	0.00	0.00	0.00	0.00
225.0	NO	51	7	8	20	10	4	2	0	0	0	0
-SW-	PCT	7.02	0.96	1.10	2.75	1.37	0.55	0.27	0.00	0.00	0.00	0.00
247.5	NO	23	1	10	6	4	2	0	0	0	0	0
-WSW-	PCT	3.16	0.14	1.37	0.82	0.55	0.27	0.00	0.00	0.00	0.00	0.00
270.0	NO	12	2	7	2	1	0	0	0	0	0	0
-W-	PCT	1.65	0.27	0.96	0.27	0.14	0.00	0.00	0.00	0.00	0.00	0.00
292.5	NO	11	4	4	1	0	1	1	0	0	0	0
-WNW-	PCT	1.51	0.55	0.55	0.14	0.00	0.14	0.14	0.00	0.00	0.00	0.00
315.0	NO	19	9	5	4	1	0	0	0	0	0	0
-NW-	PCT	2.61	1.24	0.69	0.55	0.14	0.00	0.00	0.00	0.00	0.00	0.00
337.5	NO	12	5	4	1	0	1	1	0	0	0	0
-NNW-	PCT	1.65	0.69	0.55	0.14	0.00	0.14	0.14	0.00	0.00	0.00	0.00
CALM	NO	0										
	PCT	0.00	------	------	------	------	------	------	------	------	------	------
TOTAL	NO	248	60	82	62	25	11	4	1	3	0	0
	PCT	34.11	8.25	11.28	8.53	3.44	1.51	0.55	0.14	0.41	0.00	0.00

AVERAGE WIND SPEED 5.50 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 768

Amendment 3
(New)

ER Table 6.2.4-2
Perkins Nuclear Station (Sheet 4 of 7)

PERKINS LOW LEVEL - NEW SYSTEM FOR PERIOD OF 11287401-12297424
SUMMARY OF PASQUILL E WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR,PERCENT)
DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	12	3	7	2	0	0	0	0	0	0	0
-N-	PCT	1.65	0.41	0.96	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	10	3	3	3	0	1	0	0	0	0	0
-NNE-	PCT	1.38	0.41	0.41	0.41	0.00	0.14	0.00	0.00	0.00	0.00	0.00
45.0	NO	8	4	4	0	0	0	0	0	0	0	0
-NE-	PCT	1.10	0.55	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67.5	NO	11	3	5	1	0	2	0	0	0	0	0
-ENE-	PCT	1.51	0.41	0.69	0.14	0.00	0.27	0.00	0.00	0.00	0.00	0.00
90.0	NO	6	5	1	0	0	0	0	0	0	0	0
-E-	PCT	0.83	0.69	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
112.5	NO	3	2	1	0	0	0	0	0	0	0	0
-ESE-	PCT	0.41	0.27	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	9	7	2	0	0	0	0	0	0	0	0
-SE-	PCT	1.24	0.96	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	5	5	0	0	0	0	0	0	0	0	0
-SSE-	PCT	0.69	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	10	3	4	3	0	0	0	0	0	0	0
-S-	PCT	1.38	0.41	0.55	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	13	4	4	2	3	0	0	0	0	0	0
-SSW-	PCT	1.79	0.55	0.55	0.27	0.41	0.00	0.00	0.00	0.00	0.00	0.00
225.0	NO	22	4	13	4	1	0	0	0	0	0	0
-SW-	PCT	3.03	0.55	1.79	0.55	0.14	0.00	0.00	0.00	0.00	0.00	0.00
247.5	NO	18	2	6	8	2	0	0	0	0	0	0
-WSW-	PCT	2.48	0.27	0.82	1.10	0.27	0.00	0.00	0.00	0.00	0.00	0.00
270.0	NO	26	11	3	8	3	1	0	0	0	0	0
-W-	PCT	3.58	1.51	0.41	1.10	0.41	0.14	0.00	0.00	0.00	0.00	0.00
292.5	NO	8	2	2	2	0	1	1	0	0	0	0
-WNW-	PCT	1.10	0.27	0.27	0.27	0.00	0.14	0.14	0.00	0.00	0.00	0.00
315.0	NO	13	2	3	5	3	0	0	0	0	0	0
-NW-	PCT	1.79	0.27	0.41	0.69	0.41	0.00	0.00	0.00	0.00	0.00	0.00
337.5	NO	4	0	0	1	2	1	0	0	0	0	0
-NNW-	PCT	0.55	0.00	0.00	0.14	0.27	0.14	0.00	0.00	0.00	0.00	0.00
CALM	NO	1										
	PCT	0.14	------	------	------	------	------	------	------	------	------	------
TOTAL	NO	178	60	58	39	14	6	1	0	0	0	0
	PCT	24.48	8.25	7.98	5.36	1.93	0.82	0.14	0.00	0.00	0.00	0.00

AVERAGE WIND SPEED 4.65 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 768

Amendment 3
(New)

PERKINS LOW LEVEL - NEW SYSTEM
SUMMARY OF PASQUILL F

FOR PERIOD OF 11287401-12297424
WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR.PERCENT)
DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	WIND SPEED CLASS 1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	2	0	1	1	0	0	0	0	0	0	0
-N-	PCT	0.28	0.00	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	2	1	1	0	0	0	0	0	0	0	0
-NNE-	PCT	0.28	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.0	NO	2	2	0	0	0	0	0	0	0	0	0
-NE-	PCT	0.28	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67.5	NO	4	3	1	0	0	0	0	0	0	0	0
-ENE-	PCT	0.55	0.41	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90.0	NO	1	0	1	0	0	0	0	0	0	0	0
-E-	PCT	0.14	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
112.5	NO	2	1	1	0	0	0	0	0	0	0	0
-ESE-	PCT	0.28	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	2	2	0	0	0	0	0	0	0	0	0
-SE-	PCT	0.28	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	2	1	1	0	0	0	0	0	0	0	0
-SSE-	PCT	0.28	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	3	3	0	0	0	0	0	0	0	0	0
-S-	PCT	0.41	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	5	3	2	0	0	0	0	0	0	0	0
-SSW-	PCT	0.69	0.41	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
225.0	NO	4	4	0	0	0	0	0	0	0	0	0
-SW-	PCT	0.55	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
247.5	NO	1	1	0	0	0	0	0	0	0	0	0
-WSW-	PCT	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
270.0	NO	3	1	2	0	0	0	0	0	0	0	0
-W-	PCT	0.41	0.14	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
292.5	NO	6	2	2	1	1	0	0	0	0	0	0
-WNW-	PCT	0.83	0.27	0.27	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00
315.0	NO	4	3	1	0	0	0	0	0	0	0	0
-NW-	PCT	0.55	0.41	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
337.5	NO	1	0	1	0	0	0	0	0	0	0	0
-NNW-	PCT	0.14	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CALM	NO	1										
	PCT	0.14	------	------	------	------	------	------	------	------	------	------
TOTAL	NO	44	27	14	2	1	0	0	0	0	0	0
	PCT	6.05	3.71	1.93	0.27	0.14	0.00	0.00	0.00	0.00	0.00	0.00

AVERAGE WIND SPEED 3.13 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 768

Amendment 3
(New)

PERKINS LOW LEVEL - NEW SYSTEM — FOR PERIOD OF 11287401-12297424

SUMMARY OF PASQUILL G — WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR, PERCENT)

DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	12	11	1	0	0	0	0	0	0	0	0
-N-	PCT	1.65	1.51	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	8	8	0	0	0	0	0	0	0	0	0
-NNE-	PCT	1.10	1.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45.0	NO	14	13	1	0	0	0	0	0	0	0	0
-NE-	PCT	1.93	1.79	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67.5	NO	25	25	0	0	0	0	0	0	0	0	0
-ENE-	PCT	3.44	3.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90.0	NO	33	33	0	0	0	0	0	0	0	0	0
-E-	PCT	4.54	4.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
112.5	NO	23	23	0	0	0	0	0	0	0	0	0
-ESE-	PCT	3.16	3.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	16	16	0	0	0	0	0	0	0	0	0
-SE-	PCT	2.20	2.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	5	4	1	0	0	0	0	0	0	0	0
-SSE-	PCT	0.69	0.55	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	2	1	1	0	0	0	0	0	0	0	0
-S-	PCT	0.28	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	0	0	0	0	0	0	0	0	0	0	0
-SSW-	PCT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
225.0	NO	1	1	0	0	0	0	0	0	0	0	0
-SW-	PCT	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
247.5	NO	4	4	0	0	0	0	0	0	0	0	0
-WSW-	PCT	0.55	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
270.0	NO	8	7	1	0	0	0	0	0	0	0	0
-W-	PCT	1.10	0.96	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
292.5	NO	12	12	0	0	0	0	0	0	0	0	0
-WNW-	PCT	1.65	1.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
315.0	NO	4	3	1	0	0	0	0	0	0	0	0
-NW-	PCT	0.55	0.41	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
337.5	NO	2	2	0	0	0	0	0	0	0	0	0
-NNW-	PCT	0.28	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CALM	NO	28										
	PCT	3.85	------	------	------	------	------	------	------	------	------	------
TOTAL	NO	169	163	6	0	0	0	0	0	0	0	0
	PCT	23.25	22.42	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

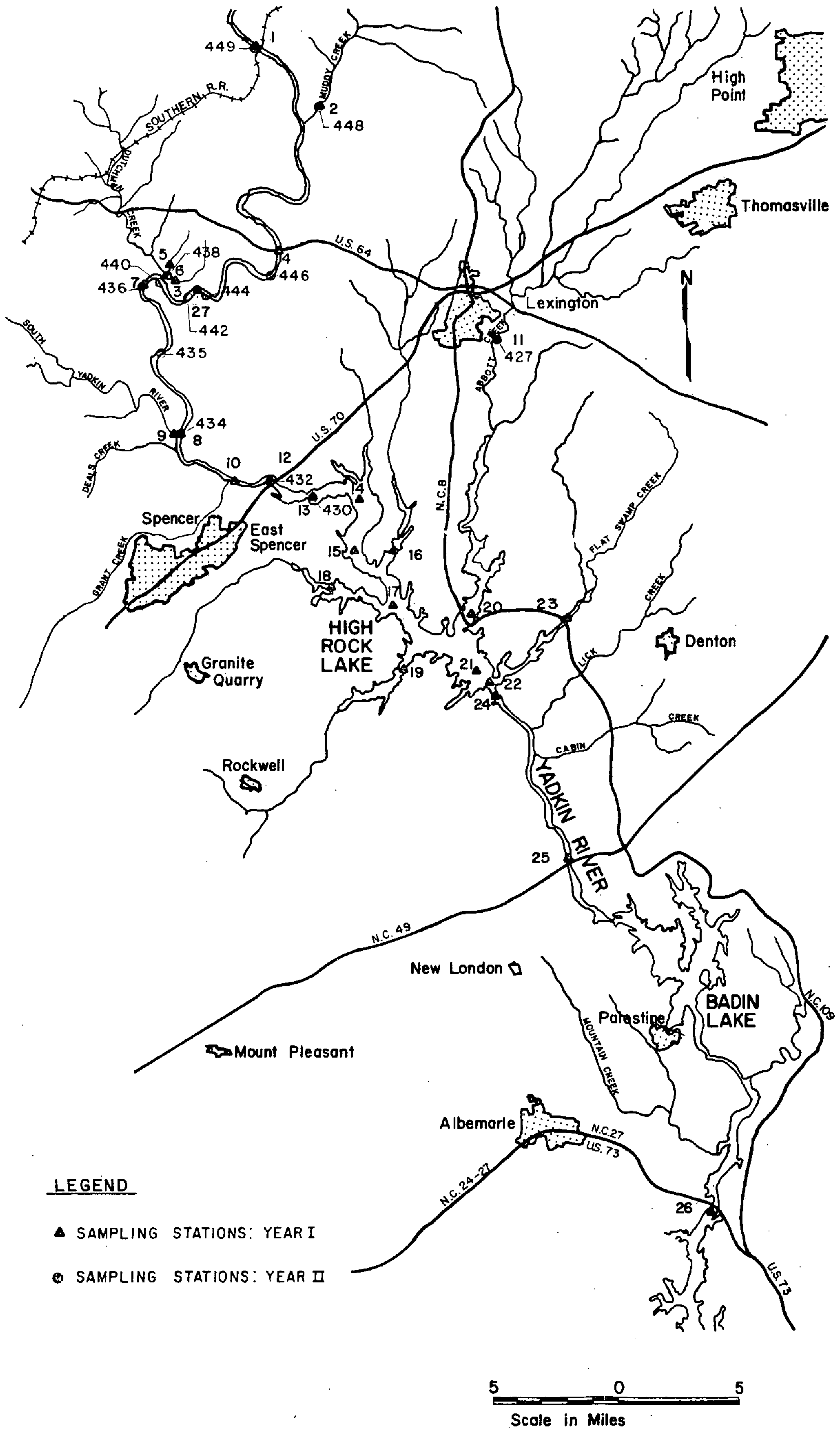
AVERAGE WIND SPEED 1.66 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 768

Amendment 3
(New)

PERKINS LOW LEVEL - NEW SYSTEM FOR PERIOD OF 11287401-12297424
SUMMARY OF PASQUILL A+C+D+E+F+G WIND OCCURRENCES BY SECTOR + SPEED CLASS (NO. OCCURR,PERCENT)
DATE OF REPORT 1-10-75

WIND SECTOR	ITEM	SECTOR TOTAL	WIND SPEED CLASS 1.0-3.2 .45-1.49	3.3-5.5 1.5-2.49	5.6-7.8 2.5-3.49	7.9-10.0 3.5-4.49	10.1-12.3 4.5-5.49	12.4-14.5 5.5-6.49	14.6-16.7 6.5-7.49	16.8-19.0 7.5-8.49	19.1-21.2 8.5-9.49	>21.2 MPH >9.5 M/S
360.0	NO	41	18	14	7	2	0	0	0	0	0	0
-N-	PCT	5.64	2.47	1.93	0.96	0.27	0.00	0.00	0.00	0.00	0.00	0.00
22.5	NO	28	14	8	5	0	1	0	0	0	0	0
-NNE-	PCT	3.85	1.93	1.10	0.69	0.00	0.14	0.00	0.00	0.00	0.00	0.00
45.0	NO	45	23	13	7	1	1	0	0	0	0	0
-NE-	PCT	6.19	3.16	1.79	0.96	0.14	0.14	0.00	0.00	0.00	0.00	0.00
67.5	NO	60	34	12	4	4	3	0	0	3	0	0
-ENE-	PCT	8.25	4.68	1.65	0.55	0.55	0.41	0.00	0.00	0.41	0.00	0.00
90.0	NO	52	42	6	2	1	0	0	1	0	0	0
-E-	PCT	7.15	5.78	0.82	0.27	0.14	0.00	0.00	0.14	0.00	0.00	0.00
112.5	NO	35	29	6	0	0	0	0	0	0	0	0
-ESE-	PCT	4.81	3.99	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
135.0	NO	31	27	4	0	0	0	0	0	0	0	0
-SE-	PCT	4.26	3.71	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
157.5	NO	16	14	2	0	0	0	0	0	0	0	0
-SSE-	PCT	2.20	1.93	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180.0	NO	26	13	8	5	0	0	0	0	0	0	0
-S-	PCT	3.58	1.79	1.10	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00
202.5	NO	46	9	17	13	6	1	0	0	0	0	0
-SSW-	PCT	6.33	1.24	2.34	1.79	0.82	0.14	0.00	0.00	0.00	0.00	0.00
225.0	NO	86	17	23	26	12	4	4	0	0	0	0
-SW-	PCT	11.83	2.34	3.16	3.58	1.65	0.55	0.55	0.00	0.00	0.00	0.00
247.5	NO	55	9	18	18	8	2	0	0	0	0	0
-WSW-	PCT	7.57	1.24	2.47	2.47	1.10	0.27	0.00	0.00	0.00	0.00	0.00
270.0	NO	57	23	14	13	6	1	0	0	0	0	0
-W-	PCT	7.84	3.16	1.93	1.79	0.82	0.14	0.00	0.00	0.00	0.00	0.00
292.5	NO	49	21	9	5	2	7	5	0	0	0	0
-WNW-	PCT	6.74	2.89	1.24	0.69	0.27	0.96	0.69	0.00	0.00	0.00	0.00
315.0	NO	43	18	11	9	4	1	0	0	0	0	0
-NW-	PCT	5.91	2.47	1.51	1.24	0.55	0.14	0.00	0.00	0.00	0.00	0.00
337.5	NO	27	7	5	3	5	4	3	0	0	0	0
-NNW-	PCT	3.71	0.96	0.69	0.41	0.69	0.55	0.41	0.00	0.00	0.00	0.00
CALM	NO	30										
	PCT	4.13	------	------	------	------	------	------	------	------	------	------
TOTAL	NO	697	318	170	117	51	25	12	1	3	0	0
	PCT	95.87	43.74	23.38	16.09	7.01	3.44	1.65	0.14	0.41	0.00	0.00

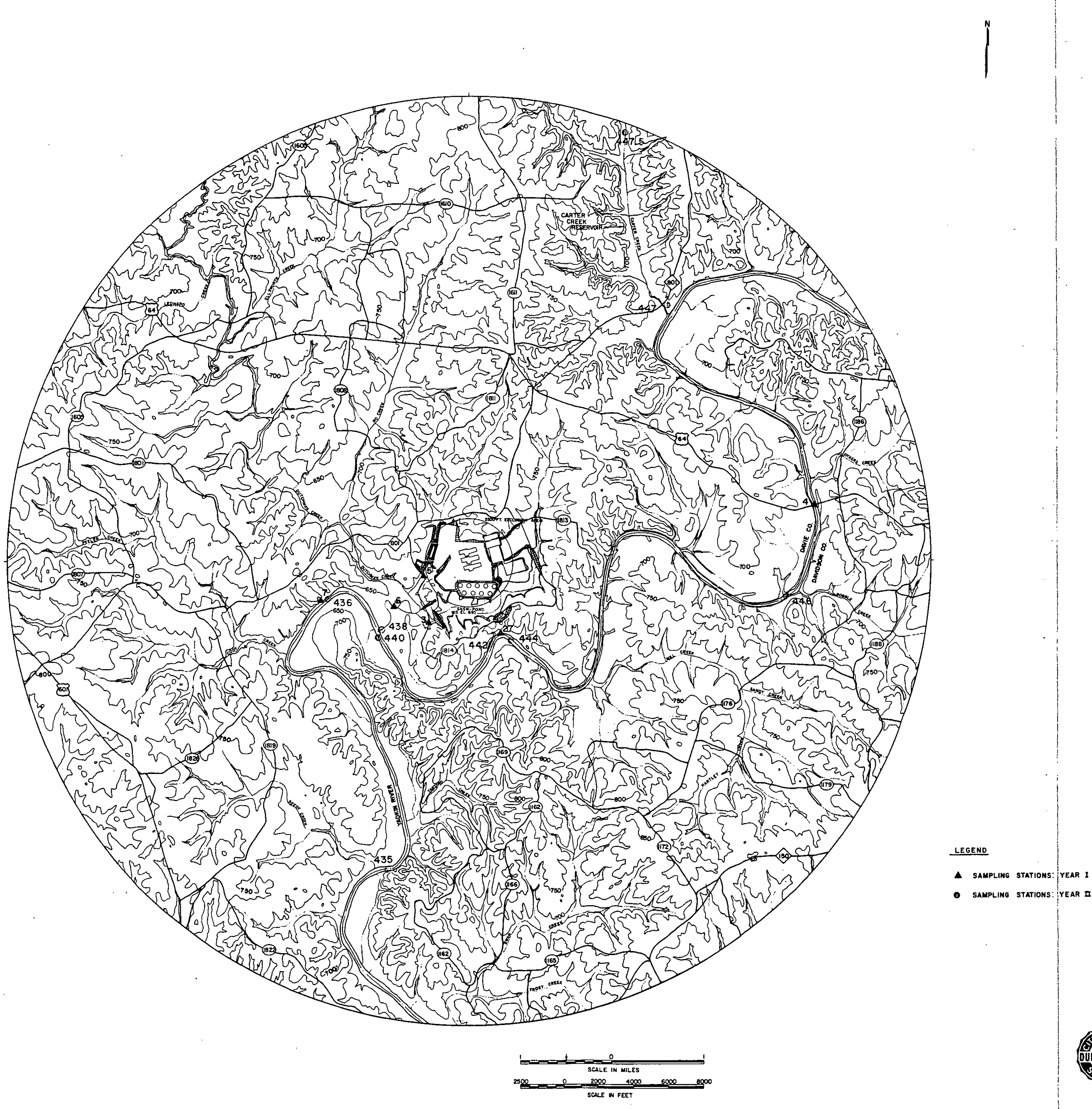
AVERAGE WIND SPEED 4.26 TOTAL VALID OBSERVATIONS 727 TOTAL OBSERVATIONS 768



LOCATION OF AQUATIC SAMPLING STATIONS
ON THE YADKIN RIVER SYSTEM

PERKINS NUCLEAR STATION

ER Figure 6.1.1-1
Amendment 1
Amendment 2



LOCATIONS OF AQUATIC SAMPLING STATIONS IN THE SITE AREA

PERKINS NUCLEAR STATION

ER Figure 6.1.1-2
Amendment 2

WATER SAMPLES FIELD DATA

SITE____________________ DATE____________________ TIME__________

SAMPLING PERIOD____________________ STATION____________________

LOCATION	BOTTLE NO.	D.O.	TEMP.	COND.	pH	DEPTH	FLOW	SEECHI 1	SEECHI 2

Location Code:

s = surface
b = bottom
mw = midwater

l = left bank (facing downstream)
c = center stream
r = right bank (facing downstream)

Comments:

Total depth____________________ Substrate____________________
Other:

Vehicle:____________________

Boat:____________________

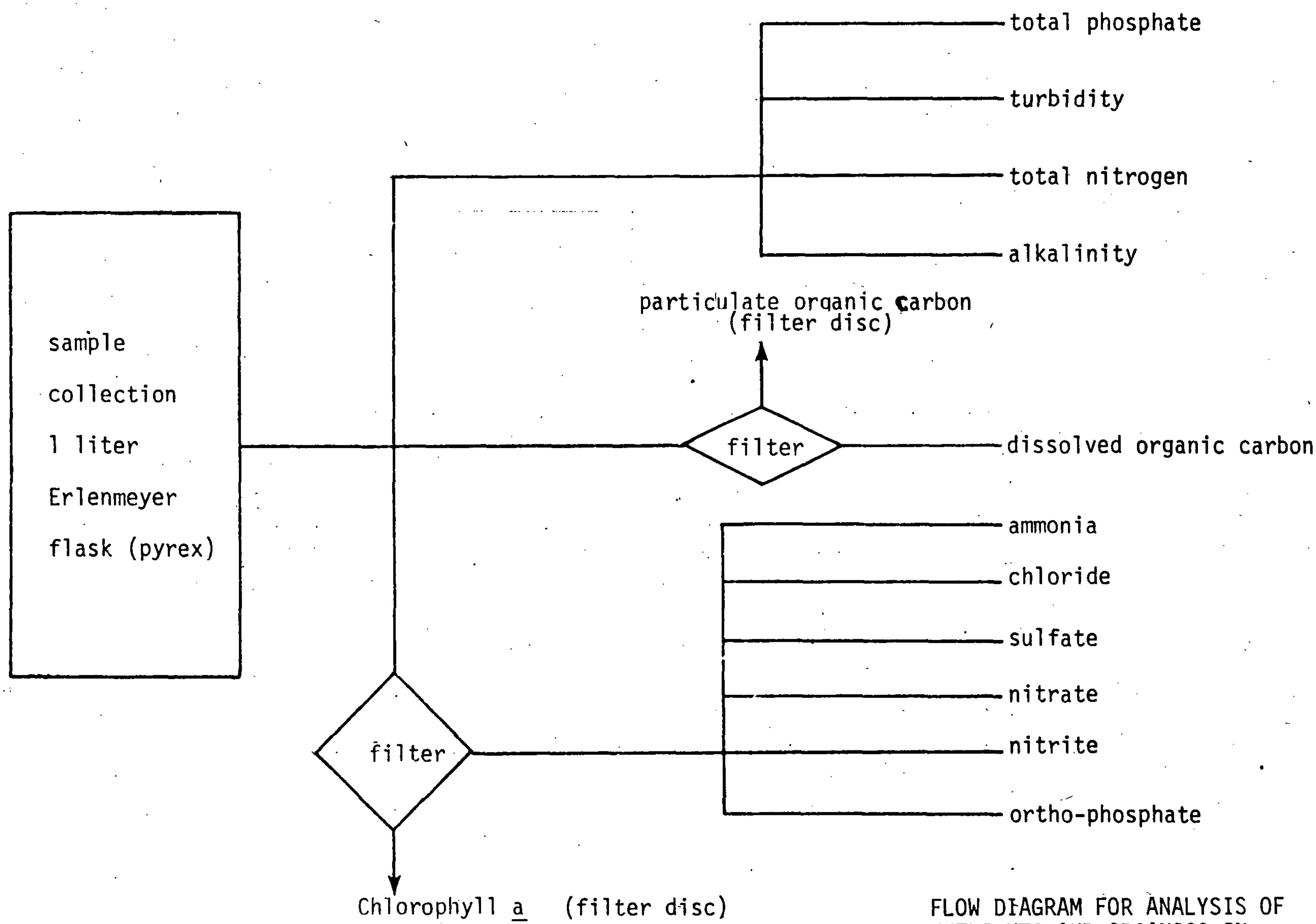
Instruments:
Temperature
D.O.
Cond.

Personnel:____________________

WATER SAMPLE FIELD DATA FORM

PERKINS NUCLEAR STATION

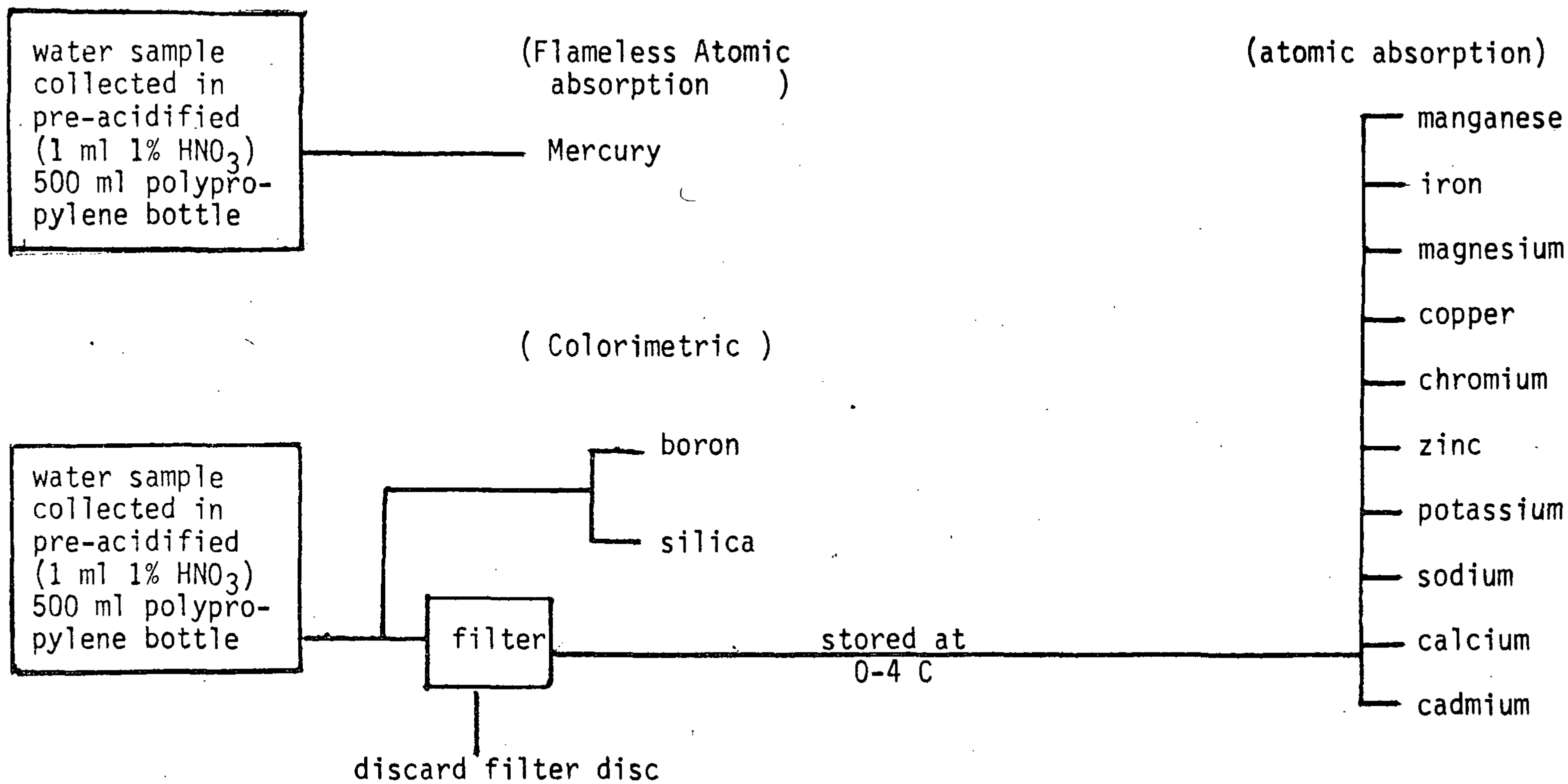
ER Figure 6.1.1-3



FLOW DIAGRAM FOR ANALYSIS OF
NUTRIENTS AND ORGANICS IN
WATER SAMPLES

PERKINS NUCLEAR STATION

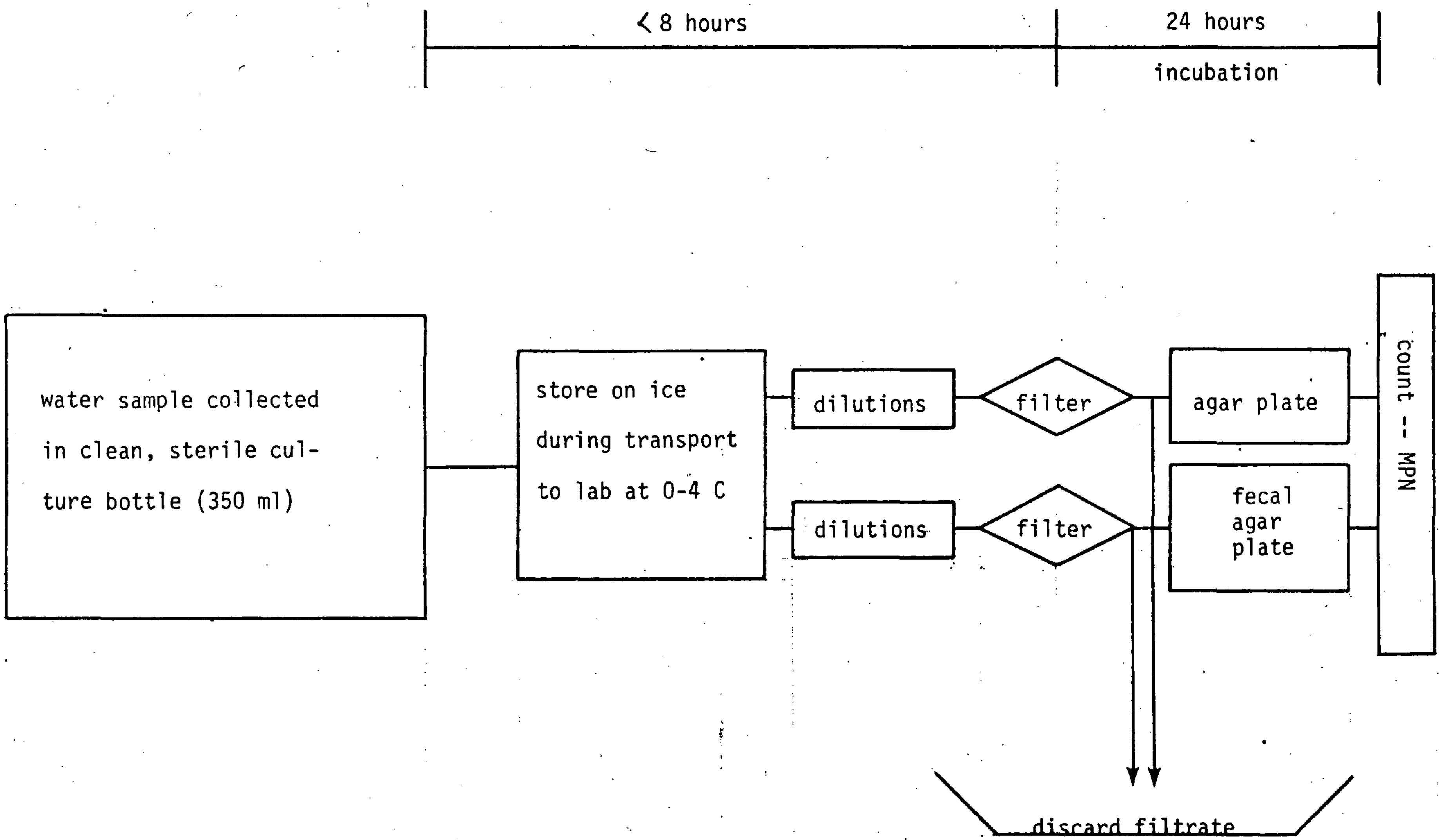
ER Figure 6.1.1-4



FLOW DIAGRAM FOR THE ANALYSIS OF BORON, SILICA AND SELECTED CATIONS IN WATER SAMPLES

PERKINS NUCLEAR STATION

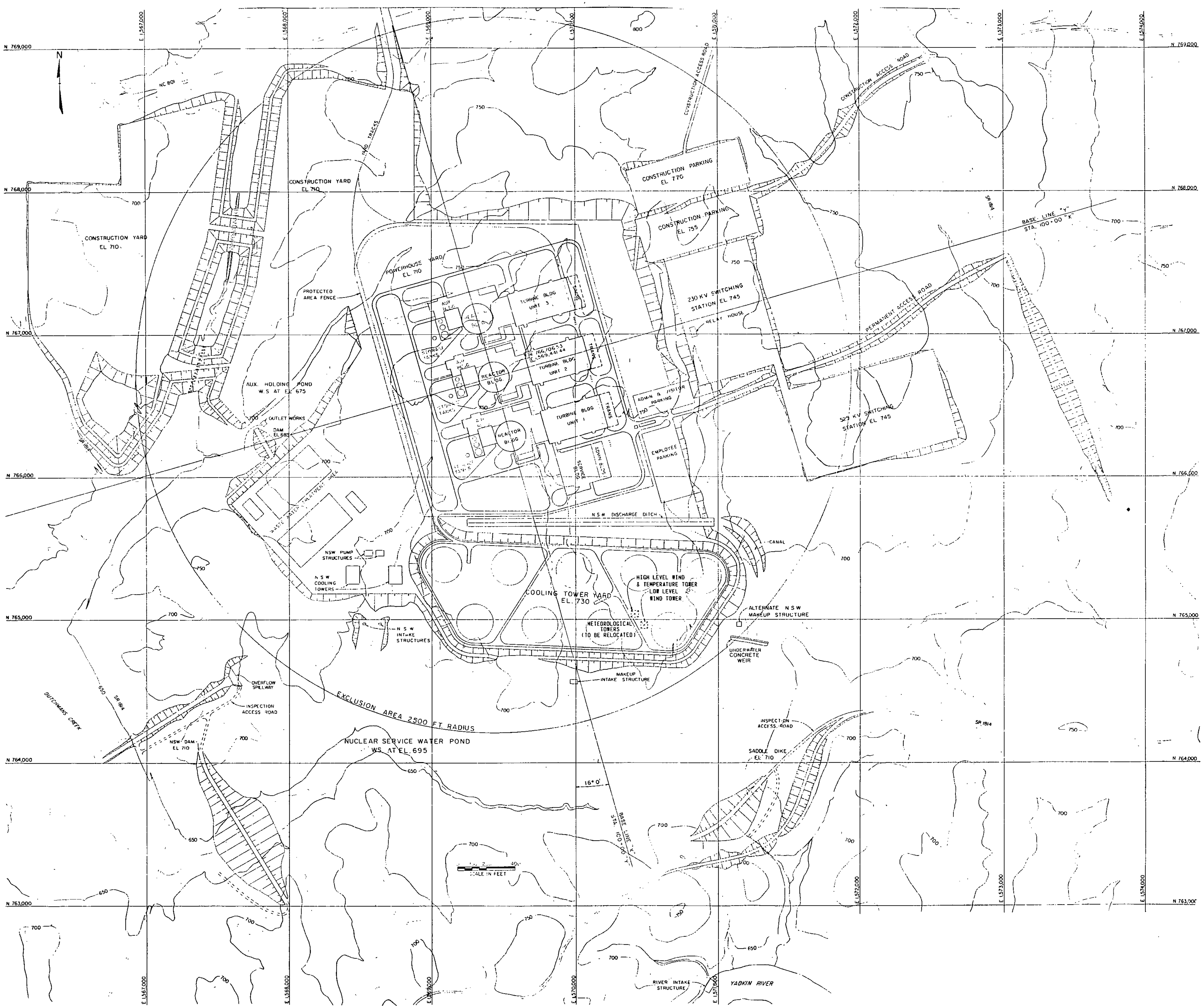
ER Figure 6.1.1-5



FLOW DIAGRAM FOR THE DETERMINATION OF TOTAL AND FECAL COLIFORM COUNTS IN WATER SAMPLES

PERKINS NUCLEAR STATION

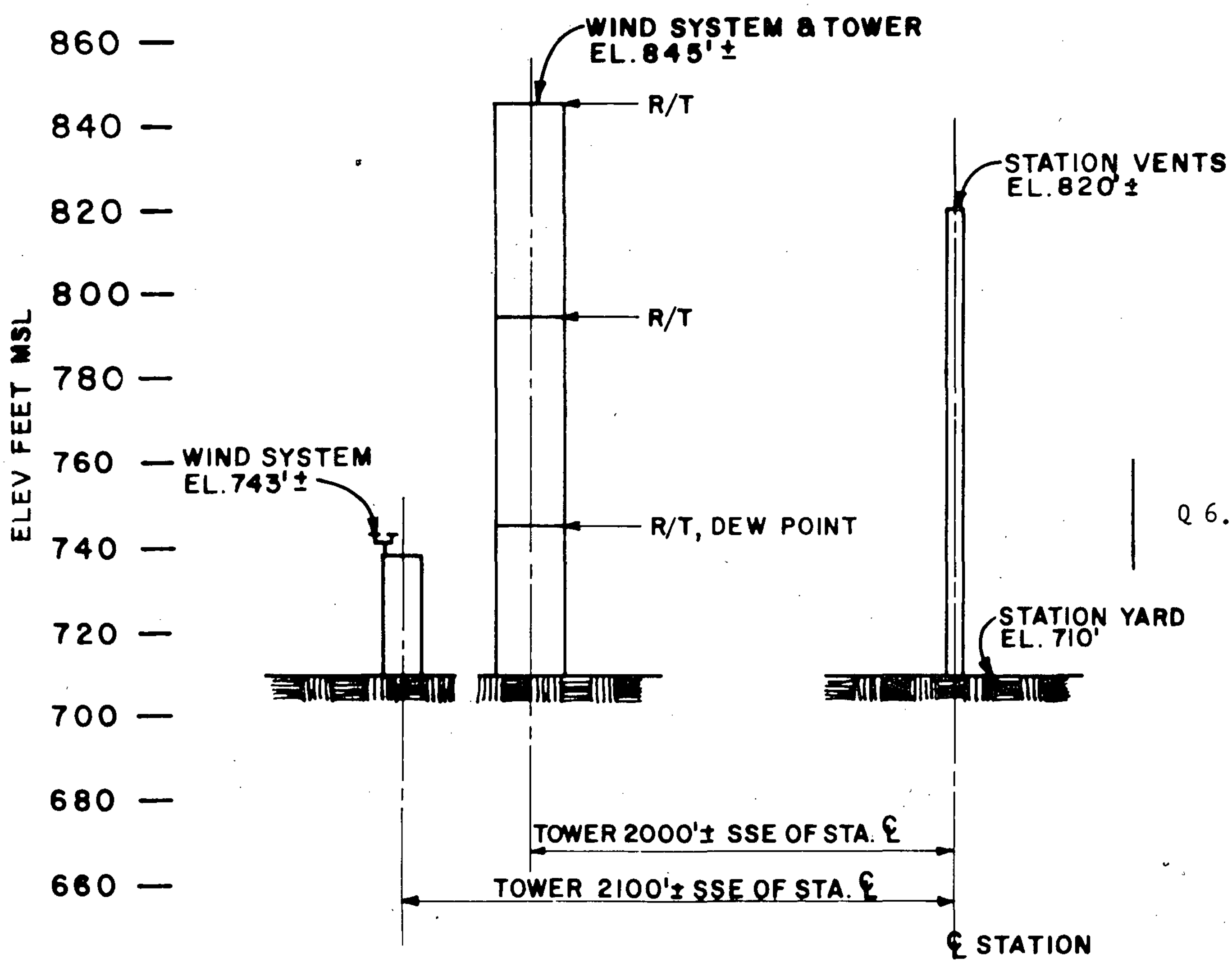
ER Figure 6.1.1-6



LOCATION OF METEOROLOGICAL INSTRUMENTS

PERKINS NUCLEAR STATION

ER Figure 6.1.3-2
Amendment 2
Amendment 3



R/T = RESISTANCE THERMOMETER

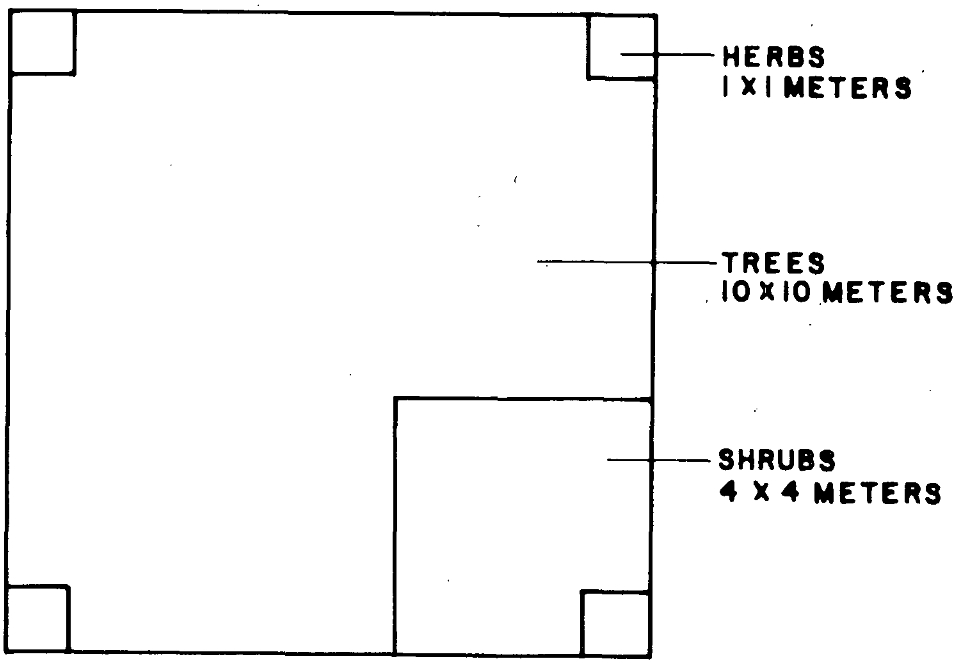
Q 6.1.4

ELEVATIONS OF METEROLOGICAL INSTRUMENTS

PERKINS NUCLEAR STATION

ER Figure 6.1.3-3

Amendment 1



SCHEMATIC OF NESTED QUADRATS

PERKINS NUCLEAR STATION

ER Figure 6.1.4-1

COMMUNITY TYPE

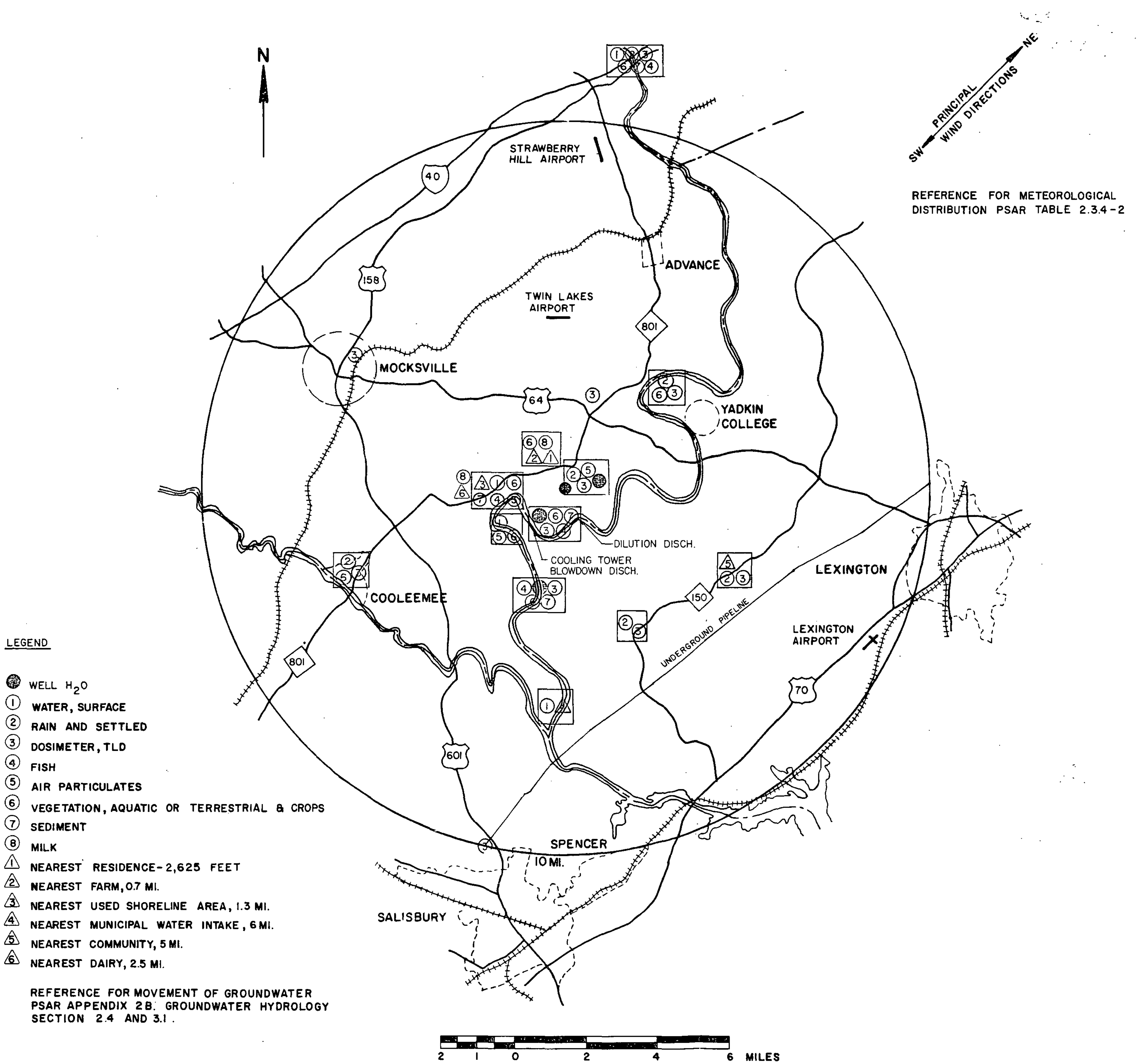
Alluv. Forest	Mixed Mesophytic Hardwood	Mesic Pine	Oak-Hickory	Abandoned Field
1. abc 8. bde 15. b	2. abce 6. abd 16. b	3. abc 9. b 17. bde	4. abcde 7. b 18. b	25. bcd 26. b 27. b
Alluvial Thicket	**Pine Plantation**	**Cultivated Fields**	**Pasture**	
5. abcde 10. b 19. b	22. bc 23. bd 24. b	11. b 13. b 20. bcd	12. b 14. bcd 21. b	

Leaf Litter --a
Vegetation Analysis and Bird Strip Census -------b
Mammal Trapping ---------c
Breeding Bird and Herp Census -------d
Vegetation Quadrat Analysis -----e

LOCATIONS OF TERRESTRIAL SAMPLING STATIONS ON PROPOSED SITE

PERKINS NUCLEAR STATION

PSAR Figure 6.1.4-2
Amendment 2
(New)



RADIOLOGICAL SAMPLING STATIONS

PERKINS NUCLEAR STATION

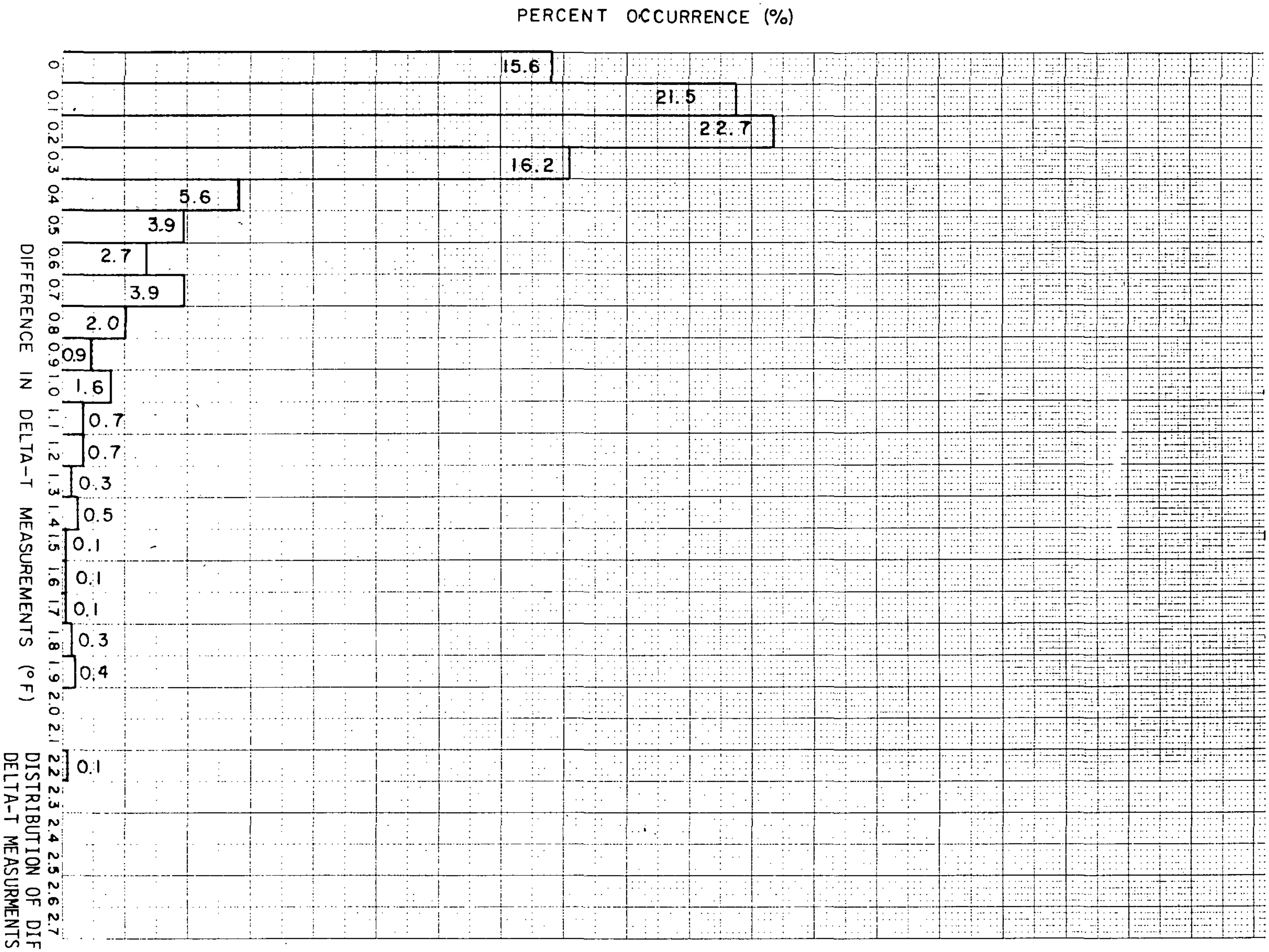
ER Figure 6.1.5-1
Amendment 1
Amendment 2

Figure 6.2.1-1
Environmental Monitoring
Semi-Annual Report Form

Medium Sampled	(1) Number of Sampling Locations	(2) Total Number of Samples	(3) Number of Locations Significant Levels	Sampling Point with Highest Concentration or Highest Radiation Level above Background			
				(4) Highest	(5) Lowest	(6) Average	(7) Location

NO. 341-10½ DIETZGEN GRAPH PAPER
10 X 10 PER HALF INCH

EUGENE DIETZGEN CO.
MADE IN U. S. A.



DISTRIBUTION OF DIFFERENCES IN DELTA-T MEASURMENTS FOR THE OLD AND THE NEW TEMPERATURE SYSTEMS

PERKINS NUCLEAR STATION
ER Figure 6.2.4-1
Amendment 3
(New)

Table Of Contents

Amendment 1
(Entire Page Revised)

Amendment 2
(Entire Page Revised)

LIST OF TABLES

Perkins Nuclear Station

7.0 ENVIRONMENTAL EFFECTS OF ACCIDENTS

The Atomic Energy Commission requires that applicants for Construction Permits and Operating Licenses for nuclear power plants submit analyses of the environmental effects of possible accidents which may occur within the plant or during transportation of radioactive materials. The accident analysis follows the guidelines and assumptions given in the AEC document "Guide to the Preparation of Environmental Reports for Nuclear Power Plants" Q7.2

1 issued in March, 1973.

Amendment 1

7.1 PLANT ACCIDENTS INVOLVING RADIOACTIVITY

2

Environmental consequences of a spectrum of postulated accidents involving radioactive releases have been evaluated for Perkins Nuclear Station. Table 7.1.1-1 lists the results of these evaluations. The Perkins Preliminary Safety Analysis Report (PSAR) and the Combustion Engineering Standard Safety Analysis Report (CESSAR) contain an extensive examination of the design basis accidents. The principal line of defense is accident prevention through correct design, manufacture, and operation. Even though the likelyhood of a serious accident occurring is extremely small, the conservative postulate is made that they might occur so that a realistic evaluation of their possible environmental consequences can be made. Accidents evaluated in this report are chosen to encompass a wide spectrum of postulated accidents such that environmental consequences of other accidents may be evaluated by comparison.

Since the PSAR and CESSAR are safety evaluations documents, all parameters used in their evaluations are of a very conservative nature. This conservative approach to safety evaluation is used so that the design features of the plant will be more than adequate to protect the health and safety of the public.

The assumptions used for the safety evaluation are not suitable for a realistic evaluation of the environmental consequences of accidents. It is necessary to make more realistic assumptions to obtain a realistic appraisal of the environmental consequences of postulated accidents. The assumptions used in this report closely follow the guidance in Chapter 7 of AEC Regulatory Guide 4.2 These realistic assumptions are discussed with each accident considered. General exceptions to Regulatory Guide 4.2 are listed in Table 7.1.0-1 along with those assumptions which are common to all accidents.

Commercial power generating reactors have been in operation since 1957 (Shippingport) and many more are in operation today. Throughout this experience there have been no significant releases of radioactivity due to accidents and there have been no injuries or deaths due to radioactive releases. It is logical that an event which damages equipment or causes severe operating inconveniences is unlikely to recur during the life of the plant due to remedial procedures, redesign or replacement of the fault causing component. No probabilities of occurrence are presented, because a realistic evaluation of the accidents indicates no significant environmental consequences.

Radiological consequences of most accidents are dependent on the primary coolant system activity. The design basis for reactor coolant activity level assumes 1.0 percent defective fuel. Based on experience with currently operating reactors, a more realistic assumption would be continuous operation with 0.1 percent fuel defects or less. Fuel experience is discussed in detail in the PSAR Subsection 11.1.

Operating experience (1) indicates that an average of 110 pounds per day primary to secondary leakage is reasonable. This value is recommended in AEC Regulatory Guide 1.42 for calculation of offsite doses due to routine releases. There is no reason to expect that this value will be greater in an accident situation unless of course that is the accident under consideration.

The Steam Generator Blowdown System is designed to operate normally with 50 gallons per minute continuous blowdown as described in Subsection 11.2 of the PSAR. It will accommodate larger quantities of blowdown.

This section examines seven of the nine classes of accidents that are listed in AEC Regulatory Guide 4.2 Chapter 7. Class 4 accidents are not considered because they apply only to Boiling Water Reactors. Class 9 accidents are not considered credible and are discussed in Regulatory Guide 4.2 as follows:

> "The occurrences in Class 9 involve sequences of postulated successive failures more severe than those postulated for establishing the design basis for protective systems and for site evaluation purposes. Their consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (Multiple physical barriers), quality assurance for design, manufacture, and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain the required high degree of assurance that potential accidents in this class are and will remain sufficiently remote in probability that the environmental risk is extremely low."

The accident classes are defined as follows:

Class No.	Description
1	Trivial Incidents
2	Small releases outside containment
3	Radwaste system failures
5	Fission product to the Primary and Secondary Systems
6	Refueling accidents
7	Spent fuel handling accidents
8	Accident initiation events considered in design basis evaluation in the Safety Analysis Report.

Average meteorology conditions are assumed for all accidents. The calculation of X/Q and the data base are found in Section 2.6. The population weighted
2 annual average X/Q is shown in Table 2.6.2-5.

External whole body doses from submersion in noble gases and iodines are calculated for the population within fifty miles. The submersion dose conversion factors are based upon the infinite cloud equation used in USAEC Regulatory Guides and fully described in Reference 1.

The dose is established from the following:

$$D = \sum_{i=1}^{N} \psi_i \cdot DCF_i$$

where:

D = The Dose received by an individual from the postulated accident under consideration (rem)

$\sum_{i=1}^{N}$ = The summation of the dose contribution from each isotope

i = the ith isotope

N = the total number of isotopes considered

ψ_i = The concentration time integral. If it is assumed that the time over which the dose is received is equal to the time over which the release of the radioactivity occurs, then $\psi_i = A_i \cdot (X/Q)$

A_i = The amount of activity of the ith isotope released from the postulated accident under consideration (Curies)

X/Q = The atmospheric dilution factor corresponding to the postulated accident under consideration (sec/cubic meter)

DCF_i = A dose conversion factor for the ith isotope (further described below) (rem/Curies-sec/cubic meter)

$DCF_i = (0.23 E_{\beta i} + 0.25 E_{\gamma i})$

DCF_i - The submersion dose conversion factor for the ith isotope (rem/Ci-sec/m3)

0.23 = a conversion factor for the expression of the surface body dose from beta emitters in an infinite cloud. This constant takes into consideration the density of air as well as the conversion from Mev to Rem. $\frac{(\text{dis-m}^3\text{-rem})}{(\text{Mev-sec-Ci})}$

$E_{\beta i}$ = The average beta energy per disintegration

0.25 = a conversion factor for the expression of the tissue dose from submersion, in a semispherical, infinite cloud of gamma emitters.

This constant takes into consideration the density of air, the conversion from Mev to Rem as well as the difference between the electron densities of tissue and air. $\frac{(dis\text{-}m^3\text{-}rem)}{(Mev\text{-}sec\text{-}Ci)}$

$E_{\gamma i}$ = The average gamma energy per disintegration $\frac{(Mev)}{(dis)}$

2 The dose resulting from the above calculation is the dose to an average individual. This dose must then be multiplied by the population within 50 miles to obtain the population dose in Man-rem. Q 7.1.1

2 Source terms for all postulated accidents are included in Tables 7.1.0-2 through 7.1.0-14. Q7.1.2

7.1.1 TRIVIAL INCIDENTS

Trivial incidents by their definition pose no risk to the general population. Incidents of this category are included and evaluated under routine releases in Chapter 5.

7.1.2 SMALL RELEASES OUTSIDE CONTAINMENT

Incidents of this category are included and evaluated under routine releases in Chapter 5. Subsection 12.2.6 of the PSAR includes an analysis of the effects of minor spill and leaks on plant operating personnel. Like the trivial incidents, these small releases pose no risk to the general population.

7.1.3 RADWASTE SYSTEM FAILURES

7.1.3.1 Release of Contents of a Waste Gas Storage Tank

The waste gas storage tanks and associated systems are described in Subsection 3.5.2. System design insures that the failure of some component in the Gaseous Waste Management System will not release the contents of more than one waste gas storage tank.

To mitigate the consequences of any accidental releases from the waste gas storage system, the activity contained in any one tank is limited by the technical specifications, Chapter 16 of the PSAR.

It is assumed that one hundred percent of an average storage tank is released. Filling of the tank as described in Subsection 3.5.2, is completed 90 days prior to rupture. Kr 85 is the major source of radioactivity release with minor amounts of Xe 131m and Xe 133.

7.1.3.2 Release of Contents of a Liquid Storage Tank

Release of the contents of a Liquid Storage Tank is evaluated so as to encompass a variety of postulated accidents. The release is assumed to result from the rupture of a reactor coolant holdup tank, although such an event is highly unlikely. Subsection 11.2.3 contains classification of storage tanks used to store radioactive liquids.

Since all floor areas drain to sumps and are collected, any spill would not be released from the plant without treatment. Only those radionuclides which
3 become airborne may be released. A 30,000 gallon tank is assumed to fail.
The tank contains reactor coolant from the Chemical and Volume Control System reduced in concentration by appropriate ion exchange decontamination factors. No credit is taken for decay prior to release from the tank. 0.5 percent of the radioactive iodines and all noble gases are released as airborne effluent to the environment. Credit is taken for building ventilation filters.

7.1.4 FISSION PRODUCTS TO PRIMARY SYSTEM

This section (Class 4) does not apply to a Pressurized Water Reactor.

7.1.5 FISSION PRODUCTS TO PRIMARY AND SECONDARY SYSTEMS

7.1.5.1 Fuel Cladding Defects and Steam Generator Tube Leaks

Minor fuel cladding defects and Steam Generator tube leaks are expected occasionally during normal operation. These events are included and evaluated under routine releases in Chapter 5.

7.1.5.2 Off-Design Transients That Induce Fuel Failure Above Those Expected and Steam Generator Tube Leak

If an off-design transient were to cause the release of a large amount of radioactivity to the primary coolant, the unit would have to be shut down. Since one of the reasons for the shut down would be high releases of radioactivity (from the condenser air ejector or building ventilation) the environmental consequences of such accident may be generally estimated as 2 to 8 times the design objectives for normal operation. For example, if the reactor coolant system activity were 25 times the design basis coolant activity (total coolant system inventory would be about .02 percent of the core inventory), and this condition persisted for four days prior to shutdown, the additional release would be about three times the normal annual release. (Design basis reactor coolant activity is ten times higher than normal.) This same release would also result from operation with design basis coolant activity for three months.

7.1.5.3 Steam Generator Tube Rupture

Rupture of a steam generator tube in a pressurized water reactor system results in the release of radionuclides into the secondary system. Although some of the activity is removed by the blowdown system, much of it will be transported throughout the secondary system. The accident will be discovered from the high activity released through the Condenser Air Ejector System. Other indicators will be the excessive primary system makeup and the high activity in the Steam Generator Blowdown System. Proper operator action isolates the affected steam generator within 30 minutes of the rupture thus eliminating further release to the environment from the faulty steam generator. It is assumed that 15 percent of the reactor coolant inventory of noble gases and iodines, based on concentration at normal operation, are released into the secondary system. All noble gases are assumed to be released by the Condenser Air Ejectors. Due to the effects of plateout in the secondary system and partitioning between the water and steam, only 0.1 percent of the radioiodine is assumed to be released by the condenser air ejector. Doses are calculated according to the methods described above.

7.1.6 REFUELING ACCIDENTS

2 #### 7.1.6.1 Fuel Bundle Dropped Inside the Containment

In the event of a fuel handling accident inside the Containment, the Containment can be isolated to prevent the release of radionuclides to the environment. It is estimated that no more than five minutes will elapse before the Containment is isolated. During this time period approximately one-eighth of the containment atmosphere is exhausted. Since the fuel elements are never removed from the water, any damage to the fuel pins would occur well below the surface of the water. Section 15.4.6 of CESSAR presents

an analysis of the energy required to damage one row of fuel pins. For a realistic evaluation of a fuel handling accident, it is assumed that only
2 one row of fuel pins is damaged and that the gap activity from that one row of fuel pins is released to the surrounding water. The activity contained in the gas gap is assumed to be 1 percent of the total activity in the damaged pins. The dropped assembly is assumed to be an average assembly in the core at the time of shut down. Full power operation prior to shutdown is assumed. Fuel handling operations do not commence for more than three days after the reactor has been shut down, and it is assumed that the accident does not occur until one week after shut down. The iodine released to the water is reduced by a factor of 500 as it passes through the water. No building ventilation filters are assumed.

2 7.1.6.2 Heavy Objects Dropped Onto Fuel In Core

The assumptions used to evaluate this event are the same as in 7.1.6.1 since they both occur inside the containment. A minimum of 100 hours is required before the system can be opened for fuel handling operations. Credit is taken for decay during this time. It is assumed that fuel pins equivalent to those in one average fuel assembly are damaged and that the gas fraction
2 from that number is released to the surrounding water.

7.1.7 SPENT FUEL HANDLING ACCIDENT

2 7.1.7.1 Fuel Assembly Dropped Into Fuel Storage Pool

The consequences of a fuel handling accident are evaluated in a similar manner whether in the Fuel Storage Pool or in the Containment. The environmental consequences of the refueling accident are mitigated by the accident occurring in the Containment. As in the case of the fuel bundle drop, the fuel handling accident is assumed to damage one row of fuel pins in an average assembly. One percent of the assembly activity is assumed to be in the gas gap and is released to the fuel pool water after one week decay. All the noble gases are released to the environment. The radioiodines are reduced by a factor of 500 as they pass through the pool water. The iodines are further reduced by a factor of 100 due to the building ventilation carbon filters. Doses to the population are calculated according to the methods described above.

2 7.1.7.2 Heavy Object Dropped Into Fuel Rack

This event is calculated the same as the fuel assembly drop, except that an entire fuel assembly is damaged after 30 days decay.

7.1.7.3 Fuel Cask Drop

The spent fuel assemblies are not moved from the pool in less than 150 days in accordance with the Technical Specifications listed in Section 16 of the PSAR. It is assumed that the spent fuel assembly is inside the shipping cask prior to the accident. The cask is then dropped while being loaded onto the truck for shipping to a fuel processing facility. If the fuel cask is broken open in the accident, the fuel pins must be damaged for a release of radionuclides to occur.

2 If all these events do occur, it is assumed that the fraction of the noble gases and iodines in the gas gap are released to the environment. The gas gap fraction is assumed to be one percent. Credit is taken for decay during the 150 days since the reactor was shutdown. Doses to the population are calculated according to the methods described above.

7.1.8 SAFETY ANALYSIS REPORT DESIGN BASIS ACCIDENTS

7.1.8.1 Loss of Coolant Accidents

Loss of coolant accidents are divided into two categories. A small loss of coolant accident is the release to the containment of a reactor coolant system inventory of activity. The large loss of coolant accident, which is the Safety Analysis Report design basis accident, is the loss of one reactor coolant volume of primary coolant plus some fraction of the core activity inventory to the containment. The loss of the core activity is due to the core damage as a result of the transient which occurs. CESSAR Chapter 15 provides a complete analysis of the accident and the corresponding action of the safety related systems which are designed to operate following the accident. The systems and their responses are further described in PSAR Chapter 6. Due to the action of these systems and the double containment, leakage to the environment of radionuclides is quite small.

The large break is assumed to cause the release of 2 percent of the core inventory of radionuclides into the coolant. Core inventory is determined from the power history of the core and the fission product yeilds from reference 3. Coolant activity before the accident is at normal operating levels and is all released to the containment. All noble gases in this inventory is assumed to be released. The radioiodines are reduced by a factor of five due to plateout and sprays. The leak rate from the containment to the annulus is .05 percent of the containment volume for the first day and .025 percent per day thereafter. The activity leaked to the annulus is assumed to mix with the annulus air prior to exhaust from the carbon filtered recirculation system. Carbon filter efficiency is assumed to be 99 percent. Due to the redundancy of the hydrogen recombiners, no containment purge is required for hydrogen removal. Containment leakage which bypasses the annulus is assumed to be negligible. Doses to the population resulting from these releases are calculated according to the methods described above.

7.1.8.2 Rod Ejection Accident

An ejection of a control rod drive mechanism results in a loss of coolant accident, although it is less severe than the one described above. The environmental consequences are calculated in the same manner as the loss of coolant accident except that only 0.2 percent of the core inventory is released to the coolant at the time of the accident. The resulting consequences are proportionally smaller.

7.1.8.3 Steamline Break

A steamline rupture would have environmental consequences only if there had been primary to secondary leakage prior to the accident. A primary to secondary leak results in the buildup of radionuclides in the secondary system. Steam generator concentrations resulting from normal operation are listed in PSAR Table 11.1-4. The steam line rupture accident would result

2 in the release to the environment of at most one steam generator volume (CESSAR Table 11.1-18) prior to isolation of the affected steam generator. All noble gases in the steam generator at that time would be released. The release of radioiodines is reduced by a factor of 10 due to plateout in the steam generator and steam line during release. Doses are calculated in the manner described above.

7.2 OTHER ACCIDENTS

Protection of the environment from adverse effects of nonradioactive accidents will be achieved by primary and contingent preventive measures.

Primary protection will consist of careful design of station systems to minimize the likelihood of occurrence of postulated accidents. Examples of these include:

1. Underground storage tanks for auxiliary boiler fuel oil tanks;

2. Design of lubricating oil systems to minimize leakage;

2 3. Storage of combustible cleaning solvents and paint thinners in areas with OSHA required safeguards; Q5.4.1

4. Storage and handling of compressed gas cylinders in compliance with OSHA requirements;

5. Regular safety training sessions for all employees and special training and supervision of lab personnel handling potentially hazardous chemicals.

In spite of extensive safeguards, minor accidents involving spills, leakage, and fires are possible. Back up systems will be provided to prevent such accidents from causing harm to the environment or the station personnel. These contingent methods include:

1. Placement of fire extinguishers at appropriate positions throughout the station with special emphasis on areas where flammable solutions are stored or used for cleaning and maintaining station equipment.

2. Routing of Turbine Building drains to the Waste Water Collection Basin to prevent spillage, leakage, overflows, and drum or tank ruptures from discharging directly to the environment. The Waste Water Treatment
2 System will be equipped with an oil trap on the discharge structure to allow collection and cleanup of any oils spilled in the station. The volume of the basin will provide approximately 16 million gallons of water for dilution of chemical spills, and the holdup capacity will allow retention time for additional neutralization or treatment if necessary.

ER Table 7.1.0-1

Perkins Nuclear Station

2 Assumptions for Accident Release Calculations

1. General exceptions to Regulatory Guide 4.2

   a. 0.1 percent failed fuel

   b. 110 lbs per day primary to secondary leakage

   c. Steam generator blowdown rate of 50 gpm

2. Assumption common to all accidents

   a. Reactor power 3800 MWt

   b. Carbon filter efficiency of 99 percent is assumed for radioiodines.

   c. Letdown to CVCS is 85 gpm.

ER Table 7.1.0-2

Perkins Nuclear Station

Radioactivity Sources From Waste Gas Storage Tank Release Accident

Isotope	Activity [Curies]
Kr 85	1.4(3)
Xe131M	5.5(-3)
Xe133	1.4(-6)

Notation: 1.0(-1) means 1.0×10^{-1}.

ER Table 7.1.0-3

Perkins Nuclear Station

Radioactivity Sources From Liquid Storage Tank Release Accident

Isotope	Activity [Curies]
I 131	1.6(-3)
I 132	4.2(-4)
I 133	2.2(-3)
I 134	3.0(-4)
I 135	1.2(-3)

Notation: 1.0(-1) means 1.0×10^{-1}.

ER Table 7.1.0-4

Perkins Nuclear Station

Radioactivity Sources From Off Design Transient Accident

Isotope	Activity [Curies]
Kr 85M	1.7(1)
Kr 85	2.2
Kr 87	1.0(1)
Kr 88	3.7(1)
Xe131M	2.1
Xe133	3.3(2)
Xe135	6.8(1)
Xe138	2.4
I 131	3.4(-3)
I 132	3.3(-4)
I 133	2.8(-3)
I 134	3.1(-4)
I 135	1.2(-3)

Notation: 1.0(-1) means 1.0 X 10^{-1}.

Amendment 1
(New)
Amendment 3
(Entire page revised)

ER Table 7.1.0-5

Perkins Nuclear Station

Radioactivity Sources From Steam Generator Tube Rupture Accident

Isotope	Activity [Curies]
Kr 85M	5.1
Kr 85	8.6(-2)
Kr 87	3.5
Kr 88	9.0
Xe131M	2.9(-1)
Xe133	9.4(1)
Xe135	1.7(1)
XE138	2.2
I 131	4.3(-4)
I 132	2.1(-5)
I 133	1.1(-4)
I 134	1.2(-4)
I 135	2.7(-4)

Notation: 1.0(-1) means 1.0×10^{-1}.

Amendment 2
(New)

Amendment 3
(Entire page revised)

ER Table 7.1.0-6

Perkins Nuclear Station

Radioactivity Sources From Fuel Bundle Drop Inside Containment Accident

Isotope	Activity [Curies]
Kr 85	2.9
Xe131M	1.1
Xe133M	1.9
Xe133	2.7(2)
Xe135	2.1(-3)
I 131	3.2(-1)
I 133	5.2(-3)

Notation: 1.0(-1) means 1.0×10^{-1}.

ER Table 7.1.0-7

Perkins Nuclear Station

Radioactivity Sources From Object Drop Onto Fuel In Core Accident

Isotope	Activity [Curies]
Kr 85M	3.1(-4)
Kr 85	4.9(1)
Xe131M	2.2(1)
Xe133M	7.4(1)
Xe133	6.4(3)
Xe135	5.7
I 131	6.7
I 133	8.2(-1)
I 135	6.6(-4)

Notation: 1.0(-1) means 1.0×10^{-1}.

ER Table 7.1.0-8

Perkins Nuclear Station

Radioactivity Sources From Fuel Assembly Drop In Fuel Storage Pool Accident

Isotope	Activity [Curies]
Kr 85	2.4(1)
Xe131M	9.0
Xe133M	1.5(1)
Xe133	2.1(3)
Xe135	1.6(-2)
I 131	2.6(-2)
I 133	4.2(-4)

Notation: 1.0(-1) means 1.0×10^{-1}.

ER Table 7.1.0-9

Perkins Nuclear Station

Radioactivity Sources From Heavy Object Drop Onto Fuel Rack Accident

Isotope	Activity [Curies]
Kr 85	3.9(2)
Xe131M	3.9(1)
Xe133M	2.1(-1)
Xe133	1.7(3)
I 131	5.8(-2)

Notation: 1.0(-1) means 1.0×10^{-1}.

ER Table 7.1.0-10

Perkins Nuclear Station

Radioactivity Sources From Fuel Cask Drop Accident

Isotope	Activity [Curies]
Kr 85	380
Xe131M	3.4(-2)
Xe133	2.6(-4)
I 131	9.6(-2)

Notation: 1.0(-1) means 1.0 X 10^{-1}.

ER Table 7.1.0-11

Perkins Nuclear Station

Radioactivity Sources From Loss-of-Coolant Accident (Small Break)

Isotope	Activity (Curies) 0-8 hr.	8 hr-1day	1-4 day	4-30 day
Kr 85M	8.7(-3)	1.0(-2)	1.4(-3)	0
Kr 85	1.3(-3)	8.3(-3)	4.4(-2)	1.3
Kr 87	1.3(-3)	6.7(-5)	0	0
Kr 88	1.1(-2)	5.6(-3)	1.8(-4)	0
Xe131M	2.5(-3)	1.5(-2)	7.4(-2)	3.5(-1)
Xe133M	1.3(-2)	7.2(-2)	2.3(-1)	1.4(-1)
Xe133	7.1(-1)	4.2	1.8(1)	3.4(1)
Xe135M	1.1(-4)	0	0	0
Xe135	3.6(-2)	9.6(-2)	5.5(-2)	2.2(-4)
Xe138	1.2(-4)	0	0	0
I 131	1.2(-5)	1.1(-5)	0	0 0
I 132	3.0(-6)	0	0	0
I 133	1.8(-5)	1.1(-5)	7.5(-6)	0
I 134	1.8(-6)	0	0	0
I 135	9.2(-6)	2.2(-6)	0	0

Notation: 1.0(-1) means 1.0 X 10^{-1}.

ER Table 7.1.0-12

Perkins Nuclear Station

Radioactivity Sources From Loss-of-Coolant Accident (Large Break)

Isotope	Activity (Curies)			
	0-8 hr	8 hr-1 day	1-4 day	4-30 day
Kr 83M	1.6	3.2(-1)	1.5(-3)	0
Kr 85M	9.4	1.1(1)	1.5	1.5(-5)
Kr 85	4.5(-1)	2.9	1.5(1)	4.4(2)
Kr 87	4.8	2.5(-1)	7.6(-5)	0
Kr 88	1.8(1)	9.3	2.9(-1)	0
Kr 89	1.9(-1)	0	0	0
Xe131M	2.6(-1)	1.6	7.5	3.6(1)
Xe133M	2.3	1.2(1)	4.0(1)	2.4(1)
Xe133	9.9(1)	5.9(2)	2.5(3)	4.8(3)
Xe135M	4.7(-2)	0	0	0
Xe135	6.9(1)	1.8(2)	1.1(2)	4.1(-1)
Xe137	3.3(-1)	0	0	0
Xe138	1.7	0	0	0
I 131	2.5(-2)	2.3(-2)	4.4(-2)	1.5(-1)
I 132	2.6(-2)	6.5(-4)	3.2(-6)	0
I 133	5.4(-2)	3.3(-2)	2.2(-2)	2.2(-3)
I 134	4.0(-2)	8.3(-6)	0	0
I 135	4.5(-2)	1.1(-2)	1.4(-3)	0

Notation: 1.0(-1) means 1.0×10^{-1}.

ER Table 7.1.0-13

Perkins Nuclear Station

Radioactivity Sources From Rod Ejection Accident

Isotope	Activity (Curies)			
	0-8 hr	8hr-1day	1-4 day	4-30 day
Kr 83M	8.8(-2)	1.7(-2)	7.8(-5)	0
Kr 85M	5.1(-1)	6.0(-1)	7.9(-2)	0
Kr 85	2.5(-2)	1.5(-1)	8.2(-1)	2.4(1)
Kr 87	2.6(-1)	1.3(-2)	4.1(-6)	0
Kr 88	9.5(-1)	5.0(-1)	1.6(-2)	0
Kr 89	1.0(-2)	0	0	0
Xe131M	1.4(-2)	8.5(-2)	4.1(-1)	1.9
Xe133M	1.2(-1)	6.7(-1)	2.1	1.3
Xe133	5.4	3.2(1)	1.4(2)	2.6(2)
Xe135M	2.6(-3)	0	0	0
Xe135	3.7	9.9	5.7	2.2(-2)
Xe137	1.8(-2)	0	0	0
Xe138	9.2(-2)	0	0	0
I 131	1.3(-3)	1.2(-3)	2.4(-3)	7.9(-3)
I 132	1.4(-3)	3.5(-5)	0	0
I 133	2.9(-3)	1.8(-3)	1.2(-3)	1.2(-4)
I 134	2.6(-3)	0	0	0
I 135	2.4(-3)	5.9(-4)	7.5(-5)	0

Notation: 1.0(-1) means 1.0×10^{-1}.

ER Table 7.1.0-14

Perkins Nuclear Station

Radioactivity Sources From Steamline Break Accident

Isotope	Activity [Curies]
Kr 85M	7.8(-4)
Kr 85	1.3(-5)
Kr 87	5.3(-4)
Kr 88	1.4(-3)
Xe131M	4.8(-4)
Xe133	1.4(-2)
Xe135	2.6(-3)
Xe138	3.4(-4)
I 131	1.7(-4)
I 132	1.1(-5)
I 133	4.5(-5)
I 134	1.4(-4)
I 135	1.2(-4)

Notation: 1.0(-1) means 1.0×10^{-1}.

ER Table 7.1.1-1

Perkins Nuclear Station

Summary of Radiological Consequences of Postulated Accidents

	Class	Incident	Potential Site Boundary Whole Body Dose (rem)	Population Whole Body Dose (man-rem)
	3	Release of Waste Gas Storage Tank Contents	6.3×10^{-3}	4.7
	3	Release of Liquid Waste Storage Tank Contents	1.8×10^{-4}	.14
3	5	Transient Induced Fuel Failure	4.4×10^{-2}	3.2
	5	Steam Generator Tube Rupture	2.4×10^{-3}	1.7
	6	Fuel Bundle Drop	4.9×10^{-4}	.39
	6	Heavy Object Drop Onto Fuel	1.1×10^{-2}	8.0
	7	Fuel Assembly Drop Into Storage Pool	4.3×10^{-3}	3.2
	7	Heavy Object Drop Into Fuel Rack	1.6×10^{-2}	12.
	7	Fuel Cask Drop	9.3×10^{-3}	6.8
	8	Loss of Coolant Accident (Small Break)	1.1×10^{-6}	.34
	8	Loss of Coolant Accident (Large Break)	1.4×10^{-3}	57.
3	8	Steamline Break	4.2×10^{-7}	3.0×10^{-4}
	8	Rod Ejection Accident	6.8×10^{-5}	5.7

ER Table 7.1.3-1

Perkins Nuclear Station

Average Fission Product Activities Due to Continuous Operation Under Normal Operation Including Anticipated Operational Occurrences

2	Nuclide	Specific Activity at 70°F μCi/cc
3	H-3	4.1 (-1)
	BR-84	3.2 (-3)
	KR-85M	1.3 (-1)
	Kr-85	2.2 (-3)
	KR-87	8.8 (-2)
	KR-88	2.3 (-1)
	RB-88	2.2 (-1)
	RB-89	6.9 (-3)
	SR-89	3.4 (-4)
	SR-90	1.5 (-5)
	Y-90	4.6 (-5)
	SR-91	3.6 (-4)
	Y-91	1.7 (-3)
	ZR-95	4.8 (-4)
	MO-99	2.0 (-1)
	TE-129	1.0 (-3)
	I-129	3.1 (-4)
	I-131	2.7 (-1)
	XE-131M	7.3 (-3)
	TE-132	2.8 (-2)
	I-132	7.5 (-2)
	I-133	3.9 (-1)
	XE-133	2.4
	CS-134	2.2 (-2)
	TE-134	3.7 (-3)
	I-134	5.3 (-1)
	I-135	2.2 (-1)
	XE-135	4.4 (-1)
	CS-136	2.3 (-2)
	CS-137	8.9 (-2)
	XE-138	5.7 (-2)
	CS-138	1.0 (-2)
	BA-140	6.1 (-4)
	LA-140	5.7 (-4)
	RU-103	5.8 (-4)
	RU-106	1.2 (-4)
	PR-143	4.5 (-4)
	CE-144	2.9 (-4)

Amendment 1
(Entire page revised)
Amendment 2
Amendment 3

ER Table 7.1.6-1

Perkins Nuclear Station

Core Activity at
End of Cycle

	Elememt	Total Core Inventory (Ci)	Average Assembly Inventory (Ci)
	KR85M	4.5×10^{7}	1.8×10^{5}
	KR85	1.1×10^{6}	4.2×10^{3}
	KR87	8.7×10^{7}	3.6×10^{5}
	KR88	1.2×10^{8}	5.1×10^{5}
	XE131m	5.8×10^{5}	2.4×10^{3}
	XE133	2.3×10^{8}	9.5×10^{5}
	XE135	2.2×10^{8}	9.3×10^{5}
	XE138	2.0×10^{8}	8.4×10^{5}
2	I131	9.9×10^{7}	4.1×10^{5}
	I132	1.4×10^{8}	6.1×10^{5}
	I133	2.3×10^{8}	9.5×10^{5}
	I134	2.7×10^{8}	1.1×10^{6}
	I135	2.1×10^{8}	8.8×10^{5}

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8.0 ECONOMIC AND SOCIAL EFFECTS OF PLANT CONSTRUCTION AND OPERATION

3 Construction and operation of the Perkins Nuclear Station is expected to result in certain social and economic benefits and costs. The purpose of this chapter is to present Duke's assessment of these effects. There are limits to which the social and economic consequences of station construction and operation can be evaluated and measured, in meaningful terms, over the productive life of the facility. It is possible, however, to identify the main benefits and costs of the proposed station.

In discussing the benefits and costs, it is possible, to the extent practical, to indicate who is likely to be affected and for how long. In some instances, there are secondary effects which flow from primary or first-order social and economic impacts. These are identified where they significantly modify the aggregate of costs or benefits. However, such impacts are difficult if not impossible to quantify. For example, one primary benefit of the station will be increased tax revenues to Davie County. This benefit has consequences in terms of the county's ability to improve local services (water, sewers, police and fire protection) and community facilities (schools, hospitals, parks and recreation areas). This secondary effect -- coupled with lower tax rates -- might attract more people to the county, stimulate housing construction, and increase school enrollments. These impacts are largely speculative.

8.1 BENEFITS

The benefits of the Perkins Nuclear Station can be categorized into direct benefits, those derived from the value of the generated electricity delivered to the customer; improved system reliability; and social and economic benefits, including tax revenues, employment, regional product, and public education facilities.

8.1.1 DIRECT BENEFITS

The fundamental measure of benefits to be derived from the Perkins Nuclear Station is the power generated and delivered to the customers. Expected peak capability of the proposed units when fully operational is 1280 Mwe per unit, or 3840 Mwe for the total plant. The expected annual generation of the facility, assuming a 76 percent load factor, is 25,565,000 net Mwh of electrical output.

The 76 percent capacity factor is an assumed capacity factor based on a mature generating station. The assumption reflects the knowledge that while the station capacity factor may not be 76 percent during the first few years due to start up and testing procedures, it is expected to average 76 percent over the useful station lifetime. Q8.1.1

As discussed in Section 1.1, the Duke transmission grid provides increased reliability through centralized dispatching. Under this system, no power plant operates in isolation. If a generating unit suffers an outage, a supply of electric energy flows from alternate sources.

It is difficult to quantify the secondary effects that follow the availability of electrical energy from the Perkins units, since it is impossible to distinguish such effects from those traceable to the availability of electric power from numerous other Duke generating facilities. It is possible, however, to provide estimates of the ultimate use of power by certain classes of customers based on recent usage. Power from the station then tied into the Duke grid is assumed to be distributed for the uses shown in Table 8.1.1-1.

The future tariff for electricity produced by a generating facility depends on a number of variable and rather unpredictable factors.

Both North Carolina and South Carolina require, by statute, that all public utility rates must be just and reasonable. North Carolina General Statutes (G.S.) §62-131 (1965); S. C. Code (S.C.) §24-31 (1962). The statutory schemes of the two states are very similar, with regard to rate proceedings, and provide that a utility give 30 days notice to the Commission before any changes are put into effect (G.S. §62-134; S.C. §24-36; both statutes also permit the Commission to waive the notice requirement), and that the Commission may, in its discretion, hold public hearings and suspend proposed changes until a hearing is held, or until the passage of certain periods of time set forth in statutes. G.S. §62-134; S.C. §24-37. Only certain minor differences, such as time requirements, prevent the two states from having identical procedural provisions. Q8.1.4

North Carolina, however, additionally sets out, in statutory form, the factors to be considered by the Commission in determing reasonableness of rates. G.S. §62-133. The basic premise of this section is that a just and reasonable rate is one that will produce a fair rate of return on investments. A fair rate of return has been defined as one which will be able to attract on reasonable terms the capital needs for the expansion of its service to the public. State ex. rel. Utilities Commission v. Morgan, 278 N.C. 235, 179 S.E.2d 419 (1972). For the purpose of rate hearings, estimates are based on figures derived from a twelve-month test period which usually expires as closely as possible to the initial date of hearings. The primary factor to be considered in determining the reasonableness of rates is the rate base, or the value of the investment which earns the return. This determination is made by ascertaining the fair value of the property "used and useful" in providing service. G.S. §62-133(b)(1). Fair value takes into account the reasonable original cost of the property less that portion of the cost consumed by previous use recovered by depreciation expense, the replacement cost of the property, and "any other factors relevant." G.S. §62-133(b)(1). "Book value" or cost minus depreciation are, alone, insufficient to determine fair value. Property "used and useful" includes all plants in operation at the end of the test period, but not future plants or ones under construction. In addition, replacement cost may be evidenced by "trended" figures, or "by any other reasonable method." G.S. §62-133(b)(1).

The next step in the process is to estimate the company's revenue under present and proposed rates. Then, the Commission must allow a deduction for reasonable operating costs, including the amount of capital investment currently consumed through reasonable actual depreciation. It should be noted that depreciation for income tax purposes is often in excess of the actual depreciation spoken of here. Next, the Commission should determine the rate of return by which the utility, through "sound management," can "produce a fair profit for its stockholders, considering changing economic conditions and other factors, as they then exist, to maintain its facilities and services in accordance with the reasonable requirements of its customers . . . and to compete in the market for capital funds on terms which are reasonable and which are fair to its customers and to its existing investors." G.S. §62-133(b)(4). Finally, the Commission must correlate the rates to be charged with the established facts, by determining the amount of additional gross revenue which will be required to produce the desired net return. Additionally, the statute provides that the Commission should consider "all other material facts of record that will enable it to determine what are reasonable and just rates." G.S. §62-133(d). Examples of such additional factors include: access to a large amount of working capital; the rate of return enjoyed by the company in other states; the financial condition and demand for bought securities which affect the company's capacity to compete, on the open market, for additional equity and debt capital; inflation; the quality of service, excess plant margin; and inadequacy of facilities. The facts are to be established by evidence and set forth in the record. As long as the Commission complies with the statutory mandates, its decisions will be upheld on appeal. Q8.1.4

The South Carolina statute is not explicit in dictating what factors are to be taken into account in determining rate schedules. By inspecting recent actual rate cases, however, one finds that the South Carolina Public Service Commission establishes rates in much the same way as its North Carolina

counterpart. South Carolina also uses the twelve-month test period in determining a fair rate of return on the rate base, and the rate base includes all property "used and useful" in service. However, the method of arriving at the rate base in South Carolina is slightly different. The first factor to be considered is the electric plant in service. Here, the Commission takes the original cost minus depreciation to come up with gross plant in service. Construction work in progress is included in the rate base in South Carolina. From these two figures, the Commission subtracts accumulated provisions for depreciation, contributions in aid of construction, and accumulated deferred income tax (liberalized depreciation) to arrive at the net electric plant. The addition of allocations for material and supplies and cash working capital make the determination of the original cost rate base complete. The Q8.1.4
Commission also looks at the capital structure of the company--the cost of debt (cost of stocks and bonds) and coverage of fixed charges. The latter term refers to the ratio of earnings (after all operating and income deductions, except income taxes and fixed charges) to fixed charges. "Fixed charges" include interest on debt, amortization of debt premium, discount and expense, and one-third of rentals. Inflation, equality of rates in states serviced by the company, expansion, rate schedules, cost of fuel and the rate of return needed to maintain financial security and to assure adequate service are other factors considered in making rate determinations. The South Carolina Code also provides that parties can demand a hearing after the Commission issues an order made in the absence of a hearing (S.C. §24-43); that the Commission may allow the company to enjoy additional profits which result from economy efficiency or improvements in methods of service (S.C. §24-47); and that sales of appliances and other merchandise are not to be considered in the rate proceeding (S.C. §24-53).

It should be noted that on March 25, 1973, the North Carolina legislature amended G.S. 62-133(c) to provide that unless otherwise ordered by the Commission, a twelve-month test period shall be used "beginning on the first day of the month following the date the rates are proposed to become effective".

It is impractical to predict the selling price of power through the life of this station. Because the Duke system is an integrated system, serving both North and South Carolina from its distribution grid and Duke's rates are set by regulatory commissions, as outlined above the effects of a single generating station or unit on the electric rate cannot be estimated. However, a Q8.1.14
nuclear generating plant presents the most economical source of base load. It must also be recognized that customer classification affects rates and revenues. Assuming electrical usage by class remains in the same ratio to total usage as in 1973, it is possible to obtain a typical breakdown of future electric sales and revenues.

Tables 8.1.1-2 and 8.1.1-3 show the results of projections which involve generally conservative assumptions.

8.1.1.1 <u>Value of Delivered Products</u>

The generating capacity of Perkins Nuclear Station is made available throughout the entire Duke service area; therefore, no attempt is made to confine the use characteristics within a particular area or zone.

The generating costs and revenues evaluated in Section 9.3 are based on 76 percent station capacity factor. Assuming that revenue contributions by class of service remain constant until the commercial operation of the Perkins units and that rates for electrical energy remain unchanged, then the approximately 25.6-billion killowatt hours of electricity produced annually have revenues estimated at $353-million as shown on Table 8.1.1-1.

8.1.2 SOCIAL AND ECONOMIC BENEFITS

Primary benefits other than electricity produced by the facility, such as the sale of steam or the use of waste heat for industrial or agricultural uses, are not applicable to Perkins Nuclear Station.

There are other benefits, social and economic, which will affect various political jurisdictions or interests to a greater or lesser degree. The important benefits are discussed in this Subsection.

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8.1.2.1 Averting Electrical Power Shortages

The importance of the Perkins Nuclear Station in providing adequate capacity to assure reliability of the Duke system has been considered in Subsections 1.1.2 and 1.1.3. Section 1.3 shows that the consequences of delay of commercial operation of the units would be detrimental not only to the Duke system, but to all of the systems in the VACAR Subregion of SERC.

Without the Perkins units, additional coal-fired or other less economic types of generation would be required to meet system capacity demands. Also, retirement of the older, less efficient units would have to be delayed. Table 1.1.2-2 indicates a total of 203.7 MW of old capacity retired in 1974 and 1975. Without additional retirements, there would remain by 1988 319 MW of conventional coal-fired steam units which were placed in service prior to 1943, and 594 MW of combustion turbines which were placed in service prior to 1972, all of which, from the standpoint of age and cost, should be retired. It is not possible at this time to schedule unit retirements for future years on a firm basis because of the low reserve levels currently forecast, but it is Duke's intention to retire its old conventional units and combustion turbines at the earliest practicable time.

Two factors have a significant bearing on the economic evaluation of the Perkins units:

1. The rapidly escalating fossil fuel costs will have created a large differential in cost between electric energy generated by fossil fuel plants and that generated by nuclear plants by the time the Perkins units go in service. Every increment of energy produced by Perkins, which displaces energy produced from a fossil fuel plant, results in a substantial reduction in cost for that increment of energy.

2. Because of the difficulty in securing new capital, and the resulting curtailed construction program, the Perkins units are currently scheduled for a date later than desired. This is manifest clearly in the low reserve margins in the 1983-88 period. If the load should fail to grow as rapidly as forecast, the effect would be to install the Perkins units more nearly in keeping with the desired reserve margin, thereby approaching the optimum capacity.

Because a lead time of up to ten years may be required to place a nuclear unit in service, the need for that unit is based on a load forecast made ten years prior to the scheduled start-up date. Actual construction of the facility may take six years, with about 75% of the total cost of the plant appearing in the first four years of the construction period. Consequently, from a practical standpoint the optimization of timing of a nuclear unit with respect to load is somewhat academic. A major portion of the investment will have been made prior to any possibly significant changes in load growth trends which might affect the timing. The effect of load growth less than or greater than forecast, therefore, is to provide the system with greater or less reserve capacity than originally planned. This has a significant bearing on total system production costs, as illustrated in the table below.

Total System Production Cost - $1000

YEAR	Perkins In-Service Date As Scheduled	One Year Late	One Year Early	Two Years Early
1981	752 033.0	753 452.7	749 298.8	690 935.9
1982	815 196.9	820 305.1	755 581.9	748 169.4
1983	878 650.6	950 747.9	873 540.6	822 410.3
1984	962 733.1	972 610.5	908 399.5	900 151.4
1985	1 038 617.4	1 114 188.0	1 033 384.9	982 650.8
1986	1 162 123.0	1 163 551.0	1 101 096.0	1 101 206.0
1987	1 266 127.0	1 332 678.0	1 260 964.0	1 247 921.0
1988	1 402 254.0	1 412 610.0	1 396 572.0	1 390 064.0
Totals	8 277 735.0	8 520 233.2	8 078 837.7	7 883 508.8
(Above) or Below Schedule		(242 498.2)	198 897.3	394 226.2

If the load should grow more rapidly than forecast, to the extent that by 1983 it has reached a value forecast for 1984, the Perkins units would, in effect, go in service one year late. The production cost penalty which accrues over the eight-year period of 1981-1988 amounts to $242,498,200 should this situation exist. Conversely, if the load fails to reach the forecast peak by the equivalent of a year's growth, the Perkins units are, in effect, installed a year early. A saving in production costs for the 1981-1988 period amounts to $198,897,300 in this case. If the load growth should be slowed to the extent that the Perkins units go into service, in effect, two years early, the savings in production costs amount to $394,226,200. It is evident, therefore, that it is in the consumers' best interests that a facility be installed as scheduled, with the possibility of the load not reaching the forecast value, than to pursue the alternative of delaying the unit and facing the possibility that the load will be higher than forecast. The additional reserve capacity afforded by the former also works to the consumers' advantage by providing a more reliable system.

3

8.1.2.2 Tax Revenues

Each year, the Davie County tax rate is set to bring in revenues sufficient to cover the county's budgeted expenses. While the presence of the Perkins Nuclear Station is expected to provide substantial amounts of tax revenues, it is not certain whether these amounts will increase Davie County's total tax revenues. Indeed, the county could elect to lower its tax rate rather than increasing its tax revenues in order to conform to the concept of sufficient funds to cover budgeted expenses.

Decisions concerning a county's tax rate and revenues are expected to be based more on local politics, economics and various social issues. Thus, the effect of the facility on the Davie County tax revenues cannot be isolated, but must be considered as one of many aspects of the county's overall growth.

The historical and expected growth in Davie County has been discussed in Section 2.2. In order to evaluate future increases in the county's tax base and tax revenues, assumptions are made dealing with continuing and future rates of growth. Such assumptions must be conservatively based on the best available information. While the population growth in the county may be less than thirteen percent for the 1960-1970 period, the general value of new homes and other land improvements is increasing faster than the population; therefore, the increase in the total assessed value of the county is expected to remain at about 160 percent per decade.

In rapidly growing areas, there is a need to undertake developments which require substantial capital investments, such as sewage facilities, roads and water projects, all of which tend to make the county's budget grow at a rate substantially greater than the overall growth of the county. Additionally, increased costs of labor and materials require larger funds for county services.

Table 8.1.2-1 details the tax base and revenues for Davie County for the immediate past ten years. The results of studies of property tax liability to Davie County during construction of the Perkins Station are presented in Table 8.1.2-2.

3 The investment of $2,369,587,000 (detailed on Table 8.1.2-3) in generating and transmission facilities at Perkins creates approximately $133-million annually in new tax revenues, according to the formula used by the Federal Power Commission.

The Federal Power Commission in Hydroelectric Power Evaluation, U.S. Government Printing Office, FPC P-35, sets forth economic data "considered appropriate for use in power evaluation studies. Updated data appears in Hydroelectric Power Evaluation, Supplement No. 1, U. S. Government Printing Office, FPC P-38. Q8.1.5

The "formula" applied by Duke in determing state and local taxes is estimated plant cost times the percentage, 2.59, shown in Table 36, column 7, Supplement No. 1, for Duke Power Company.

The justification for using this method of determing tax amounts is that stated in the FPC publications. Experience has shown a significant correlation between the amount of plant investment and the amount of state and local taxes. Use of Duke's own experience, as reflected in the FPC data, is appropriate. Use of data derived from operation of Duke's entire system rather than of data relating to specific localities is justified in that the tax situation of a locality can change drastically for a number of reasons while the tax situation of an entire region over an extended period tends to be stable.

The balance of state and local taxes after deduction of property taxes would go to the State of North Carolina in the form of franchise tax, income tax and several minor taxes. On the basis of the formula described above the total would be as follows:

4	Plant investment	$2,369,587,000
	Formula percentage	2.59
3		$ 61,372,000
3	Property tax portion of amount above	11,223,000
	Balance to North Carolina	$ 50,149,000

Q8.1.8

In addition, operation of Perkins would be expected to give rise to Federal income tax. Hydroelectric Power Evaluation, FPC-35, and Hydroelectric Power Evaluation, Supplement No. 1, FPC-38 provide the basis for calculation of the tax amount. Table 35, Supplement No. 1, indicates Federal income tax equal to 3.03% of plant investment.

4	Plant investment	$2,469,587,000
	Formula percentage	3.03
4 3	Tax amount	$ 71,798,000

The justification for using this method of determining tax amounts is that stated in the FPC publications. Experience has shown a significant correlation between the amount of plant investment and the amount of Federal income taxes. Use of Duke's own experience, as reflected in the FPC data, is appropriate. Q8.1.8

Assuming that 1972 procedures, regulations, and rates are in effect, the Q8.1.6
3 assessed valuation of the Perkins Nuclear Station would be $1,020,275,000.
4 The amount of taxes, based on the assessed value, would be $11,223,000, all Q8.1.7
of which goes to local governmental units.

Effects due to the change that the Perkins station will have on the Davie County tax base must center on the total valuation of Davie County in 1972 which was $110,247,329.

The assessed value of the Perkins units, based upon rules applicable in the
4 3 County by 1972 is $1,020,275,000 or approximately 9.25 times the total county
valuation in 1972.

There could be many primary and secondary effects of the large increase in the tax base, all of which are speculative, including the following: Q8.1.16

1) Lowering of tax rates may accelerate industrialization of Davie County in preference to surrounding counties; decrease tax burden on current property owners; cause influx of population from other counties; and effect the total tax revenues of the county.

2) Increase the tax revenues, which: may allow for additional public facilities construction, such as roads, schools, water and sewage systems, etc.; may allow for higher wages for local government employees; may allow for more local studies for planning; and may cause influx of population seeking better public facilities and services.

3) Any combination of the two above, which could cause any or all of the previously stated effects or others.

The effects on the tax base and tax rates in Davie County due to the construction and operation of Perkins will depend in whole upon the decisions made by county officials at some future time. It is not possible for Duke to predict with any reasonable level of accuracy as to what changes in their
3 tax structure county officials may elect in the 1980s.

4 The Perkins station is expected to be an unusual asset to the county as it will be practically free of demands on the tax supported agencies of the county. No tax-paid police or fire staffs, publicly supported water, sewer or trash disposal services are required.

In summary, the construction and operation of the Perkins units is expected to allow Davie County to plan on a rapidly increasing source of tax revenue into the 1980s.

8.1.2.3 Employment

Duke's construction and operating experience provides the necessary background information needed to estimate the benefits associated with increased employment for the Perkins Nuclear Station

Construction experience indicates that about 74 percent of the work force at the project is expected to be drawn from Davie and adjoining counties. About 12 percent are expected to move into the area from other Duke projects and the remaining 14 percent live within commuting distance. Construction of the project will be a major engineering effort. Construction employment is estimated to reach a peak of 2,660 persons and average 1,482 as shown in Section 4.1.

A major portion of the skilled labor force at the project site is expected to be drawn from the unskilled laborers hired locally and trained under the Duke in-house training program. Previous experience at Duke's Oconee and McGuire Nuclear Stations indicates that about 44 percent of the skilled labor force at those projects were hired as unskilled labor, trained by Duke and promoted to the skilled ranks.

The estimated total construction payroll is over $335-million as detailed in Table 8.1.2-3 and Table 8.1.2-4. It is anticipated that the majority of this money will be spent in the area. The total cost in Table 8.1.2-3 includes the estimated cost of $14-million for the Carter Creek Reservoir. Q8.1.9 Q 17

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A detailed discussion of the social impacts of permanent and construction employment on the communities in which they will live is given in Appendix III. Q8.1.10

About 250 full-time employees are expected to be needed to operate the three unit station. The annual operating payroll is expected to be approximately $7.0-million.

8.1.2.4 Local and Regional Products

Expenditures for materials, equipment, and services represent a substantial addition to local and regional income. While major pieces of equipment, including nuclear steam supply systems and turbine generators are not manufactured regionally, much other equipment and materials are purchased from qualified vendors.

In addition to direct operating payroll costs, money is expended on services and supplies, much of which is available locally. Examples of such services and supplies include water treating chemicals, vehicle maintenance and fuel, miscellaneous hardware, food and clothing, janitorial supplies, replacement pumps, motors, instruments, and electrical equipment.

During the time that construction is going on in the area, Duke expects to spend approximately $700,000 a year on the average for regional and local materials, services and supplies. Q8.1.11

8.1.2.5 Externalities

A number of benefits and adverse affects are expected to result from Perkins Nuclear Station and the electric power generated by its operation. These benefits are expected to be shared throughout the Duke service area since the power generated is to be fed into the power grid.

Categories of environmental benefits expected include:

1) Operation of environmental control facilities. Requirements for operation of municipal waste water treatment of domestic and industrial wastes are expected to increase due to developing regulations for higher waste water quality. Increased electrical capacity will be available for this purpose.

2) Replacement of gas burning residential and commercial heating with electric units and resultant conservation of limited gas resources will be increasingly attractive with new power capacity.

3) Available electricity may speed the building of electric powered mass transit systems, thereby reducing the number of metropolitian automobiles and the associated air pollution.

   There are currently no plans for electric powered mass transit systems within Duke's service area; however, the Charlotte-Mecklenburg Planning Commission in their "Comprehensive Plan 1995" has addressed mass transit systems as follows:[1]

   > At the present time, less than 3 percent of internal person trips are by mass transit. For the preferred plan, it is estimated that by 1995 7 percent of internal person trips would be mass transit ..... It is possible that the mass transit percentage of internal person trips could go higher than 7 percent by 1995.

   Q8.1.12

   The Planning Commission has not addressed the type of power to be used in such a mass transit system but it is likely that energy requirements will be a major consideration in determining the power used. Eric Hirst in his paper "Pollution Control Energy Costs"[2] notes, "mass transit is often suggested as an environmentally attractive substitute for automobiles because of its lower air pollution emissions, smaller land requirements, greater safety, and improved fuel economy". He additionally calls for a shift of 10 percent of automobile transit to mass transit and states, "If the 10 percent shift were entirely to electric transit, that added electricity requirements would have been 21 billion kwh for 1970, 1.5 percent of the total electricity used for that year".

   The availability of low cost electric energy may serve as a benefit to speed up the possible construction of mass transit.

4) The operation of Perkins will permit the retirement of older, less environmentally pleasing fossil-fired generating units.

   It is Duke's intention to retire old conventional units and combustion turbines at the earliest practicable time. Because it is not possible to schedule firm retirement dates far in the future, however, particularly in view of the curtailed construction program, no specific program can be stated at this time. The following units are scheduled for retirement when it becomes feasible to do so:

Conventional Coal-Fired Units

Station	Unit No.	MW Capacity	Year Installed
Buck	2	31	1926
Buck	3	70	1941
Buck	4	38	1942
Riverbend	1	52	1929
Riverbend	2	52	1929
Riverbend	3	52	1938
Cliffside	1	38	1940
Cliffside	2	38	1940

Combustion Turbine Units

Station	Unit No.	MW Capacity	Year Installed
Dan River	4	30	1968
Dan River	5	30	1968
Dan River	6	25	1969
Buck	7	31	1970
Buck	8	31	1970
Buck	9	31	1970
Riverbend	8	30	1969
Riverbend	9	30	1969
Riverbend	10	30	1969
Riverbend	11	30	1969
Lee	5	30	1968
Lee	6	30	1968
Urquhart	3	15	1969
Urquhart	4	25	1969
Buzzards Roost	6	22	1971
Buzzards Roost	7	22	1971
Buzzards Roost	8	22	1971
Buzzards Roost	9	22	1971
Buzzards Roost	10	18	1971
Buzzards Roost	11	18	1971
Buzzards Roost	12	18	1971
Buzzards Roost	13	18	1971
Buzzards Roost	14	18	1971
Buzzards Roost	15	18	1971

Q8.1.15

Categories of long-term social impact associated with commitment of the land required for plant operation are as follows:

1) Recreation

Recreation in the vicinity of Perkins will not be affected by plant operation. Access to land or water areas preferred for recreational use will not be affected by removing the Plant Site Area from accessibility. Fishing on the Yadkin River will not be affected by plant operation. Boone's Memorial Park, located about 2 1/2 miles south of Perkins, is the major recreational facility within 5 miles of the site. Use of the park will not be affected by plant operation. Q8.1.10

2) Areas of Unique Value

Operation of the Perkins Station will not influence the aesthetic or scenic value of the area surrounding the station. Design of the plant and landscaping in the vicinity will create an aesthetically pleasing appearance for the station. No restrictions will be placed on any access to areas of scenic, historic, or cultural interest; no access to these areas exist within the proposed Plant Site Area. Operation of Perkins will not cause any degradation to areas having historic, cultural, natural or archaeological value; no areas of value are known to exist within the Plant Site Area. Q8.1.10

3) Commitment of Land

3 Approximately 822 acres of land will be inaccessible and committed to operation of the Perkins Station. This land exists presently as wooded
3 land, pasture or farmland. Removal of 822 acres from present or contemplated alternative uses is not expected to significantly affect the local region.

4) Human Resources

The closed cycle heat dissipation system proposed for Perkins will cause some insignificant effects to the local population. These effects are discussed in Chapter 5.

5) Fishing

There is no commercial fishing on the Yadkin River. Operation of Perkins will not affect fishing of any type on the Yadkin River.

6) Land Value

Duke knows of no decrease in real estate values in the area adjacent to the proposed plant. Operation of Perkins will not cause a decrease in property value in the vicinity.

Some adverse effects can be expected from the construction and operation of the station:

1) During the construction phase, the temporary increase in employment will bring a large number of persons to the area for a short time. Assuming that some of the 1,482 average construction phase employees locate within a ten mile radius, a temporary local population increase can be expected.

2) Much of the construction phase employees will be housed in temporary housing such as trailers. Upon completion of the construction phase, some abandonment of these trailer courts can be expected.

3) Four families have been displaced due to land acquisition. An additional 22 families will be displaced before the plant becomes operational. The slight relocation of the population in the immediate site area will not significantly affect the overall local population. Q8.1.10

Categories of social benefits to be expected from the Perkins units include:

1) A possible social benefit of the power produced by the additional generating capacity of the Perkins units is the increased availability of electrical energy for public services, such as schools, police and radio.

Duke does not have information pertaining to the fraction of its electrical production utilized by public service categories. Q8.1.13

The peak power usages in Duke's service Area generally occur in January or February (winter peak) between eight and ten in the morning, and in July and August between four and six in the afternoon. Duke generally expects that the winter peak does include a portion for school usage, but that the summer peak, when schools except for some colleges are closed, does not.

Duke has no current knowledge pertaining to emergency power sources of police and radio stations in the service area.

2) Added power generation to the Duke system will permit the continued expansion and growth in the availability and use of creature comfort, convenience and liesure items. This will increase the regional portion of the Gross National Product and improve the standard of living.

3) Local and temporary benefits can be anticipated during the construction phase with an average of 1,482 employees per year for a 12 year period. A portion of these employees can be expected to temporarily reside locally, thus increasing the local commerce and tax base.

4) From past experience, Duke does not feel that there will be a significant influx of students into local school systems. Most employees will come from adjacent counties and would not move their children into local school systems. (See Appendix III) Q8.2.1

5) Duke Power's Construction Department wage scale for various crafts is structured in such a way as to be competitive with large general contractors in the Southeast. This wage scale does not vary between plant location. It is Duke's construction policy to hire and train the unskilled individual, raising his wages as his skills increase. Q8.2.2 Most of the required labor for Perkins will come from the area surrounding Perkins with a relatively small influx from other areas. This will affect the average prevailing wage scale in the area through competition among various industries for labor and through increased cash flow in the area around Perkins.

Amendment 2
(Entire Page Revised)
Amendment 3

8.1.2.6 Effects of Carter Creek Impoundment on Surrounding Community

The 1400 acre reservoir site area is a rural community with a population density of approximately 22 people per square mile. Of the total area, approximately 64 percent is wooded, 19 percent is pasture, 10 percent is cropland, and 7 percent is cleared and idle. Eighteen buildings are anticipated to be affected by the creation of the reservoir. Of the 18, 13 are houses, 3 are mobile homes, and 2 are farm buildings. The residents displaced by the reservoir are expected to relocate in other areas of Davie County or in Davidson County. To minimize the impact on local residents, Duke plans to coordinate with the North Carolina State Highway Department, the closing of portions of County Roads 1617 and 1618 which will be inundated. Q 18

The creation of the reservoir for stream flow augmentation will assure adequate flow in the Yadkin River for the operation of Perkins Nuclear Station during periods of low stream flow. For this reason, water levels in the reservoir may fluctuate more than is desirable for a recreational impoundment. Duke does not plan to encourage such usage. Recreational patterns that may be established on the reservoir or surrounding area will be subject to Duke's use of the reservoir for its intended purpose.

8.2 COSTS

Temporary external costs of the Perkins Nuclear Station which are non-quantifiable are discussed in Chapter 4. The long term external costs associated with the project are discussed in Chapter 5. Primary internal costs and their benefits are discussed in Subsection 8.1.1. The social and economic secondary costs are discussed in Subsection 8.1.2.2 through
2 8.1.2.5.

ER Table 8.1.1-1
Perkins Nuclear Station
Benefits From The Proposed Facility

Direct Benefits

Expected average annual generation in kilowatt-hours	25,656,184,000
Capacity in kilowatts	3,840,000
Proportional distribution of electrical energy (Expected annual delivery in kilowatt-hours)	
Residential	6,110,079,000
General Service	4,371,646,000
Textiles	6,646,948,000
Other Industry	4,652,863,000
Other	3,783,647,000
Expected average annual Btu (in millions) of steam sold from the facility	None
Expected average annual delivery of other beneficial products	None
Revenues from delivered benefits:	
Electrical energy generated	$ 352,800,000
Steam sold	$ 0.00
Other products	$ 0.00

Indirect Benefits

Taxes (local, State, Federal)	$ 132,500,000
Research	$ 0.00
Regional product	$ 0.00
Environmental enhancement:	
Recreation	Nil
Navigation	Nil
Air Quality:	
SO_2	Nil
NO_x	Nil
Particulates	Nil
Others	Nil
Employment	$ 7,000,000
Education	Nil
Others	Nil

ER Table 8.1.1-2
Perkins Nuclear Station
Duke Power Company
Revenue And Kilowatt-Hours Sold By Class Of Service
12 Months Ended December 31, 1973

Class Service	Revenues $1000	Mwh	Kwh % of Total	Revenue per Kwh Cents
Residential	212,213	10,195,953	23.9	2.08
General Service	122,788	7,286,921	17.1	1.69
Textiles	108,133	11,086,173	26.0	0.98
Other Industrial	81,746	7,762,097	18.2	1.05
Other	72,629	6,837,479	14.8	1.06
	597,509	43,168,623	100.0	1.38

ER Table 8.1.1-3
Perkins Nuclear Station
Estimated Kilowatt-Hours And Dollar Value
By Class of Customers

Class	Class of Customer % of Total	Estimated Kwh	Revenue Per Kwh, cents	Value of Delivered Products ($)
Residential	23.9	6,110,079	2.08	127,090,000
General Service	17.1	4,371,646	1.69	73,881,000
Textiles	26.0	6,646,948	0.98	65,140,000
Other Industrial	18.2	4,652,863	1.05	48,855,000
Other	14.8	3,783,647	1.06	40,107,000
	100.0	25,565,183		352,800,000

ER Table 8.1.2-1
Perkins Nuclear Station
Property Taxes and Assessment
Davie County

Year	Total Assessment	Total Taxes
1962	36,765,200	433,800
1963	53,381,900	427,100
1964	58,586,400	468,700
1965	61,456,800	491,700
1966	64,239,900	642,400
1967	70,004,400	700,000
1968	75,155,200	826,700
1969	87,644,500	964,100
1970	87,357,200	960,900
1971	97,733,000	1,075,100
1972	110,247,300	1,212,700

All Dollars Rounded to Hundreds

ER Table 8.1.2-2
Perkins Nuclear Station
Property Tax Liability

During Construction (Non-Operational Station)

Year	Estimated Property Tax Liability
1975	39,000
1976	51,000
1977	131,000
1978	350,000
1979	726,000
1980	1,482,000
1981	2,728,000
1982	5,043,000
1983	2,641,000
1984	5,073,000
1985	2,260,000
1986	3,786,000
TOTAL	24 ,310,000

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ER Table 8.1.2-3
Perkins Nuclear Station
Internal Costs

	Dollars
Direct cost of site and plant	$1,486,580,000
Engineering	31,252,000
Steam Production Department Expense (Programming, Training, Startup)	32,973,000
Licensing Fees, Quality Assurance	16,277,000
General Office Overheads	4,158,000
Interest During Construction	433,005,000
Property Taxes During Construction	24,310,000
Contingencies	313,330,000
Total Nuclear Production Plant with Substation	2,341,885,000
Initial Fuel (Three Units)	$ 275,871,000
Transmission Facilities (Complete)	27,702,000
Total Internal Cost	$2,645,450,000

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ER Table 8.1.2-4
Perkins Nuclear Station
Construction Payroll

Year	Average Employment	Average Payroll $1000
1976	162	3,791
1977	542	12,683
1978	1,184	27,706
1979	1,835	42,939
1980	2,477	57,962
1981	2,593	60,676
1982	2,554	59,764
1983	2,291	53,609
1984	1,935	45,279
1985	1,378	32,245
1986	746	17,456
1987	90	2,106

Average Employment 1,482

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9.0 ALTERNATIVE ENERGY SOURCES AND SITES

The need for additional generating capacity in the Duke Service area is demonstrated in Chapter 1. Actual selection of specific sites for development is a complex process. Because of the additional lead-times required for nuclear plant additions, it is necessary that station site
1 review be carried out in parallel with system planning studies, area water use studies, load growth studies, and contingency reviews.

2 Presented in this chapter is an overview of viable alternatives considered for future energy sources and sites. Q 9.1.1

9.1 ALTERNATIVES NOT REQUIRING THE CREATION OF NEW GENERATING CAPACITY

The three alternatives discussed below, while not viable alternatives to construction of the proposed project, are necessary considerations which must be made in evaluating the project.

9.1.1 PURCHASED ENERGY

Purchased energy, as a general principal, is not considered a viable alternative to the construction of new generation because it does not supply any new capacity in the area, but serves, instead, only to shift the site of the new capacity from one system to another. The cost of additional transmission losses and heavy conductor loading, often incurred by wheeling a large block of power from one system to another, work against the objective of utilizing facilities in an optimum manner.

The following items relate specifically to purchased energy as an alternative to installing generating capacity on the Duke system.

1) The total reserve capacity in the VACAR Subregion of SERC during the summer of 1983, when the first of the Project 81 units is scheduled for operation, will be 4012 MW if all the facilities which are
3 1 scheduled, go in service on time. This reserve margin, 8.6 percent, is well below that considered prudent, and it would drop to 5.8 percent if Project 81 were delayed for one year by the purchase of energy from alternative sources within the region. Such a low margin of reserve would fail to provide backstand capacity for loss of one nuclear unit if another were out for refueling anywhere in the Subregion. Other factors, such as severe weather or a forecast error, could actually result in having insufficient capacity to meet the peak load.

2. Transmission interconnections among the companies in SERC are based on criteria established by SERC for operating security and reliability of service among those companies. It is not possible to realize this objective while a large block of energy is being transported on a firm basis from one system to another within the region. Consequently, additional high voltage interconnections have to be built if one company is to purchase such energy. The environmental impact of these transmission facilities could be substantial.

   Costs of building transmission lines in the Duke service area average generally about $125,000 per mile for 230 kV and $160,000 per mile for 500 kV. Duke does not have cost information for other SERC systems but believes its own costs are representative. Q 9.1.2

   Due to the nature of the interconnected transmission network, a portion of all transactions between companies in the southeastern portion of the United States appears on the Duke system. In addition, Duke at times is a party to these transactions either importing power for its own use or exporting power to other companies. It is estimated that in excess of 1,000,000 kW has been wheeled by the Duke system in this manner.

It is impossible to estimate at this time what other transactions may be in effect in 1983 so as to determine the total amount of power which may flow through the Duke system. However, Duke will have the capability by 1983 to import or export in excess of 1,500,000 kW either for its own use or for emergency assistance to other companies. Q 9.1.2

3) Duke historically is able to install generating capacity on its own system at a lower cost than any other system in the southeast. It is not in the best interest of Duke Power Company to purchase energy from a neighboring system and pay a higher production cost for that energy than it could have been produced for on the Duke system, to which would be added the cost of losses and possible wheeling charges.

The following table gives a comparison of charges for electrical power on neighboring systems as of April 2, 1974.

COMPARISON OF BILLS
CALCULATED ON RATES OF THE COMPANIES
IN EFFECT ON APRIL 2, 1974 INCLUDING ALL ADJUSTMENT CHARGES

SCHEDULE	KWH	DUKE	CP&L	SCE&C	VEPCO	TVA AREA *(SCH. R-31)
R	100	$ 4.40	$ 5.02	$ 6.82	$ 5.99	$ 3.47
R	500	15.46	13.76	16.56	16.77	10.88
RW	750	18.77	18.51	21.19	22.06	13.79
RW	2000	44.30	44.93	49.00	45.16	28.38

Q 9.1.3

*64 percent of TVA distributor residential customers are on R-3 or higher rates.

9.1.2 UPGRADING OLDER PLANTS

3 | 1 The two largest coal-fired plants on the Duke system, the 2025 MW Plant Marshall and the 2120 MW Belews Creek Station, scheduled to be in full commercial operation in the fall of 1975, are expected to operate in the base portion of the load curve indefinitely. This is due not only to their low heat rate, but also to their super-critical design which is not conducive to load-following operation. The largest of the remaining coal-fired plants on the Duke system, the 1140 MW Plant Allen, is less than one-third the rating of the proposed Perkins Nuclear Station. Upgrading an older plant as an alternative to building a new station, therefore, is not feasible for the following reasons:

1) The two largest plants on the Duke system which conceivably could be upgraded due to their size, Marshall and Belews Creek, are already committed to base load operation for the foreseeable future.

2) Plant Allen, the largest of the remaining older plants, is severely restricted by existing site constraints, and could not physically be expanded to triple its present size. In addition, the entire transmission system emanating from Plant Allen, and in the general area of the plant, would have to be rebult to include not only much heavier conductors on existing lines, but also a number of new circuits in an area of the system where rights-of-way are extremely difficult and expensive to acquire.

3) Similar conditions would prevail at the other remaining older sites except that two or more of these sites would have to be rebuilt simultaneously to provide the necessary capacity to equal the one Perkins site.

4) A need exists on the Duke system for a major block of generation to operate in the load-following portion of the load curve. This large block of energy is supplied by the intermediate pressure steam plants which have that capability. To upgrade these units to base-load operation would deprive the system of an important segment of the generation mix it must have for efficient operation.

9.1.3 BASE LOAD OPERATION OF AN EXISTING PEAKING FACILITY

Duke's peaking capacity includes hydro, combustion turbine, and old inefficient conventional steam generating units. Hydro capacity, because of streamflow limitations can be operated for peaking service only. Combustion turbine units typically have heat rates in a range from 15,000 to 17,000 BTU per KWh. The relatively inefficient conversion rate coupled with the high cost of No. 2 fuel oil renders these units totally uneconomic for baseload operation. Fuel, operation, and maintenance expense for combustion turbine units through the first five months of 1974 averaged 19.79 mills per kWh. By contrast, comparable expenses for the Marshall coal-fired units averaged 9.02 mills per kWh and for the Oconee Nuclear units, 3.15 mills per kWh. Also, experience indicates that if combustion turbine units were subjected to continuous operation, maintenance requirements would increase and the dependable capacity of the units would decrease. Q 9.1.4

Old conventional coal-fired units, normally used for peaking and for tracking the daily load cycle have operating costs generally ranging from 25 to 50 percent higher than base load units. In baseload operation, those units would also incur additional maintenance expense and reduced capability.

1 Total installed combustion-turbine capacity on the Duke system is 638 MW, less than one-sixth the capacity of Perkins. Not only is the capacity inadequate, it is also totally dependent on the availability of oil or natural gas. This is not a sound basis, financially or otherwise, upon which to build base-loaded generating capability.

9.2 ALTERNATIVES REQUIRING THE CREATION OF NEW GENERATING CAPACITY

As described in Section 1.1, system planning studies have shown that substantial amounts of additional generation are required in the 1983-1988 period in order to meet predicted future load requirements and maintain adequate reserve margins. This capacity is provided by installing six base-load units of approximately 1280 MW each.

The following tabulation shows the system load each hour of August 29, 1973, which was the day of peak demand. The tabulation also shows corresponding hourly loads estimated for the 1981 peak day (Figure 9.2.0-1): Q 9.3.3

Time EDT	August 29, 1973 MW Load	Estimated 1981 Peak Day Load-MW
1 AM	5,434	10,294
2	5,153	9,760
3	4,951	9,377
4	4,866	9,218
5	4,833	9,154
6	4,934	9,346
7	5,474	10,368
8	6,143	11,636
9	6,552	12,410
10	6,921	13,109
11	7,291	13,810
12N	7,550	14,301
1 PM	7,663	14,515
2	7,855	14,878
3	7,939	15,037
4	7,983	15,121
5	8,203	15,537
6	8,236	15,600
7	8,027	15,204
8	7,824	14,820
9	7,841	14,852
10	7,608	14,410
11	6,995	13,249
12	6,078	11,512

Preliminary engineering and construction estimates, made in 1972, showed that in order to license, construct, and place into service these six units within the required period, several potential sites would have to be identified and evaluated and the selected sites known by early 1973 in order that more detailed site data could be available prior to license application. The preliminary estimates resulted in the decision, made in early 1973, to initiate design for Project 81, consisting of two 3-unit plant sites, with facilities identical in so far as possible. The candidate areas studied are discussed in Subsection 9.2.1 and the ten
1 site-plant alternatives evaluated for Project 81 are described in Subsection 9.2.2.

9.2.1 SELECTION OF CANDIDATE AREAS

Duke and neighboring utilities are experiencing rapid growth and having to install new generating facilities to serve their customers. There is no justifiable reason or advantage for Duke to consider sites outside of its service area for Project 81 since neither the economics nor the environmental impact of the project would be improved.

As shown in Figure 9.2.1-1, the Duke Power Company Service Area covers
approximately 20,000 square miles in the Piedmont sections of North and
1 South Carolina. The major power loads are served by a transmission net-
work throughout this total area. Whenever the generalized location or
region within the service area is considered for a possible power plant
site, a major criterion is the relationship of the site to the transmission
3 network. In order to minimize environmental effects and capital costs of
required new transmission lines, the future capacity, together with that in
operation and under construction, is analyzed in detail with relation to
the existing and predicted loads. Also, since all modern base-load
generation requires large supplies of cooling water, a second major
criterion for initial location of potential sites for further study is
the availability of cooling water. For this purpose, the entire service
area is considered as being divided into the following four "Load-Gener-
ation Regions":

I.	Greenville-Anderson	(Savannah River)
II.	Spartanburg-Shelby	(Broad River)
III.	Hickory-Charlotte	(Catawba River)
IV.	Winston-Salem-Durham	(Yadkin River)

Approximate boundaries for geographical areas comprising these regions generally correspond with the four major river basins in the service area as shown on Figure 9.2.1-1. The existing Duke transmission network and major interties with neighboring utilities and the locations of the various Duke generating stations are shown on Figure 9.2.1-2.

Duke's transmission system has been developed to allow installation of new
generation on an economic basis considering the entire load area. To
realize the economic advantages of continuous construction at any given new
site, may therefore require any of the four candidate areas to become a Q
net exporter or importer of power for reasonable periods of time. Overbuild- 9.2.1
ing in any of the areas as a continuous practice, however, would be un-
4 economic because transmission facilities would have to be increased to
maintain the same degree of system reliability.

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The following is a brief description of the composition and extent of each region including their relative location, major water resources, the nearby load centers considered to be served within their designated area, and the primary generation capacity located in the area:

I. Greenville-Anderson Region - (Savannah River) - The area on the south-western end of the service area comprising portions of the Savannah, Keowee, and Saluda River basins. Major load centers are Anderson, Seneca, Greenville, Greenwood, and Laurens, S. C. Existing or under construction primary generation plants in this region are:

	Lee Steam Station (Fossil)		323 MW
	Keowee Hydro Station		140 MW
1	Oconee Nuclear Station	1973-74	2,628 MW
	Jocassee Pumped Storage Station	1973-74	610 MW
1		Total	3,701 MW (by 1981)

II. Spartanburg - Shelby Region - (Broad River) - Adjacent on the east to the Greenville Region. Includes drainage basin areas in Green, Broad, and Pacolet Rivers. Major centers served are Hendersonville and Shelby, N. C., and Spartanburg, Gaffney, Union, and Chester, S. C.
4 Thermal generation in this region consists of the following:

Cliffside Steam Station (Fossil)		770 MW
	Total	770 MW (by 1981)

III. Hickory-Charlotte Region (Catawba River - A sprawling, highly populated industrial and commercialized complex near the center of the service area which approximately coincides with the Catawba River drainage basin in both North Carolina and South Carolina. Major region load centers are Marion, Morganton, Hickory, Statesville, Concord-Kannapolis, Monroe, Gastonia, and Charlotte, N. C., and Rock Hill and Lancaster, S. C. The major portion of Duke's generation capacity is located in this Region.

Marshall Steam Station (Fossil)		2,025 MW
Allen Steam Station (Fossil)		1,140 MW
Riverbend Steam Station (Fossil)		610 MW
McGuire Nuclear Station 1976-77		2,360 MW
Catawba Nuclear Station 1979-80		2,306 MW
Cowans Ford Hydro Station		372 MW
	Total	8,813 MW (by 1981)

IV. Winston-Salem-Durham Region - (Yadkin River) - Northernmost and largest of the four regions, with heavy industrial, commercial, and residential loads. Main river basins are the Yadkin and Dan Rivers with only upper portions of the Neuse and Cape Fear basins within Duke Service area. The major load centers scattered through the region include Elkin, Mount Airy, Salisbury, Albermarle,
4 Lexington, Winston-Salem, High Point - Greensboro, Reidsville, Leaksville, Burlington and Durham, North Carolina.

The primary generation stations in this Region are:

Buck Steam Station	(Fossil)		426 MW
Dan River Steam Station	(Fossil)		284 MW
Belews Creek Steam Station	(Fossil)	1974-75	2120 MW
3	Total		2830 MW (by 1981)

The two proposed three-unit plants for Project 81, now known as the Perkins and Cherokee Nuclear Stations, could be located in any of the four described "Load-Generation Regions" since potential sites with adequate water availability exist in each portion of the Duke service area. However, there are three basic reasons for selecting the Broad River and Yadkin River Regions as the primary candidate areas over the other two regions. These are:

(1) Improved system reliability and operation with substantially less new transmission line mileage.

(2) Availability of sites for closed-cycle cooling operation with minimum land requirements.

(3) Desire to reserve existing lake sites in Savannah and upper Catawba regions until effective EPA guidelines are established. (Resulting from Duke's Catawba licensing experience.)

Additionally, since Wateree Reservoir, located at the remote southern end of the Catawba River Region, has been considered in previous site studies it is also included as a candidate area for one of the plants.

In the Duke service area, fossil fuel is the only viable alternative to nuclear fuel which can now be considered for a base-load station.[1]

On a practical basis, hydroelectric capacity could not be considered. Duke's total existing hydro capacity of about 1,002,000 kw built in 27 plants over a period of nearly 70 years is less than one-seventh of the total present capacity at Perkins. The characteristically low flows
4 of streams in the Duke territory further limit the usefulness of hydro capacity to short term peaking service. There remain only a very few hydro sites suitable for development for peaking service, and none in the Duke territory for base load service. For example, the Federal Power Commission lists[2] 30 locations in Duke's service area where undeveloped hydroelectric potential exists indicating 2.0 billion kilowatt hours to be the total annual energy potential of all 30 sites combined. Q 9.1.5

3

This is only about one-twelfth the annual energy generation planned for Perkins Nuclear Station. Q 9.1.5

Duke has briefly considered other unconventional and largely undeveloped energy sources, including geothermal. Although geothermal sources appear to offer promise in some regions of the United States, the kinds of geologic formations that produce steam appear to be non-existent in the Carolinas. Q 9.1.6

All other theoretical types of new generation methods such as wind, solar power, tidal powers, and MHD have not been developed practically for the commercial power industry. Coal is the most available and dependable alternative to nuclear fuels. Any further reliance on adequate quantities of gas and oil, domestic or foreign, throughout the 30 year life of a plant involves serious risks of system reliability.

Legitimate questions with regard to the probable availability of fuel oil, and with regard to cost, if available, make it impossible to quantify costs for an alternative source using fuel oil. However, current costs for low sulphur oil, as reported in various publications indicate costs of $2.00 or more per MBTU. Fuel at that price would be clearly uneconomic. Q 9.3.1

Thus, the two viable energy fuel alternatives considered for either the Perkins or Cherokee Stations are uranium and coal. Potential plant sites for both fuels in each of two selected candidate areas, Broad River and Yadkin River, were selected and thoroughly compared before the two proposed locations were finally singled-out for detailed site studies.

Coal costs have been escalating rapidly and as a result, Duke's estimate of future supply has recently been revised upward. Duke now estimates coal in 1979 at $35.00 per ton. Historically, the source of coal for Duke has been mine districts 7 and 8. If, however, coal was to be used for an alternative to the Perkins Nuclear units, it might be necessary to use western coal. No estimate of cost from western sources is available. Q 9.3.2

9.2.2 SELECTION OF CANDIDATE SITE-PLANT ALTERNATIVES

Both plants for Project 81 are being planned and licensed for essentially the same time schedule, as discussed in Section 4.1. Therefore, criteria for siting each plant is identical. These preliminary site criteria are summarized as follows:

1) Land Area - Sufficient acreage to provide for all plant facilities and for necessary controlled area.

2) Physical Site Characteristics - Geology, Semismology, hydrology, topography, cooling water source, and meteorology all must be suitable, as well as economic considerations for rail, highway and transmission line accessability.

3) Nature of Surrounding Area - Low population density and land use that would be minimally affected by power plant construction and operation.

4) Benefits to Surrounding Area - Increased tax revenues, employment opportunities, and the consequent effect on local commerce.

The objective of the Project 81 site study was to determine the scheme involving the two best sites for full project development from those available within the selected candidate areas. By means of topographical map study and on-site physical reconnaissance, four site-plant alternatives each were compared in both the Broad and in the Yadkin River Regions, In addition, the Wateree Reservoir site provided two site plant alternatives.

There are two site-plant alternatives, each on three locations. One site plant alternative provides cooling by cooling pond and the other alternative at the same location utilizes wet closed cycle cooling towers for heat dissipation. The seven locations involved in the ten site-plant alternatives are shown on Figure 9.2.2-1 and briefly described below.

II-I Central Piedmont S. C. Cooling Pond Site - Nuclear (Turkey Creek Site)

This site requires the creation of a new 9,500 acre lake for surface cooling. The plant site is located in the upper Piedmont area of South Carolina on a peninsula formed by impounding of a tributary of the Broad River. Cooling water flows along a $7\frac{1}{2}$ mile long recirculation path through the lake for maximum surface area. A site for an ash basin with adequate storage capacity for a coal-fired plant of the proposed size is not available, therefore, this site is suitable for nuclear generation only. A preliminary site layout is shown as Figure 9.2.2-2.

II-1 (CT) Central Piedmont S. C. Cooling Pond Site with Closed Cycle Cooling Towers - Nuclear (Turkey Creek Site)

The development of this site-plant alternative requires the creation of a new 7,350 acre lake to guarantee makeup water availability for the evaporation losses experienced in the use of the closed cycle cooling towers. The station site is located as in alternative II-1. A preliminary site layout is given on Figure 9.2.2-9.

II-2 Cherokee - Nuclear

This is the proposed site located on the Broad River in Cherokee County, S. C., just upstream from Duke's existing Ninety-Nine Islands Hydro Station. Since the river flow at the site averages about 2,570 cfs with a minimum average daily flow of 233 cfs, closed-cycle cooling towers are required. The site area is underdeveloped and in a remote, low population area about 7 miles east of Gaffney, S. C. The site layout is shown in Figure 9.2.2-3.

II-3 Cherokee - Coal

This site is just upstream of the proposed nuclear site and would also require closed-cycle cooling towers due to the insufficient river flow for once-through cooling. Two ash basins on opposite sides of the plant could be created with combined volume sufficient for the life of the plant. A preliminary plant layout is shown in Figure 9.2.2-4.

IV-1 Central Piedmont N. C. Cooling Pond Site - Nuclear (Hunting Creek Site)

This site is located in central Piedmont North Carolina on a new 9,800 acre lake formed by impounding a tributary of the South Yadkin River. A $5\frac{1}{2}$ mile long recirculation path for cooling water is provided by having intake and discharge on opposite sides of a peninsula formed by the lake. This site is considered suitable for nuclear only due to the unfavorable topography for economical construction of an ash basin with storage adequate for the life of the plant. Preliminary layout of this site is shown on Figure 9.2.2-5.

IV-1 (CT) Central Piedmont N. C. Cooling Pond Site With Closed Cycle Cooling Towers - Nuclear (Hunting Creek Site)

The development of this site requires the impoundment of approximately 7,200 acres of the Hunting Creek basin, a tributary of the South Yadkin River. The impoundment would provide adequate storage for cooling tower makeup water. A preliminary site layout is given in Figure 9.2.2-11.

IV-2 Yadkin - Nuclear

This is the proposed Perkins site located on the Yadkin River in Davie County, N. C. about six miles southeast of Mocksville. Average river flow at the site is about 2,850 cfs with minimum daily flow of about 333 cfs thus requiring closed-cycle cooling towers. Layout plan for this site is shown in Figure 9.2.2-6.

IV-3 Yadkin - Coal

This site is located about two miles upstream and on the opposite side of the Yadkin River from the proposed site, in Davidson County, N. C. and would also require closed-cycle cooling towers. The topography is suited for the creation of ash basin adequate in volume for the life of the plant. Rail access would be about 10½ miles and would require location through more populated areas than for the Davie County site. Preliminary layout of this site is shown in Figure 9.2.2-7.

III-I Wateree Reservoir Site - Nuclear

This site is wholly within Duke owned property on the existing Wateree Lake, and is previously considered as an alternate site for both the McGuire Station and Catawba Station. The plant is sited on a wide peninsula and requires both an intake and discharge canal for recirculation of cooling water. Construction of about 240 miles of new transmission lines is a big economic penalty. Rail access requires about 15 miles of new track. Due to much higher freight rates because of location, and unfavorable topography for ash basin construction, a coal-fired plant is not considered feasible for this site. A preliminary site layout is shown in Figure 9.2.2-8.

III-I (CT) Wateree Reservoir Site with Closed Cycle Cooling Towers - Nuclear

This site-plant alternative utilizes virtually the same location as alternative III-I, however, closed cycle cooling towers will be used for waste heat dissipation. A site layout is shown on Figure 9.2.2-10.

The ten site-plant alternatives are considered the best available in the three candidate areas for site selection for the Project 81 units.

9.2.3 ADDITIONAL SITE ALTERNATIVES

Additional site alternatives were proposed in the North Carolina Department of Natural and Economic Resources report, "Water Resources Aspects of the Proposed Perkins Station Nuclear Power Plant," Duke's comparison of the Perkins Nuclear Station site and the NCDNER Site on Tuckertown Reservoir, requested by the NCDNER, is detailed in Attachment 9.0.

9.3 COST EFFECTIVENESS COMPARISON OF CANDIDATE SITE-PLANT ALTERNATIVES

Section 9.1 discusses in detail why purchased power, upgrading of older plants, and the baseload operation of existing peaking facilities are not viable alternatives to the creation of new capacity on the Duke System to meet the forecasted load growth detailed in Chapter 1. Section 9.2 discusses the ten site-plant alternatives for the proposed Project 81 units. This section examines the cost-effectiveness of the alternatives in terms of both economic and environmental costs.

Subsection 9.2.2 lists the preliminary siting criteria used as a basis for selection of the site-plant alternatives listed in Table 9.3.0-1.

After candidate site-plant selection with preliminary criteria, detailed analysis of candidate site-plant alternatives is performed. Criterion for final selection of the Project 81 site-plant alternatives are given in Table 9.3.0-2. Many of the criteria are subjective and nonquantifiable.

9.3.1 SITE ALTERNATIVES

The separation of site alternatives from plant alternatives is impractical. A coal-fired facility at any given site is very different from a nuclear fueled facility at that same site. Likewise, the use of a closed cycle cooling pond, surface cooling in a large lake, cooling towers taking their makeup from a river, and cooling towers utilizing a large body of impounded water for makeup for waste heat dissipation are very different in their economic and environmental costs. The economic comparison of capital costs for each site-plant alternative is detailed in Table 9.3.1-1. The environmental comparison of each alternative is given in Table 9.3.1-2. Bases for the economic comparisons are given in Subsection 9.3.4.

9.3.2 FUEL ALTERNATIVES

As discussed in Subsection 9.2.1, coal is the only viable alternative to uranium as a fuel for the Project 81 units. Neither natural gas nor oil is presently in abundant supply from local sources within the Duke service area. Almost three-fourths of the natural gas produced in the United States comes from sources in Texas and Louisiana. About one-third of the natural gas domestically produced is consumed by industry in Oklahoma, Arkansas, Texas, and Louisiana. A large natural gas pipeline from principal continental sources by interstate delivery is not a reasonable economic choice for even one large power plant. Similarly, fuel oil is not an economic alternative to coal or uranium as a fuel choice. Since the domestic consumption of oil exceeds the total combined production of the United States and Canada, transportation of oil from overseas is necessary. The use of oil or gas as a fuel alternative is not considered a viable alternative.

Exotic sources of energy for bulk power production, or even those not so exotic, do not yet have the technical capability for the Project 81 capacity needs.

For the Duke system, therefore, coal and uranium are the only viable fuel alternatives. When compared to the coal-fired alternative, a nuclear plant offers several environmental advantages.

Since combustion of fossil fuels is not involved, the nuclear plant offers no air pollution. Air pollution control equipment for the Project 81 coal-fired alternatives is a paramount factor. Fortunately, the coal Duke now burns contains less than one percent sulphur. Whereas, the low sulphur content helps Duke meet applicable state air quality standards, it also makes particulate collection difficult. Duke plans to continue burning low sulphur coal; however, if high sulphur coal burning becomes necessary,
4 even where stringent requirements are not applicable, additional capital and operating costs are expected.

The nuclear stations require about 21 truck shipments of new fuel per year. The coal-fired alternatives require about 400 train cars of fuel per day. Put another way, a coal-fired alternative consumes, in about 15 minutes, a weight of coal equal to the weight of one year's supply of nuclear fuel for the equivalent station. The nuclear alternative generates about 300 cubic feet of highly radioactive waste per year that must be stored and isolated from the environment for hundreds of years. The coal-fired alternative generates about 74 million cubic feet of virtually useless ash per year whose storage conflicts with other beneficial land uses.

Studies by the United States Public Health Service, Bureau of Radiological Health show that a pressured water nuclear plant results in less radiation exposure to the public due to radioactivity in gaseous effluents than does a modern coal-fired plant.[1, 2] This fact is explained in the summary report of the hearings on the Environmental Effects of Producing Electric Power by the Joint Committee on Atomic Energy of the Congress of the United States, as follows:

"An interesting corollary to the air pollution problem from fossil fuel power plants concerns the radiochemical analyses of flyash samples which were obtained from the combustion of pulverized coal and fuel oil. From these analyses, estimates were made of the quantities of radium-226 and radium-228 which would be discharged from a 1,000 megawatt coal-burning power plant. Comparisons of these data on the release of fission products such as iodine and Kr 85 from nuclear power generating stations shows that when the physical and biological properties of these radionuclides are taken into consideration, the conventional fossil-fueled plants discharge relatively greater quantities of radioactive material into the atmosphere than nuclear power plants of comparable size. While no one would suggest that the amount of radium being discharged into the atmosphere of our large cities is a health hazard, the above example does emphasize the 'clean air' which is being discharged from our nuclear power plant facilities."

The radioactivity released to the environment in either alternative is well within permissible limits.

Obviously, the risk to the health and safety of the general public from an accident which releases radioactivity is greater for a nuclear station than for a conventional coal-fired alternative. The spectrum of possible accidents that release radioactivity ranges from insignificant to serious. In each case, the design features and administrative procedures for nuclear stations work to reduce the frequency of accidents and their associated environmental consequences. There is no credible accident that, when evaluated realistically, significantly affects the health and safety of the public.

Since the heat load of a coal-fired station is approximately two-thirds that of a nuclear station, a reduced consumptive water usage is noted. However, whereas a nuclear station needs no water for spent fuel handling, a coal-fired station requires the use of millions of gallons of water per day for ash handling. This water, used for ash sluicing and ash transport purposes, requires treatment before release to nearby rivers.

Land requirements for coal-fired alternatives are greater than those for the nuclear fueled alternatives. These requirements for ash storage and coal storage are a part of the land necessary for actual station operation. The requirement of land for actual station operation at alternative II-3 is approximately 2,300 acres greater than that of its nuclear fueled alternative. Similarly, the station land requirement increases from alternative IV-2 to alternative IV-3 by more than 900 acres.

9.3.3 PLANT ALTERNATIVES

Two plant design alternatives, consisting of coal and nuclear fueled alternatives, and two cooling alternatives, consisting of wet cooling towers and lake cooling alternatives, are considered. Each alternate plant is designed in sufficient detal to provide a basis for making approximate cost estimates. Coal and nuclear stations currently under construction serve as a basis for these plant alternatives.

9.3.4 SITE-PLANT COSTS

Since a major criteria of site selection was the selection of two sites, only alternative schemes involving two similarily fueled and cooled site-plant alternatives are considered.

2 In the comparision of costs for alternative generation schemes and/or station systems, where any alternative would be used in the same time frame as the proposed scheme and/or system, the concept of present worth is unnecessary. Q 9.0.1

The following bases were used to arrive at capital cost estimates for the alternative schemes:

1) The nuclear-fueled station costs are based upon the adjusted Duke estimate for the proposed Catawba Nuclear Station.

2) The coal-fueled station costs are based upon the costs experienced at Duke's Belews Creek Steam Station now nearing completion.

9.3.5 CONCLUSIONS

Table 9.3.4-2 shows Scheme 1 to be as acceptable environmentally as any other scheme.

A detailed review of Table 9.3.4-1 shows that the selection of Scheme 1, for Project 81, is the best economic choice and the most favorable combination of capital and operating costs. The annual generation cost, due to fossil fuel costs, of Scheme 2 more than offsets low capital cost.

Schemes 1, 3 (CT), 4 (CT), and 5 (CT) utilize closed cycle wet cooling towers for waste heat dissipation. Schemes 3, 4, and 5 utilize a cooling pond or existing lake for the same purpose.

Duke maintains that the construction and operation of base-load thermal generating facilities on an existing or newly built lake, using the lake for cooling water condenser, is the most practical and economic method, and is environmentally acceptable. However, communications received from the Environmental Protection Agency, Region IV,[3] in reference to Duke's request for guidance in the selection of acceptable cooling water systems for future site selection, indicated that if Duke were to select lake sites, off-stream cooling, probably by cooling towers, would also have to be provided. No assurance was given as to whether or when lake cooling could be approved without off-stream cooling. Therefore, it appeared highly unlikely that any one of the Schemes 3, 4, and 5, utilizing lake cooling for waste heat dissipation could receive the necessary regulatory approvals, in the time frame that would insure availability of additional generating capacity to meet Duke's projected load commitments.

Out of the remaining schemes, employing off-stream cooling, i.e., Schemes 1, 3 (CT), 4 (CT), and 5 (CT), the selected Scheme 1 has the least capital and generating costs. Considering the environmental impact of these schemes, as detailed in Table 9.3.4-2, it is noted that Scheme 1 is no less acceptable compared to the other three schemes.

Scheme 1, comprising three nuclear units each at Perkins and Cherokee sites with wet closed cycle mechanical draft towers, providing the heat dissipation, is the most optimum choice taking regulatory, economic and environmental factors into consideration.

Table 9.3.4-1 details the cost-effectiveness of the site-plant alternative schemes.

The additional capital cost for the nuclear-fueled, closed-cycle cooling system scheme is more than offset by the licensibility of the scheme over the lake cooling schemes and the annual operating costs of the coal-fired alternative scheme.

ER Table 9.3.0-1 (Page 1 of 2)
Perkins Nuclear Station
Site-Plant Alternatives

Alternative	Name	Location	Energy Source	Main Heat Dissipation Source
II-1	Central Piedmont S. C. Cooling Pond Nuclear	Chester County S. C.	Nuclear	Lake Cooling
II-1 (CT)	Central Piedmont S. C. Cooling Pond With Cooling Towers	Chester County S. C.	Nuclear	Cooling Towers
II-2	Cherokee Nuclear	Cherokee County S. C.	Nuclear	Cooling Towers
II-3	Cherokee Coal	Cherokee County S. C.	Coal	Cooling Towers
III-1	Wateree Pond Site Nuclear	Fairfield County N. C.	Nuclear	Lake Cooling
III-1 (CT)	Wateree Pond with Cooling Towers Nuclear	Fairfield County N. C.	Nuclear	Cooling Towers
IV-1	Central Piedmont N. C. Cooling Pond Nuclear	Iredell County N. C.	Nuclear	Lake Cooling

ER Table 9.3.0-1 (Page 2 of 2)
Perkins Nuclear Station
Site-Plant Alternatives

Alternatives	Name	Location	Energy Source	Main Heat Dissipation Source
IV-1 (CT)	Central Piedmont N. C. Cooling Pond with Cooling Towers Nuclear	Iredell County N. C.	Nuclear	Cooling Towers
IV-2	Yadkin Nuclear	Davie County N. C.	Nuclear	Cooling Towers
IV-3	Yadkin - Coal	Davidson County N. C.	Coal	Cooling Towers

ER Table 9.3.0-2 (Sheet 1 of 2)
Perkins Nuclear Station
Criteria for Site-Plant Selection

Criteria	Evaluation
Engineering Features	
Geology	Statement
Seismology	Statement
Meterology	Statement
Hydrology	Quantifiable
Demography	Quantifiable
Access	Quantifiable
Environmental Factors	
Cooling Water System	Quantifiable and Statement
Sensitivity of Habitats Affected	Statement
Risks of Potential Impacts	Statement
Commitment of Resources	Quantifiable
Recreational Usage	Statement
Scenic Values	Statement
Economic Factors	
Fuel Availability	Statement
Construction Cost	Quantifiable
Operating Costs	Quantifiable
Institutional Factors	
Site Certification	Statement
Public Acceptance	Statement
Land Use Factors	
Current Pond Use	Quantifiable
Projected Land Use	Statement
Construction Factors	
Potential Construction Work Force	Statement and Quantifiable
Access to Equipment and Materials	Statement
Availability of Construction Force Needs	Quantifiable

ER Table 9.3.0-2 (Sheet 2 of 2)
Perkins Nuclear Station
Criteria for Site-Plant Selection

Criteria	Evaluation
Transmission Hookup Factors	
Access to Transmission System in place	Quantifiable
Aesthetic Impact	Statement
Transmission Reliability	Statement
Transmission Losses	Quantifiable

ER Table 9.3.1-1
Perkins Nuclear Station
Site-Plant Alternatives
Economic Factors

Alternative	II-1	II-1(CT)	II-2	II-3	III-1	III-1(CT)	III-1	III-1(CT)	IV-1	IV-1(CT)	IV-2	IV-3
Name	Turkey Creek	Turkey Creek CT	Cherokee Nuclear	Cherokee Fossil	Wateree	Wateree CT	Wateree	Wateree CT	Hunting Creek	Hunting Creek CT	Yadkin Nuclear	Yadkin Fossil
Commercial Operation Schedule	B	B	B	B	B	B	A	A	A	A	A	A
Land and Land Rights	22,649	19,342	1,283	7,848	1,347	1,349	1,347	1,349	20,030	16,498	2,764	5,537
Structures and Improvements	169,675	202,486	203,378	124,838	174,255	201,452	172,397	199,304	160,215	191,066	196,177	122,784
Reactor Plant Equipment [1]	443,760	443,760	443,708	345,623	443,760	443,760	439,036	439,036	439,036	439,036	438,958	320,163
Turbogenerator Units	263,807	263,807	263,727	138,696	263,807	263,807	256,163	256,163	256,163	256,163	256,193	139,402
Accessory Electrical Equipment	148;291	148,291	148,310	39,901	148,291	148,291	145,701	145,701	145,701	145,701	145,715	39,205
Miscellaneous Power Plant Equipment	14,374	14,374	14,376	14,374	14,374	14,374	14,393	14,393	14,393	14,393	14,397	14,393
Transmission Plant Station Equipment	28,138	28,138	28,135	28,138	28,138	28,138	37,349	37,349	37,349	37,349	37,341	37,349
TOTAL MATERIAL COST	1,090,694	1,120,198	1,102,917	699,418	1,073,972	1,101,171	1,066,386	1,093,295	1,072,887	1,100,206	1,091,545	678,833
Labor and Overheads	413,059	422,441	413,352	314,531	403,617	412,786	386,108	394,586	337,389	400,695	395,035	305,533
Steam Production, General Office, Quality Assurance and Engineering	67,687	68,639	67,728	33,229	66,775	67,659	79,965	81,092	80,532	81,903	81,146	40,956
Licensing Fees	3,514	3,514	3,514	-----	3,514	3,514	3,514	3,514	3,514	3,514	3,514	-----
Contingencies [2]	314,991	322,958	316,939	209,436	309,576	317,026	307,195	314,498	298,864	317,264	313,330	205,064
TOTAL DIRECT AND OVERHEAD COSTS	1,889,945	1,937,750	1,904,450	1,256,614	1,857,454	1,902,156	1,843,168	1,886,985	1,793,186	1,903,582	1,884,570	1,230,386
Property Taxes During Constrution	-----	-----	-----	-----	-----	-----	-----	-----	24,089	24,663	24,310	8,775
Interest During Construction	450,787	460,821	451,064	238,517	440,648	450,475	423,481	432,616	428,970	439,199	433,005	240,899
TOTAL STATION COST	2,340,732	2,398,571	2,355,514	1,495,131	2,298,102	2,352,631	2,266,649	2,319,601	2,246,245	2,367,444	2,341,885	1,480,060
Installed Capacity (KW)	3,908,400	3,840,000	3,840,000	3,840,000	3,908,400	3,840,000	3,908,400	3,840,000	3,908,400	3,840,000	3,840,000	3,840,000
Cost ($/KW)	598.90	624.63	613.42	389.36	587.99	612.66	579.94	604.06	574.72	616.52	609.87	385.43
PLANT COST	2,280,345	2,338,322	2,295,426	1,434,981	2,237,892	2,292,515	2,187,262	2,240,359	2,168,049	2,287,076	2,261,771	1,398,428
SUBSTATION COST	60,387	60,249	60,088	60,150	60,210	60,116	79,387	79,242	78,196	80,368	80,114	81,432
TRANSMISSION COST	54,587	54,587	39,302	37,880	104,828	104,828	73,219	73,219	33,901	33,901	27,702	27,029
TOTAL SITE-PLANT COST	2,395,319	2,435,158	2,394,816	1,533,011	2,402,930	2,457,459	2,339,868	2,392,820	2,280,146	2,401,345	2,369,587	1,506,889
COST ($/KW)	612.86	638.84	623.65	399.22	614.81	639.96	598.68	623.13	583.40	625.35	617.08	392.42

Note: All costs are in thousand dollars unless otherwise noted.

(1) Boiler Plant Equipment for Fossil Alternatives.

(2) 20% for all alternatives.

Amendment 1
Amendment 2
Amendment 3

ER Table 9.3.1-2 (Sheet 1 of 10)
Perkins Nuclear Station
Site-Plant Alternatives
Environmental Factors

Alternate Sites Criteria Factor	II-1 Central Piedmont, S. C. Cooling Ponds	II-1 (CT) Central Piedmont, S. C. Cooling Pond with Cooling Towers
1. Engineering and Environmental Factors		
1.1 Topography	Gentle hills and slopes	Gentle hills and slopes
1.2 Geology/Seismology	No active faults. Adequate geological conditions for plant design.	No active faults. Adequate geological conditions for plant design.
1.3 Meteorology	Climate is temperate with moderate rainfall.	Climate is temperate with moderate rainfall.
1.4 Population Near Site	Low population (rural area) approx. 11 miles to Chester SC	Low population (rural area) approx. 11 miles to Chester SC
1.5 Accessibility to Site	Need 0.5 mile of access road and 8.9 miles of railroad to be built	Need 0.5 miles of access road and 8.9 miles of railroad to be built
1.6 Cooling Water Supply	Lake will be built to provide condenser cooling water.	Lake will be built to provide make-up water for cooling towers
1.7 Effects on Aquatic and Terrestrial Habitats	Construction of new lake will have some effects	Construction of new lake will have some effects
1.8 Aesthetics	Architectural treatment and landscaping will minimize impact.	Architectural treatment and landscaping will minimize impact
1.9 Effects On Air Quality	Negligible effects	Negligible effects
1.10 Effects On Water Quality	Slight effect due to thermal discharges	Slight effect due to discharges

ER Table 9.3.1-2 (Sheet 2 of 10)
Perkins Nuclear Station
Site-Plant Alternatives
Environmental Factors

Alternate Sites / Criteria Factor	II-1 Central Piedmont, S. C. Cooling Pond	II-1 (CT) Central Piedmont, S. C. Cooling Pond with Cooling Towers
1.11 Other Effects	Spent fuel must be disposed of.	Spent fuel must be disposed of.
2. Transmission Factors		
2.1 Transmission Facilities Required	Require construction of a 525 KV switching station and approx 110 miles of transmission lines.	Require construction of a 525 KV switching station and approx 110 miles of transmission lines.
3. Construction Factors		
3.1 Accessibility of Materials and Equipment	Readily accessible	Readily accessible
3.2 Availability of Construction Workers	Construction workers readily available .	Construction workers readily available.
3.3 Availability of Housing	Housing available	Housing available
3.4 Effect of Traffic	No effect	No effect
3.5 Effects of Air and Water Quality	Minimal	Minimal
4. Land Use Factors		
4.1 Permanent Land For Plant	9811 acres	8300 acres
4.2 Exclusion Area	450 acres	Same as II-1
4.3 Effects on Recreation	Creation of lake will improve recreational values.	Creation of lake will improve recreational values.
5. Community Benefits		
5.1 State and Local Taxes ($ annually)	33.5 million	33.7 million

Amendment 1
(New)

ER Table 9.3.1-2 (Sheet 3 of 10)
Perkins Nuclear Station
Site-Plant Alternatives
Environmental Factors

Alternate Sites

Criteria Factor	II-2 Cherokee - Nuclear	II-3 Cherokee - Fossil
1. Engineering and Environmental Factors		
1.1 Topography	Same as II-1	Same as II-1
1.2 Geology/Seismology	Same as II-1	Same as II-1
1.3 Meteorology	Same as II-1	Same as II-1
1.4 Population Near Site	Same as II-1	Same as II-1
1.5 Accessibility to Site	Need 0.2 mile of access road and 7 miles of railroad to be built.	Need 0.5 mile of access road and 6.5 miles of railroad to be built.
1.6 Cooling Water Supply	Closed-cycle cooling towers, make-up water will come from the Broad River.	Same as II-2
1.7 Effects on Aquatic and Terrestrial Habitats	Minimal effects	Same as II-2
1.8 Aesthetics	Architectural treatment and landscaping will minimize impact. The cooling towers will have some aesthetic impact.	Same as II-2
1.9 Effects On Air Quality	Possible fogging effect	Slight effect of particulates released to the atmosphere from burning coal. Possible fogging effect
1.10 Effects On Water Quality	Results in additional consumption of water due to cooling tower evaporation	Same as II-2

Amendment 1
(New)

Perkins Nuclear Station
Site-Plant Alternatives
Environmental Factors

Alternate Sites Criteria Factor	11-2 Cherokee - Nuclear	11-3 Cherokee - Fossil
1.11 Other Effects	Same as 11-1	Large amounts of coal ash refuse must be disposed of.
2. Transmission Factors		
2.1 Transmission Facilities Required	Require construction of a 230 KV switching station and approx 21 miles of transmission lines.	Require construction of a 230 KV switching station and approx 21 miles of transmission lines.
3. Construction Factors		
3.1 Accessibility of Materials and Equipment	Same as 11-1	Same as 11-1
3.2 Availability of Construction Workers	Same as 11-1	Same as 11-1
3.3 Availability of Housing	Same as 11-1	Same as 11-1
3.4 Effect of Traffic	Same as 11-1	Same as 11-1
3.5 Effects of Air and Water Quality	Same as 11-1	Same as 11-1
4. Land Use Factors		
4.1 Permanent Land For Plant	381 acres	2584 acres
4.2 Exclusion Area	Same as 11-1	Not applicable - none
4.3 Effects on Recreation	Negligible effects	Same as 11-2
5. Community Benefits		
5.1 State and Local Taxes ($ annually)	33.3 million	23.4 Million

Amendment 1
(New)

ER Table 9.3.1-2 (Sheet 5 of 10)
Perkins Nuclear Station
Site-Plant Alternatives
Environmental Factors

Alternate Sites Criteria Factor	III-1 Wateree Pond	III-1 (CT) Wateree Pond with Cooling Towers
1. Engineering and Environmental Factors	Same as II-1	Same as II-1
1.1 Topography	Same as II-1	Same as II-1
1.2 Geology/Seismology	Same as II-1	Same as II-1
1.3 Meteorology	Same as II-1	Same as II-1
1.4 Population Near Site	Same as II-1 Approx 15 mi to Camden SC	Same as II-1 Approx 15 mi to Camden SC
1.5 Accessibility to Site	Need 1 mile of access road and 12 miles of railroad to be built	Need 1 mile of access road and 12 miles of railroad to be built
1.6 Cooling Water Supply	Lake Wateree will provide condenser cooling water	Lake wateree will provide make up water for cooling towers
1.7 Effects on Aquatic and Terrestrial Habitats	Possible dredging of Lake Wateree will have some effects	Possible dredging of Lake Wateree will have some effects
1.8 Aesthetics	Same as II-1	Same as II-1
1.9 Effects On Air Quality	Same as II-1	Same as II-1
1.10 Effects On Water Quality	Same as II-1	Same as II-1

Perkins Nuclear Station
Site-Plant Alternatives
Environmental Factors

Alternate Sites Criteria Factor	III-I Wateree Pond	III-I (CT) Wateree Pond with Cooling Towers
1.11 Other Effects	Same as II-1	Same as II-1
2. Transmission Factors		
2.1 Transmission Facilities Required	Require construction of a 525 KV switching station and approx 240 miles of transmission line	Require construction of a 525 KV switching station and approx 240 miles of transmission line
3. Construction Factors		
3.1 Accessibility of Materials and Equipment	Same as II-1	Same as II-1
3.2 Availability of Construction Workers	Construction workers will probably be available	Construction workers will probably be available
3.3 Availability of Housing	Same as II-1	Same as II-1
3.4 Effect of Traffic	Same as II-1	Same as II-1
3.5 Effects of Air and Water Quality	If dredging is necessary, it will effect water quality for a short time.	If dredging is necessary it will effect water quality for a short time.
4. Land Use Factors		
4.1 Permanent Land For Plant	402 acres	710 acres
4.2 Exclusion Area	Same as II-1	Same as II-1
4.3 Effects on Recreation	Same as II-1	Same as II-1
5. Community Benefits		
5.1 State and Local Taxes ($ annually)	34.1 Million	34.4 million

ER Table 9.3.1-2 (Sheet 7 of 10)
Perkins Nuclear Station
Site-Plant Alternatives
Environmental Factors

Alternate Sites Criteria Factor	IV-1 Central Piedmont, N. C. Cooling Pond	IV-1 (CT) Central Piedmont, N. C. Cooling Pond with Cooling Towers
1. Engineering and Environmental Factors		
1.1 Topography	Same as II-1	Same as II-1
1.2 Geology/Seismology	Same as II-1	Same as II-1
1.3 Meteorology	Same as II-1	Same as II-1
1.4 Population Near Site	Same as II-1 Approx 16 mi to Statesville NC	Same as II-1 Approx 16 mi to Statesville NC
1.5 Accessibility to Site	Need 0.2 mi of access road and 16 mi of railroad to be built	Need 0.2 mi of access road and 16 mi of railroad to be built
1.6 Cooling Water Supply	Lake will be built to provide condenser cooling water	Lake will be built to provide make-up water for cooling towers
1.7 Effects on Aquatic and Terrestrial Habitats	Construction of new lake will have some effects	Construction of new lake will have some effects
1.8 Aesthetics	Same as II-1	Same as II-1
1.9 Effects On Air Quality	Same as II-1	Same as II-1
1.10 Effects On Water Quality	Same as II-1	Same as II-1

Amendment 1
(New)

Perkins Nuclear Station
Site-Plant Alternatives
Environmental Factors

Alternate Sites Criteria Factor	IV-1 Central Piedmont, N. C. Cooling Pond	IV-1 (CT) Central Piedmont, N. C. Cooling Pond with Cooling Towers
1.11 Other Effects	Same as II-1	Same as II-1
2. Transmission Factors		
2.1 Transmission Facilities Required	Require construction of 230 KV and 525 KV switching stations and approx 117 miles of transmission lines	Require construction of 230 KV and 525 KV switching stations and approx 117 miles of transmission lines
3. Construction Factors		
3.1 Accessibility of Materials and Equipment	Same as II-1	Same as II-1
3.2 Availability of Construction Workers	Construction workers available	Construction workers available
3.3 Availability of Housing	Same as II-1	Same as II-1
3.4 Effect of Traffic	Same as II-1	Same as II-1
3.5 Effects of Air and Water Quality	Same as II-1	Same as II-1
4. Land Use Factors		
4.1 Permanent Land For Plant	10,295 acres	8,124 acres
4.2 Exclusion Area	Same as II-1	Same as II-1
4.3 Effects on Recreation	Same as II-1	Same as II-1
5. Community Benefits		
5.1 State and Local Taxes ($ annually)	34.8 Million	34.8 Million

ER Table 9.3.1-2 (Sheet 9 of 10)
Perkins Nuclear Station
Site-Plant Alternatives
Environmental Factors

Alternate Sites Criteria Factor	IV-2 Yadkin - Nuclear	IV-3 Yadkin - Fossil
1. Engineering and Environmental Factors		
1.1 Topography	Same as II-1	Same as II-1
1.2 Geology/Seismology	Same as II-1	Same as II-1
1.3 Meteorology	Same as II-1	Same as II-1
1.4 Population Near Site	Same as II-1 Approx 10 mi to Salisbury NC	Same as II-1 Same as IV-2
1.5 Accessibility to Site	Need 0.2 mi of access road and 6.4 mi of railroad to be built	Same as IV-2
1.6 Cooling Water Supply	Closed cycle cooling towers. Make-up water will come from the Yadkin River	Same as IV-2
1.7 Effects on Aquatic and Terrestrial Habitats	Same as II-2	Same as II-2
1.8 Aesthetics	Same as II-2	Same as II-2
1.9 Effects On Air Quality	Same as II-2	Same as II-3
1.10 Effects On Water Quality	Same as II-2	Same as II-2

ER Table 9.3.1-2 (Sheet 10 of 10)
Perkins Nuclear Station
Site-Plant Alternatives
Environmental Factors

Criteria Factor (Alternate Sites)	IV-2 Yadkin - Nuclear	IV-3 Yadkin - Fossil
1.11 Other Effects	Same as II-1	Same as II-1
2. Transmission Factors		
2.1 Transmission Facilities Required	Require construction of 230 KV and 525 KV switching stations and approx 15 mi of transmission line	Require construction of 230 KV and 525 KV switching stations and approx 26 mi of transmission line
3. Construction Factors		
3.1 Accessibility of Materials and Equipment	Same as II-1	Same as II-1
3.2 Availability of Construction Workers	Same as Iv-1	Same as IV-1
3.3 Availability of Housing	Same as II-1	Same as II-1
3.4 Effect of Traffic	Same as II-1	Same as II-1
3.5 Effects of Air and Water Quality	Same as II-1	Same as II-1
4. Land Use Factors		
4.1 Permanent Land For Plant	289 acres	1100 acres
4.2 Exclusion Area	Same as II-1	Same as II-3
4.3 Effects on Recreation	Same as II-2	Same as II-2
5. Community Benefits		
5.1 State and Local Taxes ($ annually)	37.0 Million	28.6 Million

ER Table 9.3.4-1
Perkins Nuclear Station
Scheme Alternatives
Economic Factors

SCHEME	1	2	3	3(CT)	4	4(CT)	5	5(CT)
SITE	IV-2 & II-2	IV-3 & II-3	IV-1 & II-1	IV-1(CT) & II-1(CT)	III-1 & II-1	III-1(CT) & II-1(CT)	IV-1 & III-1	IV-(CT) & III-1(CT)
SCHEDULE A SITE[1]	YADKIN	YADKIN FOSSIL	HUNTING CREEK	HUNTING CREEK CT	WATEREE	WATEREE CT	HUNTING CREEK	HUNTING CREEK CT
SCHEDULE B SITE[2]	CHEROKEE	CHEROKEE FOSSIL	TURKEY CREEK	TURKEY CREEK CT	TURKEY CREEK	TURKEY CREEK CT	WATEREE	WATEREE CT
CAPITAL EXPENDITURES								
a) Plant Cost	4,557,197	2,833,409	4,448,394	4,625,398	4,458,607	4,578,681	4,405,941	4,579,591
b) Substation Cost	140,202	141,582	138,583	140,617	139,774	139,491	138,406	140,484
c) Transmission Cost	67,004	64,909	88,488	88,488	127,806	127,806	138,729	138,729
d) Total Capital Cost	4,764,403	3,039,900	4,675,465	4,836,503	4,735,187	4,827,978	4,683,076	4,858,804
e) Cost/KW Total - $	620.36	395.82	598.13	629.75	605.77	628.64	599.10	632.66
f) Cost/KW Station - $	611.64	387.37	586.81	620.57	588.27	614.35	581.36	614.59
GENERATING COST (ANNUAL)								
a) Annual Generation (KWH)[3]	51.13×10^9	51.13×10^9	52.04×10^9	51.13×10^9	52.04×10^9	51.13×10^9	52.04×10^9	51.13×10^9
b) Fixed Charges[4]	827,100	527,727	811,661	838,617	822,028	838,137	812,982	843,488
c) Fuel Costs[5]	368,647	1,076,491	375,208	368,647	375,208	368,647	375,208	368,647
d) Insurance Cost[6]	6,374	1,382	6,488	6,374	6,488	6,374	6,488	6,374
e) Operating and Maintenance[7]	20,890	20,890	21,262	20,890	21,262	20,890	21,262	20,890
f) Total Generating Cost[8]	1,223,011	1,626,490	1,214,619	1,235,528	1,224,986	1,234,048	1,215,940	1,239,399
g) Cost/KW[9] - $	159.25	211.78	155.15	160.88	156.71	160.68	155.55	161.38
h) Cost/KWH[10] Mills/KWH	23.92	31.81	23.34	24.16	23.54	24.13	23.36	24.24

NOTE: All dollars are in thousands unless noted.

1. A schedule A site assumes commercial operation of the three units in January 1983, 1985, and 1987.
2. A Schedule B site assumes commercial operation of the three units in January 1984, 1986, and 1988.
3. Annual generation assumes a 76 percent station capacity factor.
4. Fixed charges are 17.4 percent of the capital cost.
5. Fossil: The ten year levelized average fossil fuel cost for the period ending 1997 (242¢/MBTU)
   Nuclear: The ten year levelized average nuclear fuel cost for the period ending 1997 (72.1¢/MBTU)
6. Fossil: Assumes $.18 per kilowatt per year.
   Nuclear: Assumes $.83 per kilowatt per year.
7. Assumes $2.72 per kilowatt per year.
8. The summation of other annual costs.
9. Total annual cost divided by capacity.
10. Total annual cost divided by total annual generation.

Amendment 1
Amendment 2
Amendment 3

ER Table 9.3.4-2 (Sheet 1 of 8)
Perkins Nuclear Station
Scheme Alternatives
Environmental Factors

Alternative Schemes Criteria Factors	Scheme #1 IV-2 and II-2	Scheme #2 IV-3 and II-3
1. Engineering and Environmental Factors		
1.1 Topography	Gentle hills and slopes.	Same as scheme #1
1.2 Geology/Seismology	No active faults. Adequate geological conditions for plant design.	Same as scheme #1
1.3 Meteorlogy	Climate is temperate with moderate rainfall.	Same as scheme #1
1.4 Population Near Site	Low population (rural area)	Same as scheme #1
1.5 Accessibility to Site	Need a total of 0.4 mile of access roads and 13.4 miles of railroads.	Need a total of 0.1 mile of access roads and 12.9 miles of railroads.
1.6 Cooling Water Supply	Closed cycle cooling towers. Make up water will come from the Yadkin and Broad Rivers.	Same as scheme #1
1.7 Effects on Aquatic and Terrestrial Habitats	Minimal effects.	Same as scheme #1
1.8 Aesthetics	Architectural treatment and landscaping will minimize impact.	Same as scheme #1
1.9 Effects on Air Quality	Possible Fogging effect.	Slight effect of particulates released to the atmosphere from burning coal. Possible Fogging effect
1.10 Effects on Water Quality	Results in additional consumption of water due to cooling tower evaporation.	Same as scheme #1
1.11 Other Effects	Spent fuel must be disposed of.	Large amounts of coal ash to be disposed of.

ER Table 9.3.4-2 (Sheet 2 of 8)
Perkins Nuclear Station
Scheme Alternatives
Environmental Factors

Alternative Schemes

Criteria Factors	Scheme #1 Iv-2 and II-2	Scheme #2 IV-3 and II-3
2. Transmission Factors		
2.1 Transmission Facilities Required	Requires construction of 2-230 KV and 1-525 KV Switching stations and 36 miles of transmission lines.	Requires construction of 2-230 KV and 1-525 KV Switching stations and 53 miles of transmission lines.
3. Construction Factors	Negligible effects	Same as scheme #1
3.1 Accessibility of Materials and Equipment	Readily accessible	Same as scheme #1
3.2 Availability of Construction Labor	Readily available	Same as scheme #1
3.3 Availability of Housing	Readily available	Same as scheme #1
3.4 Effects of Traffic	No effect	Same as scheme #1
3.5 Effects on Air and Water Quality	Minimal	Same as scheme #1
4. Land Use Factors		
4.1 Permanent Land for Plant	670 acres	3,684 acres
4.2 Exclusion Area	900 acres	Not applicable - none
4.3 Effects on Recreation	Negligible effects	Negligible effects

ER Table 9.3.4-2 (Sheet 3 of 8)
Perkins Nuclear Station
Scheme Alternatives
Environmental Factors

Criteria Factors / Alternative Schemes	Scheme #3 IV-1 and II-1	Scheme #3 (CT) IV-1 (CT) and II-1 (CT)
1. Engineering and Environmental Factors		
1.1 Topography	Same as scheme #1	Same as scheme #1
1.2 Geology/Seismology	Same as scheme #1	Same as scheme #1
1.3 Meteorlogy	Same as scheme #1	Same as scheme #1
1.4 Population Near Site	Same as scheme #1	Same as scheme #1
1.5 Accessibility to Site	Need a total of 0.7 mile of access roads and 24.9 miles of railroads.	Need a total of 0.7 miles of access roads and 24.9 miles of railroads.
1.6 Cooling Water Supply	Lakes will be built to provide condenser cooling water.	Lakes will be built to provide make-up water for cooling towers.
1.7 Effects on Aquatic and Terrestrial Habitats	Construction of new lakes will have some effects.	Construction of new lakes will have some effects
1.8 Aesthetics	Architectural treatment and landscaping will minimize impact.	Architectural treatment and landscaping will minimize impact
1.9 Effects on Air Quality	Negligible effects	Negligible effects
1.10 Effects on Water Quality	Slight effect due to thermal discharges	Slight effect due to thermal discharge
1.11 Other Effects	Same as scheme #1	Same as scheme #1

Amendment 1
(New)

ER Table 9.3.4-2 (Sheet 4 of 8)
Perkins Nuclear Station
Scheme Alternatives
Environmental Factors

Alternative Schemes Criteria Factors	Scheme #3 IV-1 and II-1	Scheme #3 (CT) IV-1 (CT) and II-1 (CT)
2. Transmission Factors		
2.1 Transmission Facilities Required	Requires construction of 1-230 KV and 2-525 KV switching stations and 227 miles of transmission lines.	Requires construction of 1-230 KV and 2-525 KV switching stations and 227 miles of transmission line.
3. Construction Factors	Effects of building 19,350 acres of cooling ponds.	Effects of building a 14550 acre lake for cooling tower make-up water
3.1 Accessibility of Materials and Equipment	Same as scheme #1	Same as scheme #1
3.2 Availability of Construction Labor	Same as scheme #1	Same as scheme #1
3.3 Availability of Housing	Same as scheme #1	Same as scheme #1
3.4 Effects of Traffic	Same as scheme #1	Same as scheme #1
3.5 Effects on Air and Water Quality	Same as scheme #1	Same as scheme #1
4. Land Use Factors		
4.1 Permanent Land for Plant	20,106 acres	16,424 acres
4.2 Exclusion Area	Same as scheme #1	Same as scheme #1
4.3 Effects on Recreation	Creation of lake at both sites will improve the recreational values	Creation of lake at both sites will improve the recreational values.

Amendment 1
(New)

ER Table 9.3.4-2 (Sheet 5 of 8)
Perkins Nuclear Station
Scheme Alternatives
Environmental Factors

Criteria Factors (Alternative Schemes)	Scheme #4 II-1 and II-1	Scheme #4 (CT) II-1 (CT) and II-1 (CT)
1. Engineering and Environmental Factors		
1.1 Topography	Same as scheme #1	Same as scheme #1
1.2 Geology/Seismology	Same as scheme #1	Same as scheme #1
1.3 Meteorlogy	Same as scheme #1	Same as scheme #1
1.4 Population Near Site	Same as scheme #1	Same as scheme #1
1.5 Accessibility to Site	Need a total of 1.5 miles of access roads and 20.9 miles of railroads.	Need a total of 1.5 miles of access roads and 20.9 miles of railroads.
1.6 Cooling Water Supply	A lake will be built at site II-1 with possible dredging to be done at site III-1.	A lake will be built at site II-1 with possible dredging to be done at site III-1.
1.7 Effects on Aquatic and Terrestrial Habitats	Construction of site II-1 lake and possible dredging of site III-1 will have some effects.	Construction of site II-1 lake and possible dredging of site III-1 will have some effects.
1.8 Aesthetics	Same as scheme #3	Same as scheme #3
1.9 Effects on Air Quality	Same as scheme #3	Same as scheme #3
1.10 Effects on Water Quality	Same as scheme #3	Same as scheme #3
1.11 Other Effects	Same as scheme #1	Same as scheme #1

ER Table 9.3.4-2 (Sheet 6 of 8)
Perkins Nuclear Station
Scheme Alternatives
Environmental Factors

Criteria Factors	Alternative Schemes: Scheme #4 III-1 and II-1	Scheme #4 (CT) III-1 (CT) and II-1 (CT)
2. Transmission Factors		
2.1 Transmission Facilities Required	Requires construction of 2-525 KV switching stations and 350 miles of transmission lines.	Requires construction of 2-525 IV switching stations and 350 miles of transmission lines.
3. Construction Factors	Effects of building a 9500 acre cooling pond and from the possibility of channel dredging	Effects of building a 7350 acre lake for cooling tower make-up water and from the possibility of channel dredging
3.1 Accessibility of Materials and Equipment	Same as scheme #1	Same as scheme #1
3.2 Availability of Construction Labor	Same as scheme #1	Same as scheme #1
3.3 Availability of Housing	Same as scheme #1	Same as scheme #1
3.4 Effects of Traffic	Same as scheme #1	Same as scheme #1
3.5 Effects on Air and Water Quality	If dredging is required for site III-1, water quality will be e effected for a short time.	If dredging is required for site III-1, water quality will be effected for a short time.
4. Land Use Factors		
4.1 Permanent Land for Plant	10,213 acres	9,010 acres
4.2 Exclusion Area	Same as scheme #1	Same as scheme #1
4.3 Effects on Recreation	Same as scheme #3	Same as scheme #3

Amendment 1
(New)

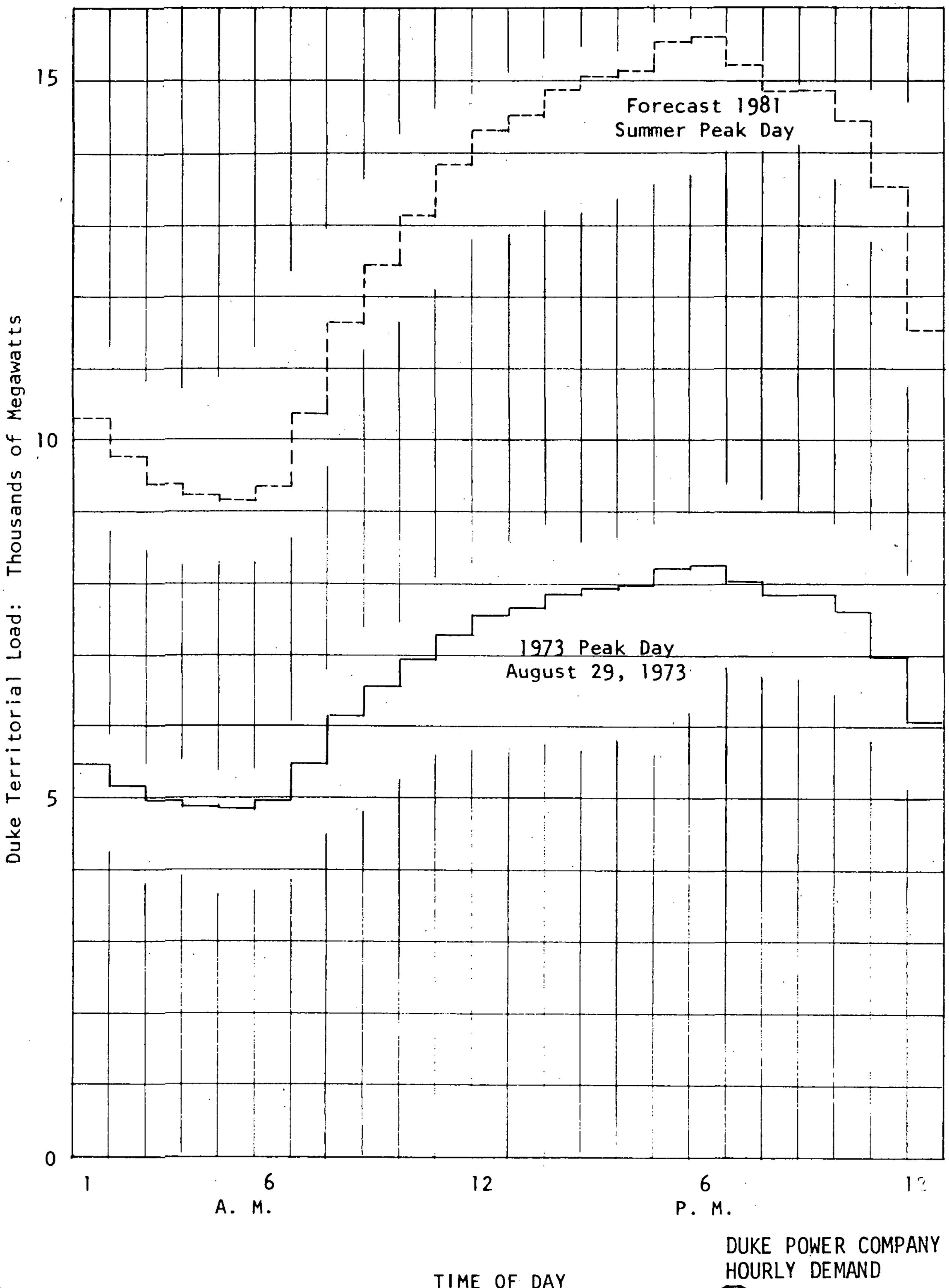
ER Table 9.3.4-2 (Sheet 7 of 8)
Perkins Nuclear Station
Scheme Alternatives
Environmental Factors

Alternative Schemes

Criteria Factors	Scheme #5 IV-1 and III-1	Scheme #5 (CT) IV-1 (CT) and III-1 (CT)
1. Engineering and Environmental Factors		
1.1 Topography	Same as scheme #1	Same as scheme #1
1.2 Geology/Seismology	Same as scheme #1	Same as scheme #1
1.3 Meteorlogy	Same as scheme #1	Same as scheme #1
1.4 Population Near Site	Same as scheme #1	Same as scheme #1
1.5 Accessibility to Site	Same as scheme #1	Same as scheme #1
1.6 Cooling Water Supply	A lake will be built at site IV-1 with possible dredging at site III-1.	A lake will be built at site IV-1 with possible dredging at site III-1.
1.7 Effects on Aquatic and Terrestrial Habitats	Construction of site IV-1 lake and possible dredging of site III-1 will have some effects.	Construction of site IV-1 lake and possible dredging of site III-1 will have some effects.
1.8 Aesthetics	Same as scheme #3	Same as scheme #3
1.9 Effects on Air Quality	Same as scheme #3	Same as scheme #3
1.10 Effects on Water Quality	Same as scheme #3	Same as scheme #3
1.11 Other Effects	Same as scheme #1	Same as scheme #1

Perkins Nuclear Station
Scheme Alternatives
Environmental Factors

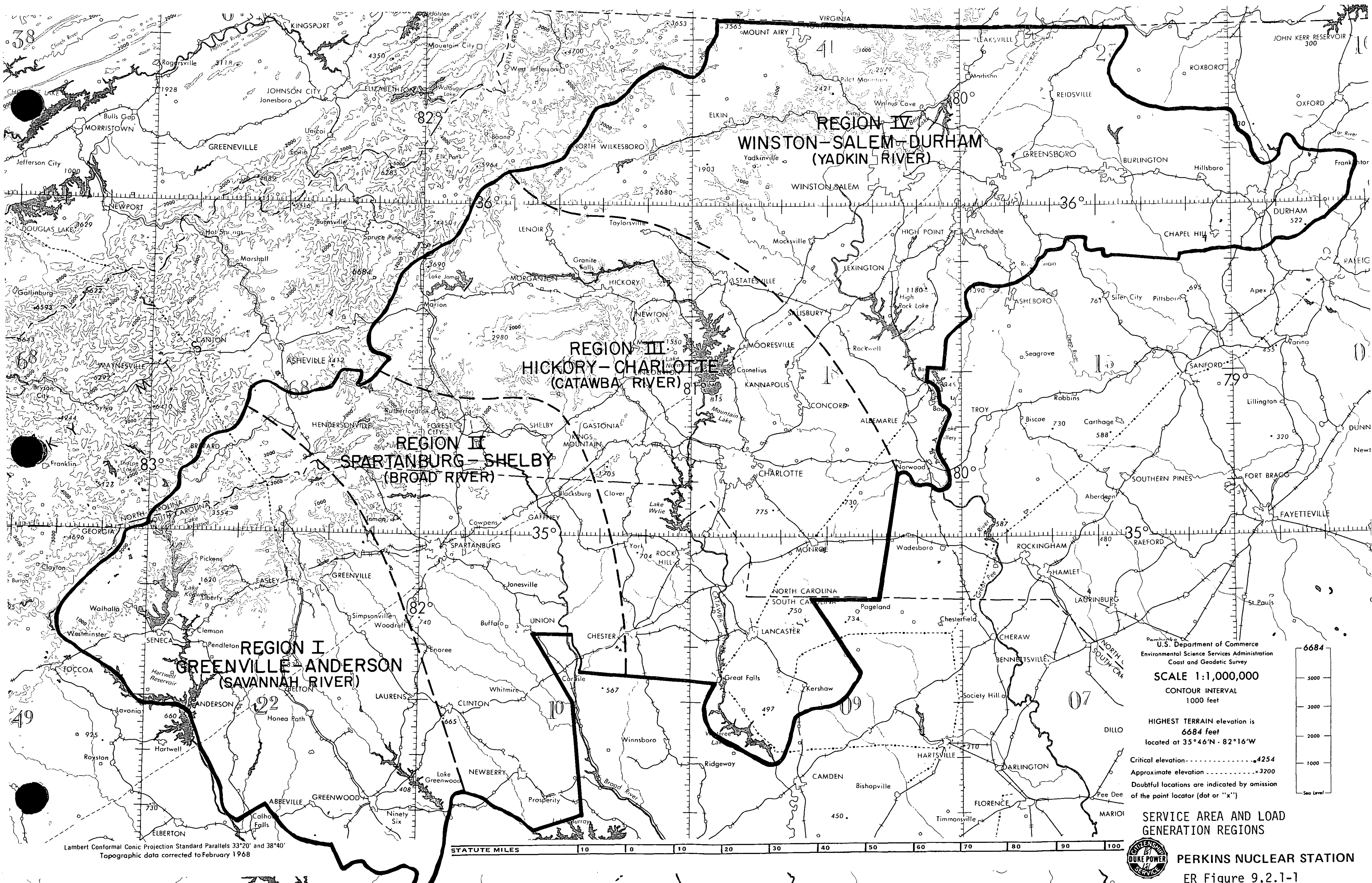
Alternative Schemes Criteria Factors	Scheme #5 IV-1 and III-1	Scheme #5 (CT) IV-1 (CT) and III-1 (CT)
2. Transmission Factors		
2.1 Transmission Facilities Required	Requires construction of 1-230 KV switching stations and 357 miles of transmission lines.	Requires construction of 1-230 KV switching stations and 357 miles of transmission lines.
3. Construction Factors	Effects of building a 9850 acre cooling pond and from the possibility of channel dredging.	Effects of building a 7200 acre lake for cooling tower make-up water and the possibility of channel dredging.
3.1 Accessibility of Materials and Equipment	Same as scheme #1	Same as scheme #1
3.2 Availability of Construction Labor	Same as scheme #1	Same as scheme #1
3.3 Availability of Housing	Same as scheme #1	Same as scheme #1
3.4 Effects of Traffic	Same as scheme #1	Same as scheme #1
3.5 Effects on Air and Water Quality	Same as scheme #4	Same as scheme #4
4. Land Use Factors		
4.1 Permanent Land for Plant	10,697 acres	8,834 acres
4.2 Exclusion Area	Same as scheme #1	Same as scheme #1
4.3 Effects on Recreation	Same as scheme #3	Same as scheme #3



PERKINS

DUKE POWER COMPANY
HOURLY DEMAND

PERKINS NUCLEAR STATION
ER Figure 9.2.0-1
Amendment 4
(New)



SERVICE AREA AND LOAD GENERATION REGIONS

PERKINS NUCLEAR STATION

ER Figure 9.2.1-1

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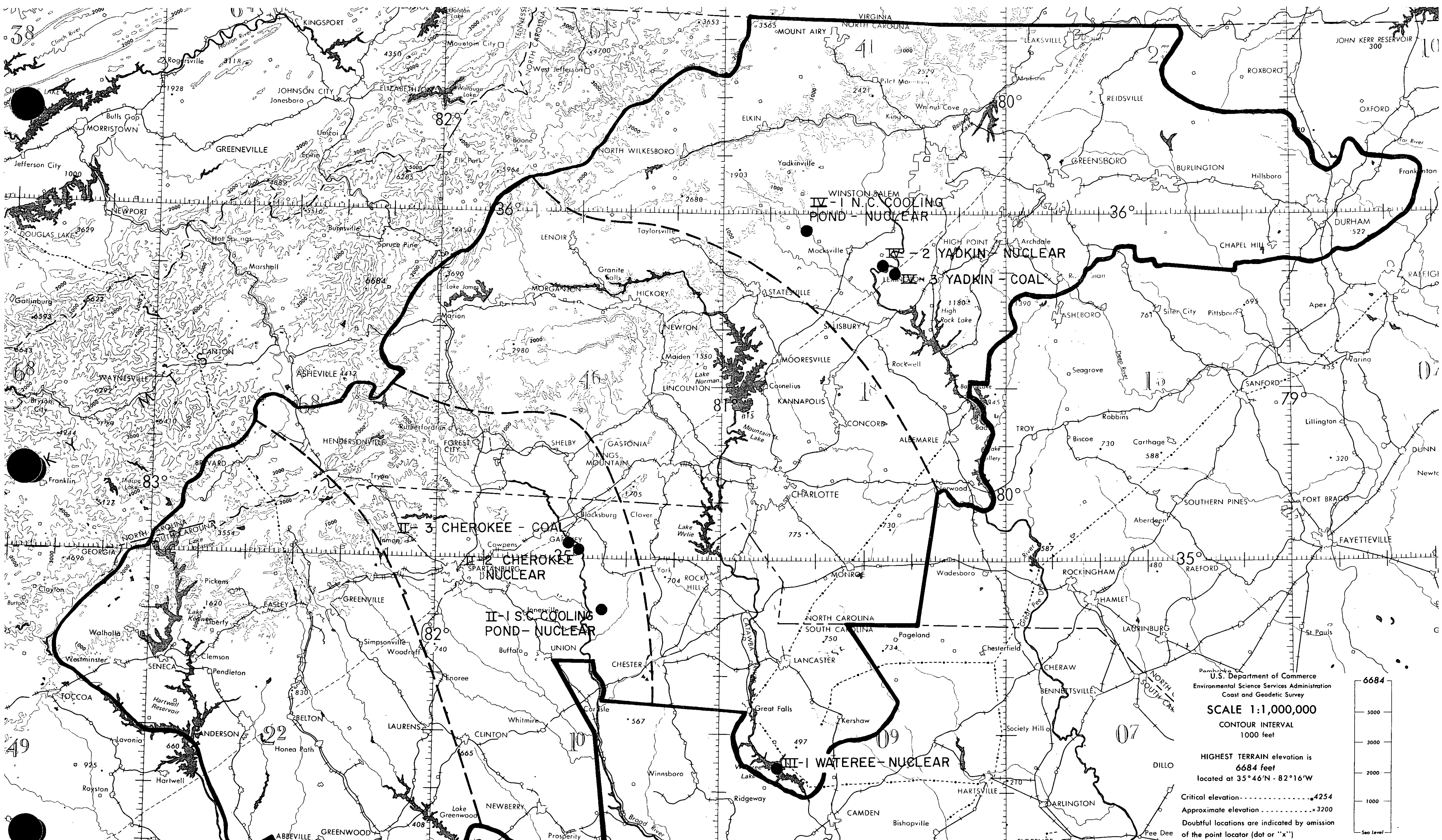
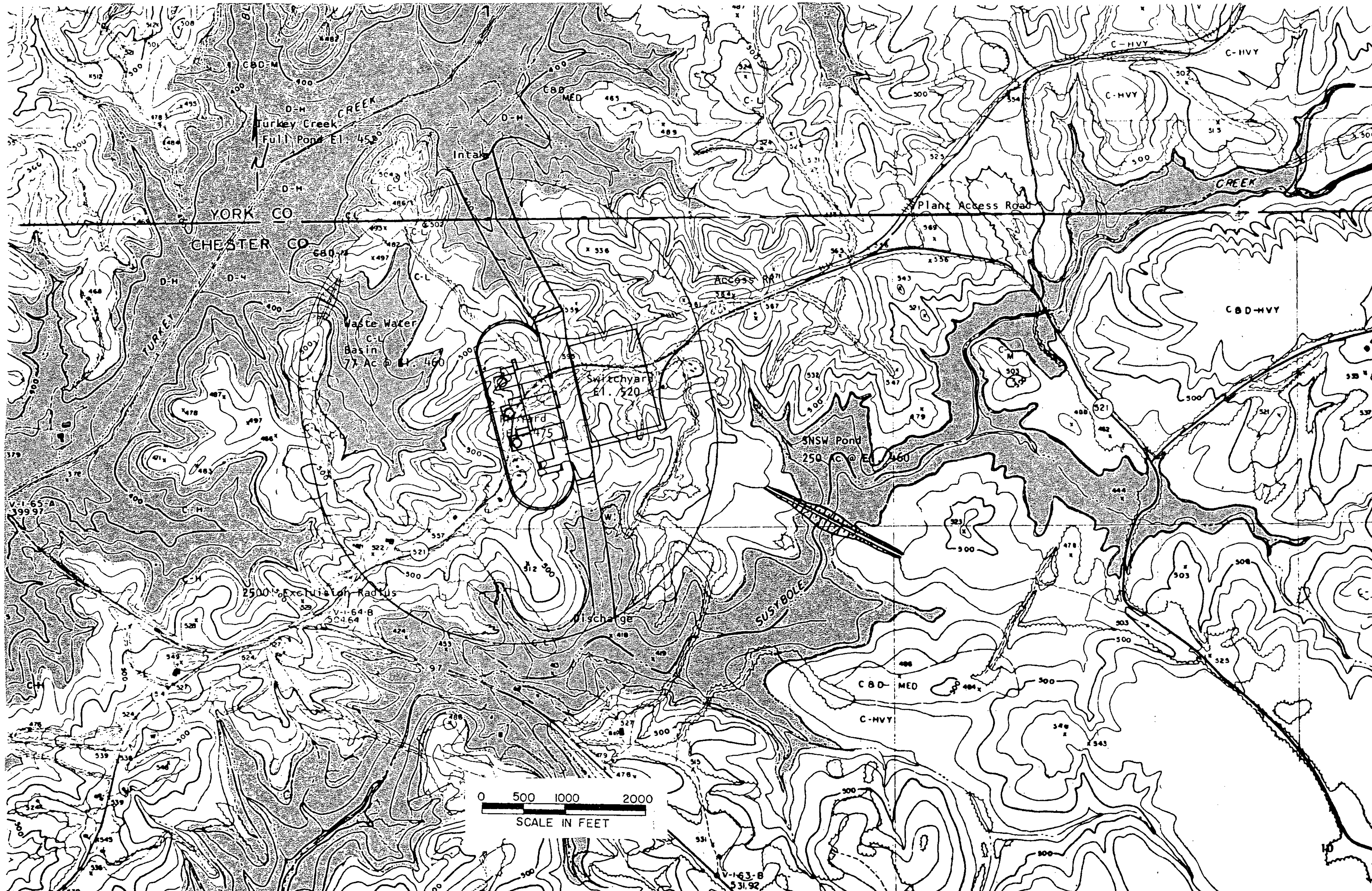


SITE ALTERNATIVE LOCATIONS

PERKINS NUCLEAR STATION

ER Figure 9.2.2-1

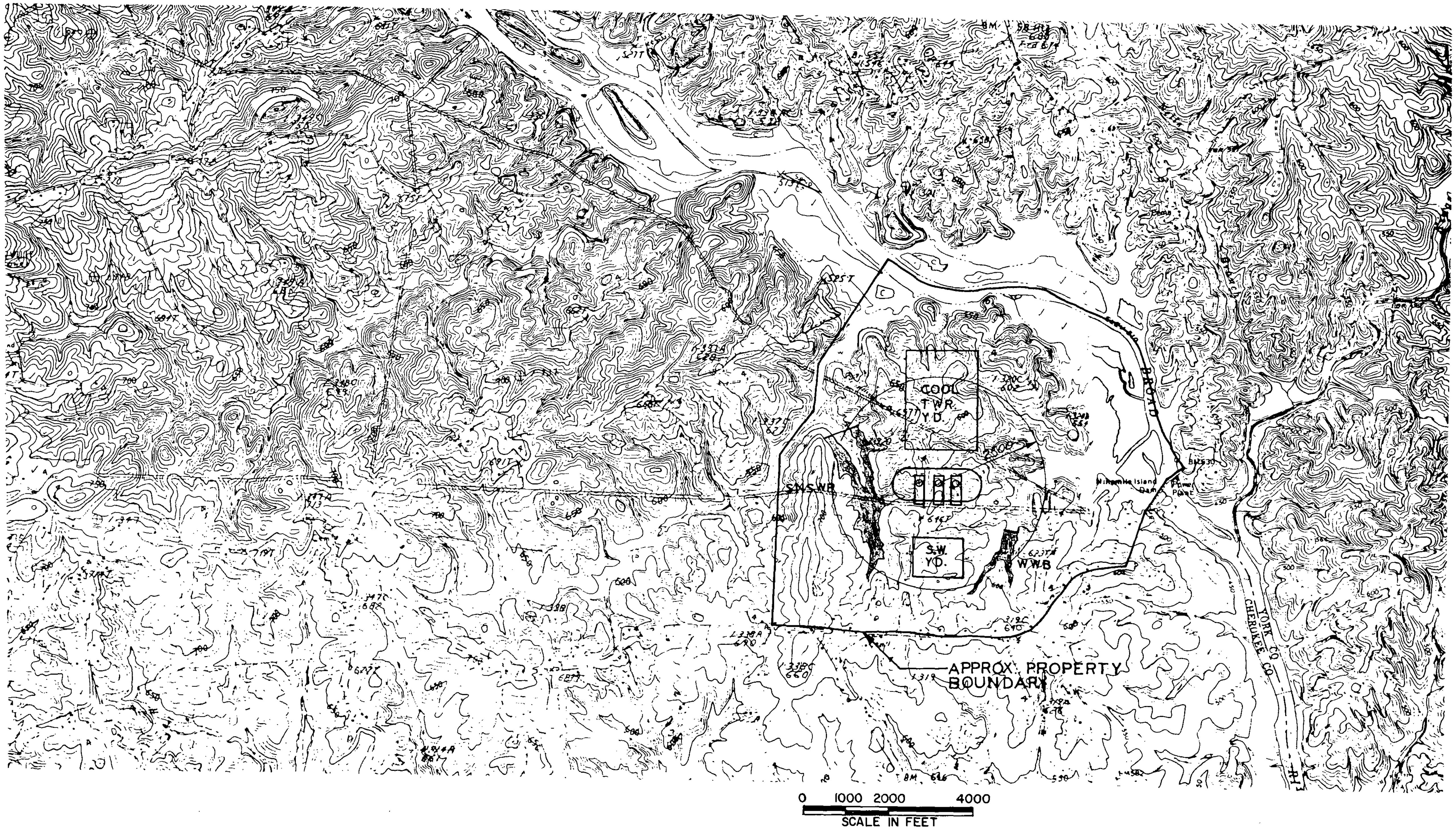


ALTERNATIVE SITE II-1,
S. C. COOLING POND - NUCLEAR

PERKINS NUCLEAR STATION

ER Figure 9.2.2-2

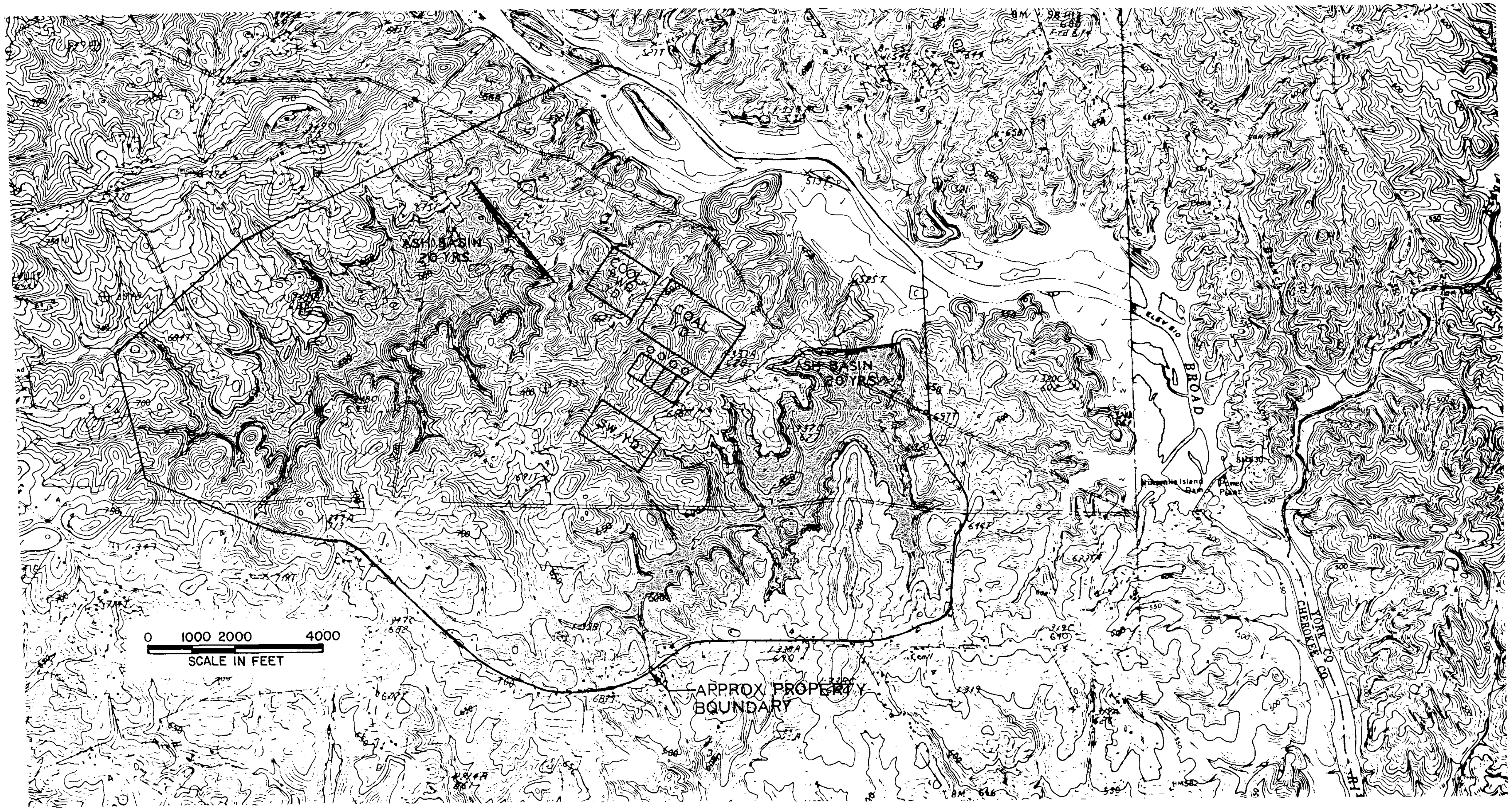
Amendment 1



ALTERNATIVE SITE II-2,
CHEROKEE - NUCLEAR

PERKINS NUCLEAR STATION

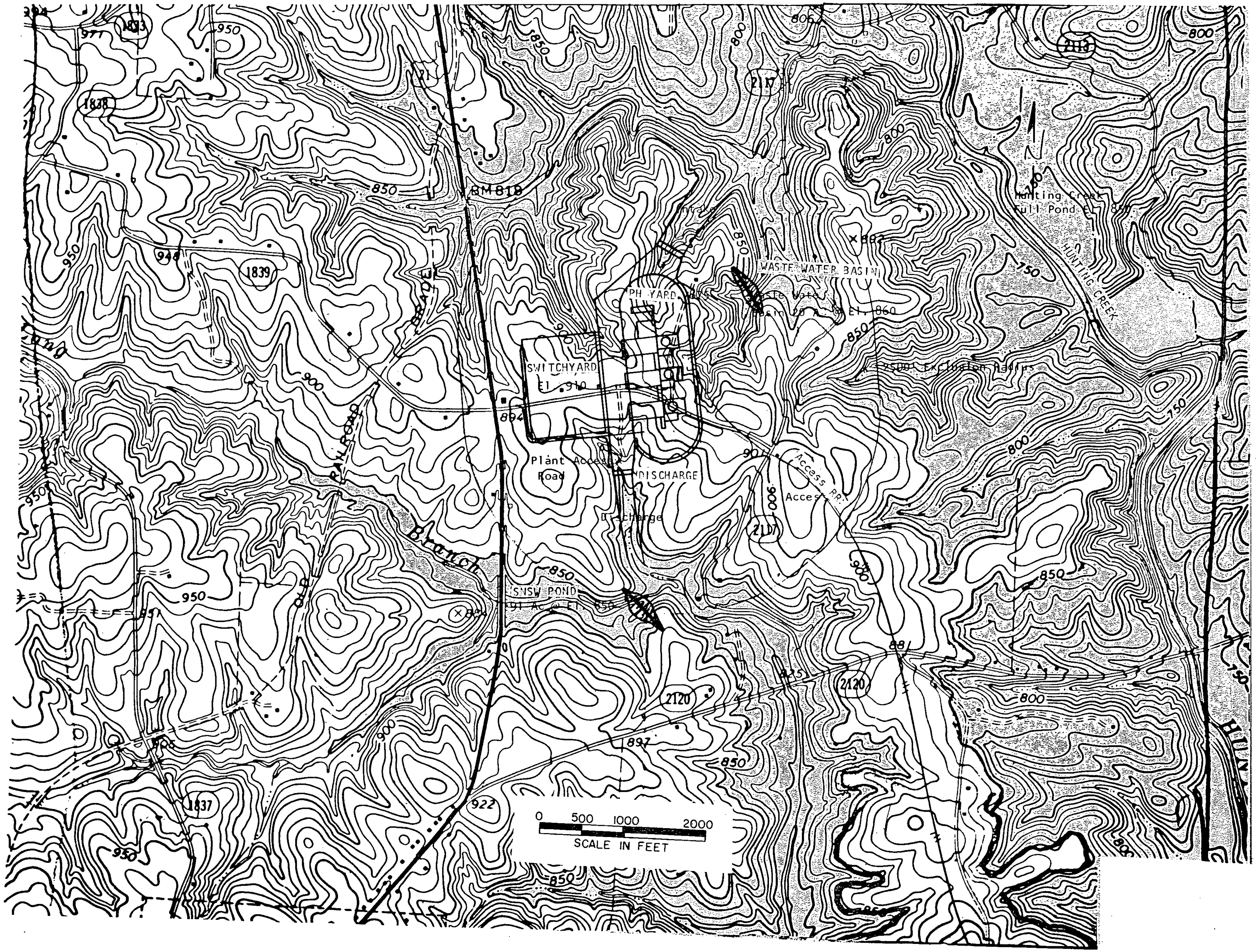
ER Figure 9.2.2-3



ALTERNATIVE SITE II-3,
CHEROKEE - COAL

PERKINS NUCLEAR STATION

ER Figure 9.2.2-4



ALTERNATIVE SITE IV-1,
N. C. COOLING POND - NUCLEAR

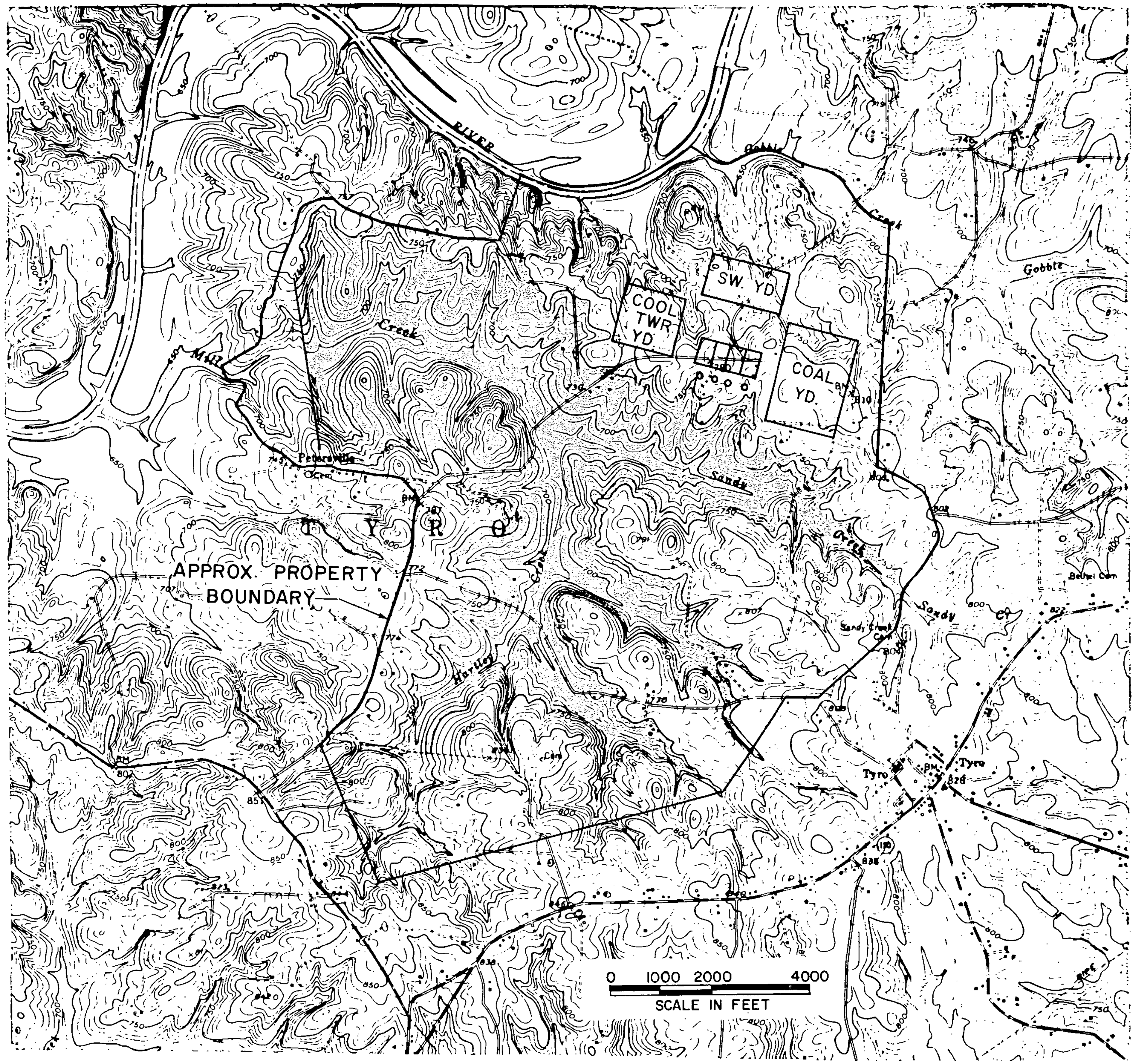
PERKINS NUCLEAR STATION

ER Figure 9.2.2-5

ALTERNATIVE SITE IV-2,
YADKIN - NUCLEAR

PERKINS NUCLEAR STATION

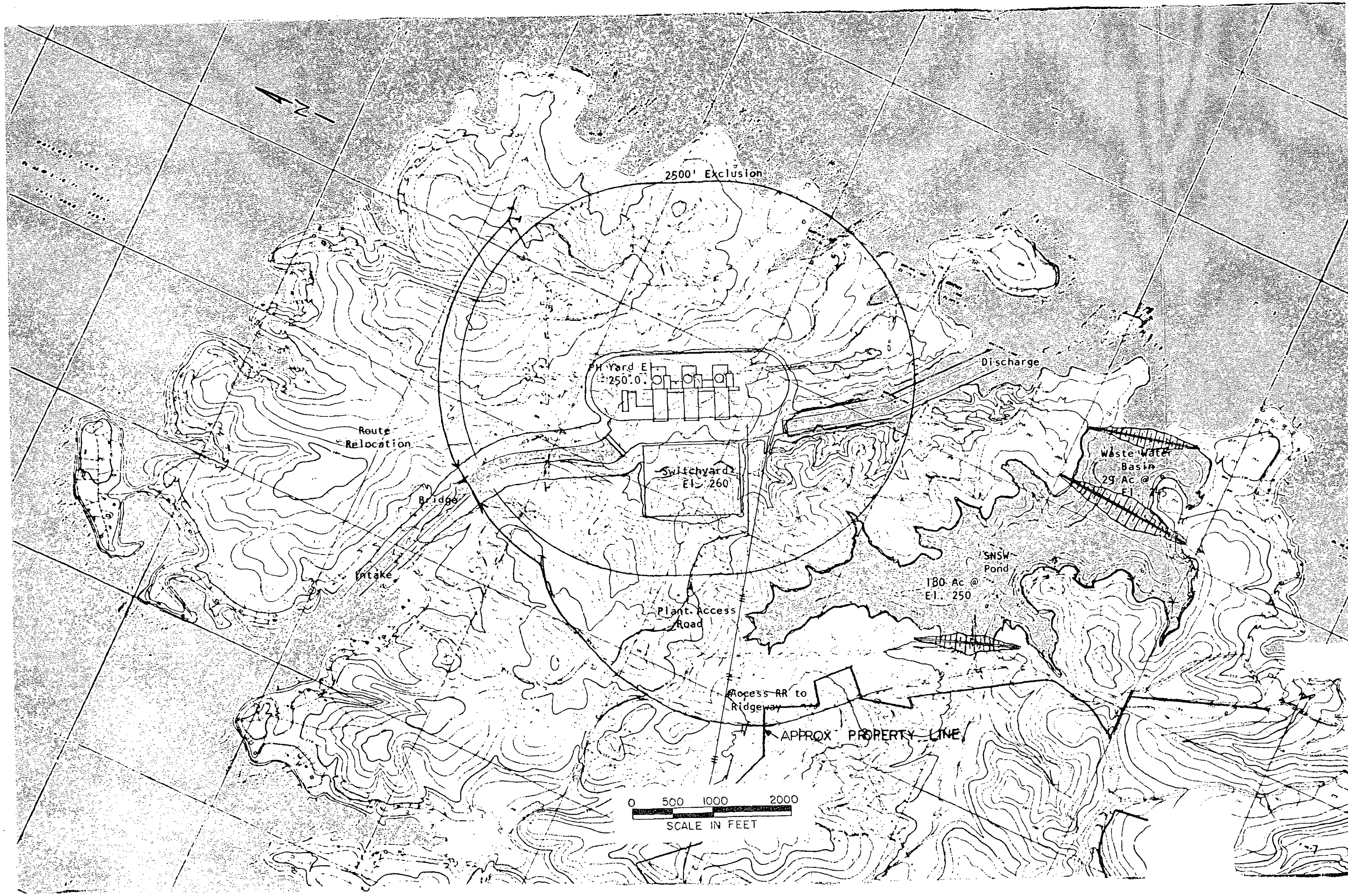
ER Figure 9.2.2-6



ALTERNATIVE SITE IV-3,
YADKIN - COAL

PERKINS NUCLEAR STATION

ER Figure 9.2.2-7

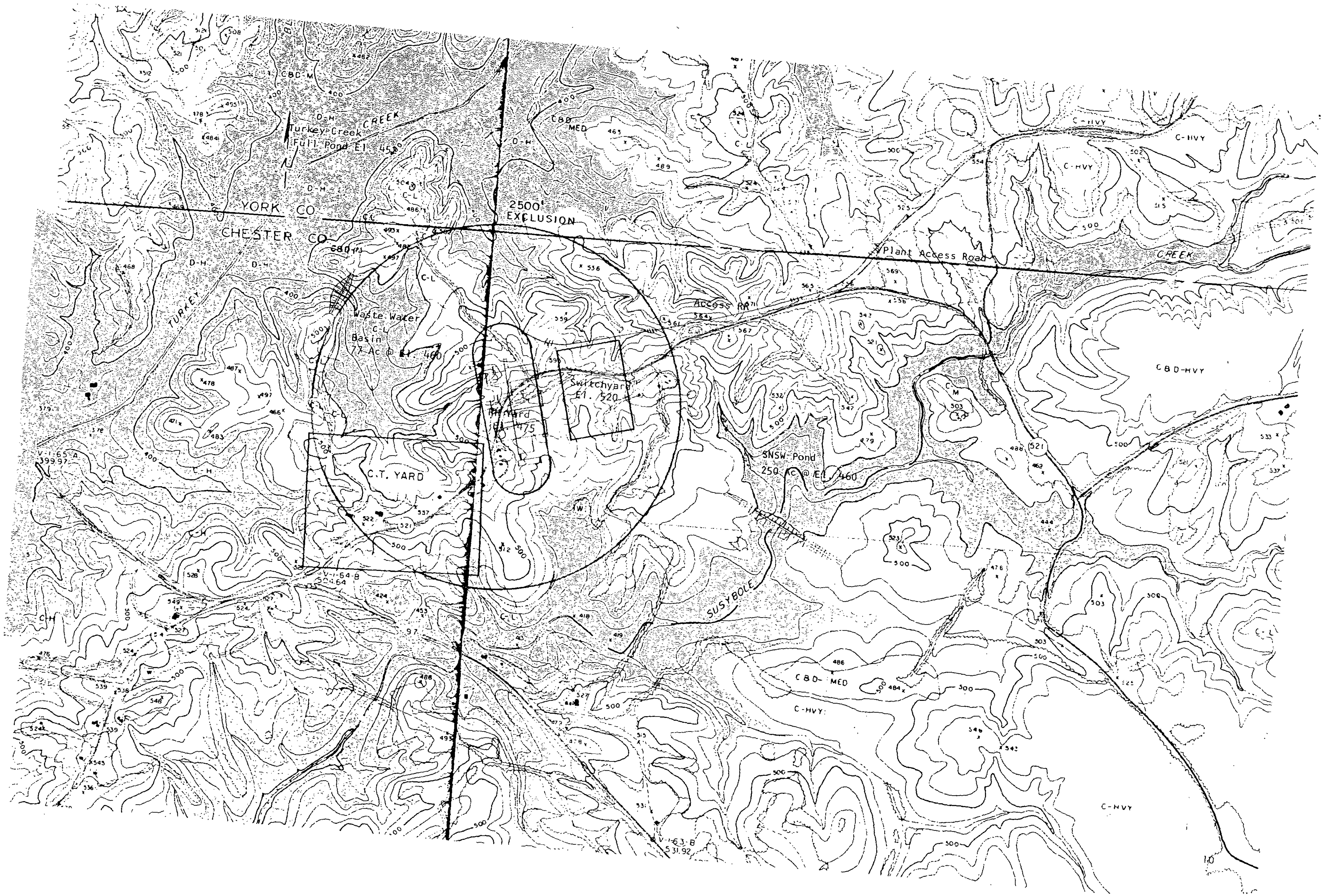


ALTERNATIVE SITE III - 1,
WATEREE - NUCLEAR

PERKINS NUCLEAR STATION

ER Figure 9.2.2-8

Amendment 1



ALTERNATIVE SITE II - 1 (CT), CENTRAL PIEDMONT, S. C. COOLING POND WITH CLOSED CYCLE COOLING TOWERS - NUCLEAR

PERKINS NUCLEAR STATION

ER Figure 9.2.2-9

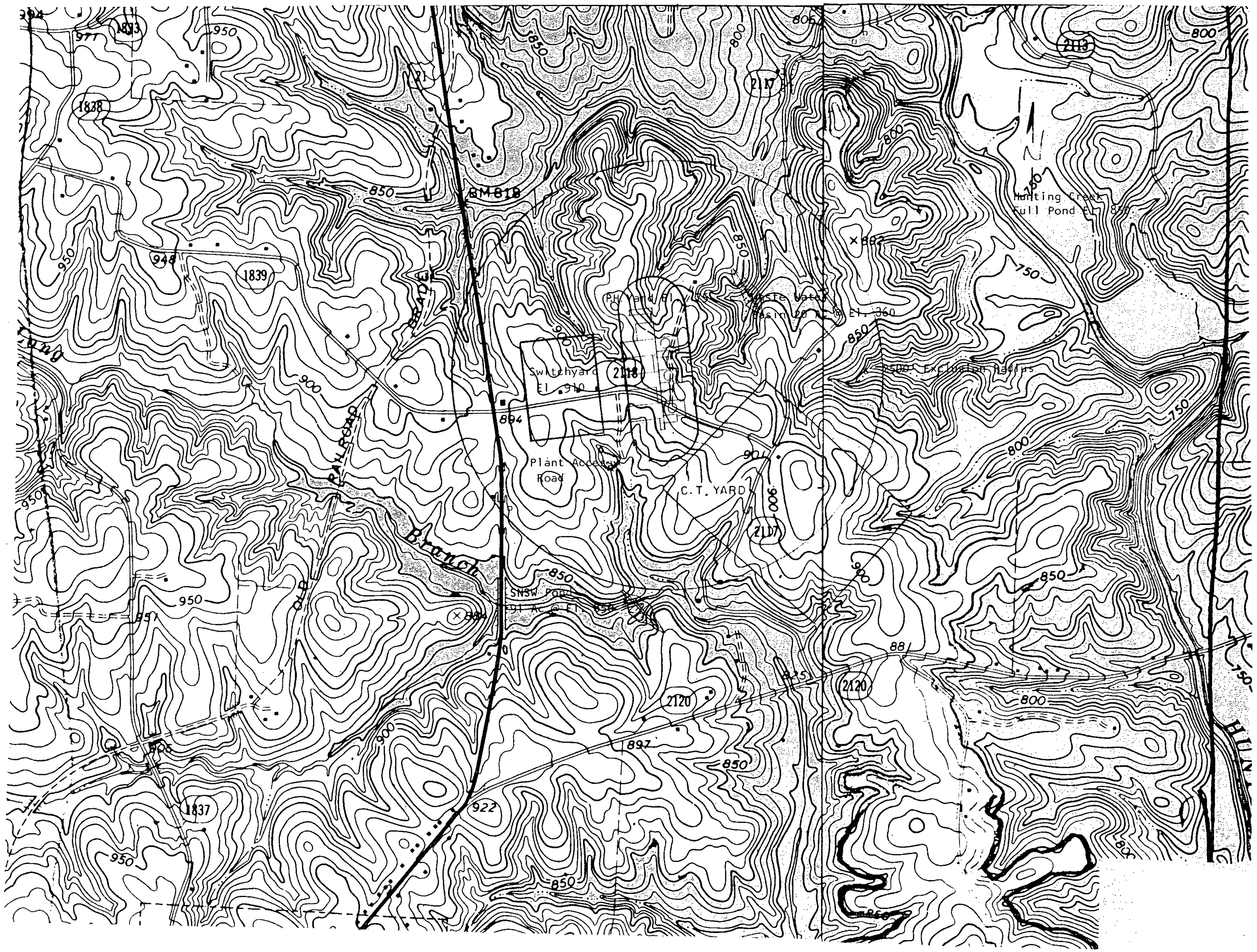
Amendment 1
(New)

ALTERNATIVE SITE III - 1 (CT), WATEREE WITH CLOSED CYCLE COOLING TOWERS - NUCLEAR

PERKINS NUCLEAR STATION

ER Figure 9.2.2-10

Amendment 1



ALTERNATIVE SITE IV - 1 (CT), CENTRAL PIEDMONT, N. C. COOLING POND SITE WITH CLOSED CYCLE COOLING TOWERS - NUCLEAR

PERKINS NUCLEAR STATION

ER Figure 9.2.2-11

Amendment 1
(New)

DELETE

PERKINS NUCLEAR STATION

Figure 9.3.1-1

Attachment 9.0
Chapter 9
Perkins Nuclear Station
Tuckertown Alternative Site

Tuckertown Alternative Site

Subsequent to receipt on December 30, 1974 of the North Carolina Department of Natural and Economic Resources Technical Report No. IV-21-C (No. 1), Water Resources Aspects of Proposed Perkins Nuclear Power Plant, October 11, 1974, Duke submitted comments to the Department's report on January 10, 1975, and as suggested by Mr. J. E. Harrington, Secretary, NCDNER, arranged a meeting on January 20, 1975 to discuss with representatives of NCDNER, Duke's comments and concerns regarding the October 11, 1974 report.

During the course of the meeting, Duke offered to examine the suitability of the NCDNER suggested Tuckertown site and to submit a supplemental report on this subject to the state within two weeks. On January 31, 1975, Duke submitted a comparative study of the Perkins and Tuckertown sites to North Carolina's Secretary Harrington which indicates that Tuckertown may be a viable site, but Perkins is clearly the best choice.

It should be noted that Duke's evaluation of Tuckertown site is based upon information readily available from USGS maps, Census data, and other published material.

A copy of Duke's comparative study, which indicates that the factors considered were sufficient to show that Perkins is the best choice without need to consider detailed biological and water quality data, is attached.

COMPARATIVE STUDY OF PERKINS AND TUCKERTOWN SITES FOR PROJECT 81 STATION IN NORTH CAROLINA

In its evaluation of potential sites for future generating facilities, Duke Power Company systematically considers engineering, environmental, economic, institutional, land use, construction, and transmission hookup factors. In Duke's experience, such evaluation results in the selection of appropriate locations for station construction. In response to a request from the North Carolina Department of Natural and Economic Resources (NCDNER), a comparative evaluation of Duke's proposed Perkins Nuclear Station site and the NCDNER proposed site on Tuckertown Reservoir has been made. The evaluation is in addition to the 10 site-plant alternatives in the Environmental Report for the Nuclear Regulatory Commission which formed the basis for selection of the Perkins site.

The attached table briefly summarizes the evaluation criteria with respect to each site. It should be noted that in certain areas a meaningful evaluation cannot be completed without a comprehensive study. Engineering features like geology and seismology cannot be completely considered without detailed subsurface exploration.

Detailed meteorological studies, based on information gathered onsite for one year, are necessary to evaluate the impact of routine and accidential releases of radioactive effluents.

Detailed flood studies, low flow analysis, and review of other hydraulic data are essential in the examination of a site for safety considerations.

A baseline study of site flora and fauna conducted through the four seasons of the year would be necessary to completely determine the environmental impact of construction and operation of the station.

Duke's Perkins Nuclear Station site is located approximately 2,200 yards north of the Yadkin River in Davie County, North Carolina, seven miles east-southeast of Mocksville. The area surrounding the site is sparsely populated and is currently being used for agricultural purposes. The site is just south of N. C. Highway 801 and will require a 6.3 mile access railroad. The Yadkin River drains approximately 2,527 square miles above the site, including about 130 miles drained by Dutchman's Creek which enters the Yadkin about two river miles downstream of the water intake location. Figure 1 locates the Perkins site.

The NCDNER Tuckertown site is located west of Tuckertown Reservoir, south of Flat Creek in Rowan County, North Carolina. Salisbury and Albemarle, located 17 miles northwest and 12 miles south of the site respectively, are the nearest urban centers. Duke has relocated the NCDNER site to the west, to provide adequate safety to the site due to estimated high flood flow elevations and necessary rail access (7 miles). The near site area is sparsely populated. USGS mapping of a useful scale for station siting is not available. Yadkin River flow records are available at a site downstream of High Rock Dam for the period 1919-1927 and 1942-1961. Figure 1 locates the Tuckertown site.

Yadkin, Inc., owner and operator of several impoundments on the Yadkin River, including High Rock and Tuckertown Reservoirs, has not been contacted by Duke with respect to siting a power plant on Tuckertown Reservoir. Tuckertown Reservoir is licensed by the Federal Power Commission in Project No. 2206. Duke has taken no action to determine the reaction of these parties, or others involved, to a proposal of construction and operation of a power plant at the Tuckertown site.

While the Tuckertown Reservoir is operated primarily for hydroelectric purposes, there are stream flow limitations. Average flow through the reservoir is approximately 4,500 cfs, more than adequate for station operation. Flow records at the High Rock gage indicate an average flow of 4,684 cfs (adjusted for storage). FPC restrictions on High Rock operation, indicated in the license, are that stream flows may be reduced to a minimum weekly average of 1,400 cfs. Based on long-term analysis, the 7Q10 flow at the High Rock gage, accounting for natural streamflow conditions, is approximately 950 cfs. The 7Q10 flow at the gage, based on recent records from 1943 to 1961, is 270 cfs. Detailed flow analysis would have to be made to assure that adequate storage in Tuckertown and High Rock is available, in conjunction with other flow restrictions, for continuous operation of a station on Tuckertown Reservoir.

As indicated in the table, Duke's system reliability and reserve margins would be in jeopardy if Duke were to change sites for the Project 81, North Carolina, site at this time.

A careful examination of the above and tabulated information indicates no major advantage of the Tuckertown site over the Perkins site. However, several major disadvantages to the Tuckertown site are:

1) Water for station dependent on impoundments controlled by others.

2) At least a two year delay in bringing plant into service endangering power supply to customers.

3) Severe transmission line penalty.

4) Closer proximity to fault zone of as yet undetermined significance.

5) Public acceptance of Tuckertown site unknown at this time.

6) Probable high impact on recreation.

In summary, Duke considered several sites in a thorough and systematic manner before selecting the Perkins site. This late comparison of yet another alternative site (as required by NCDNER) confirms that the Perkins site was the best choice.

PERKINS SITE	TUCKERTOWN SITE
1.0 Site Location	
The site is in Davie County, North Carolina approximately one mile north of the Yadkin River upstream of the confluence of Dutchman's Creek.	The site is in Rowan County, North Carolina approximately two miles west of Tuckertown Lake (backed up by Tuckertown Dam on the Yadkin River) downstream of the confluence of Flat Creek.
The nearest urban centers are Salisbury, North Carolina, 10 miles south, and Winston-Salem, North Carolina, 17 miles north-northeast.	The nearest urban centers are Albemarle, North Carolina, 12 miles south, Salisbury, North Carolina, 17 miles northwest, and Kannapolis, 22 miles west.
	Due to the flat topography, it is necessary to put the site approximately two miles off the lake to get out of the Probable Maximum Flood Zone.
2.0 Engineering Features	
2.1 Geology	
Site in Charlotte Geologic Belt.	Site in Carolina Slate Belt.
Material is a sound homogenous granite with good engineering properties.	Material is volcanic and sedimentary in nature with some metamorphic sediments with undermined engineering properties.
	Site appears to have two basic types of rock underlayment with diverse engineering properties.
17 miles to nearest known fault zone.	6 miles to nearest known fault zone.

	PERKINS SITE	TUCKERTOWN SITE
2.2	Seismology	
	Inactive for 290 million years, ± 7 million	Inactive for 180 million years, ± 10 million
2.3	Meteorology	
	Climatological data correlated to Winston-Salem - Greensboro.	Climatological data probably correlated to Charlotte.
	Diffusion estimates available for 1 year.	No diffusion estimates available.
2.4	Hydrology	
	PMF estimate 627,000 cfs	PMF Estimate 720,000 cfs
	Maximum water surface elevation 697 ft. msl	Maximum water surface elevation 606 ft. msl
	River Site	Lake Site
	Average flow 2,850 cfs	Average flow 4,684 cfs (Reference WSP 1904)
	Assume flow augmentation as recommended by NCDNER January 20, 1975.	Assume necessary flows for continuous station operation are available.
2.5	Demography	
	Population within 5 miles - 4,517 (1970)	Population within 5 miles - 2,400 (1970)
	Population within 50 miles - 1,506,152 (1970)	Population within 50 miles - 1,492,603 (1970)
2.6	Access	
	Railroad 6.3 miles, no bridges.	Railroad 7 miles, no bridges.

PERKINS SITE		TUCKERTOWN SITE
3.0	Environmental Factors	
3.1	Cooling Water System	
	Circular wet mechanical draft cooling towers. Makeup for consumptive usages from Yadkin River and augmentation pond.	Circular wet mechanical draft cooling towers, makeup from Tuckertown Reservoir and High Rock Lake.
3.2	Sensitivity of Habitats Affected	
	Cleared area will have high impact.	Same as Perkins
	Surrounding area unaffected.	Same as Perkins
3.3	Risks of Potential Impact	
	Background and baseline data collected and impact assessed.	Unknown at this time.
3.4	Commitment of Resources	
	Total land area of site area and augmentation pond 2,600± acres	Total land area required approximately 1,600 acres.
3.5	Recreational Usage	
	No planned recreation.	Probable impact on existing recreation.
3.6	Scenic Values	
	No adverse asthetic impact.	Unknown.

	PERKINS SITE	TUCKERTOWN SITE
4.0	Economic Factors	
4.1	Fuel Availability	
	Nuclear fuel available.	Nuclear fuel available.
4.2	Construction Costs	
	Total capital cost estimate is currently \$2.3-billion.	Total capital cost estimate, based on 8% per year escalation for two years (due to delayed licensing and construction) is \$2.7-billion.
4.3	Operating Costs	
	21.18 mills/kwh	Assumed about the same.
5.0	Institutional Factors	
5.1	Site Certification	
	Construction Permit Application has been submitted to NRC. Contacts with the NRC Staff indicate site will be found suitable, and Duke expects to have site licensed. Other necessary regulatory agencies have been contacted. From environmental and engineering viewpoints, no significant objections to site are known.	Duke would lose approximately 24 months in its current commercial operation schedule if application were now made on the basis of a new site location. Additional costs, due to delay, would accrue. Fresh contact with FPC, US Army COE, and other Federal, State, and local agencies will have to be established. Yadkin, Inc., owners and operators of the reservoir, will have to be contacted with respect to water usage. Duke has no means to determine their likely reaction to this proposal. A two year delay would place Duke in a position of being unable to assure its customers of reliable electric service at the lowest possible cost.

PERKINS SITE	TUCKERTOWN SITE
5.2 Public Acceptance	
There is no intervention in the Project 81 application before the AEC/NRC. Duke has established contacts with local citizens through public participation meetings. The plant is acceptable to most of the people contacted.	No public contacts have been made. The acceptance or otherwise cannot be determined unless grass root contacts are established, which requires time.
6.0 Land Use Factors	
The current and projected land usages are outlined in the Perkins Application.	Same as at Perkins.
7.0 Construction Factors	
7.1 Potential Construction Work Force	
Duke expects no problem in hiring competent work forces.	Believed to be the same as at Perkins.
7.2 Access to Equipment and Materials	
Site located within 20 miles of Winston-Salem via Interstate highways.	Site located 25 miles from Charlotte via State highways.
8.0 Transmission Hookup Factors	
8.1 Access to Transmission System in Place	
3 lines required: 230 Kv 2.7 mi.; 230 Kv 5.5 mi.; 525 Kv 7.9 mi.	3 lines required: 230 Kv 11.5 mi.; 230 Kv 25.2 mi.; 525 Kv 14.0 mi.
Total 16.1	Total 54.2
Estimated Cost $ 27,702,000	Estimated Cost $ 31,611,000

PERKINS SITE

9.0 System Reliability

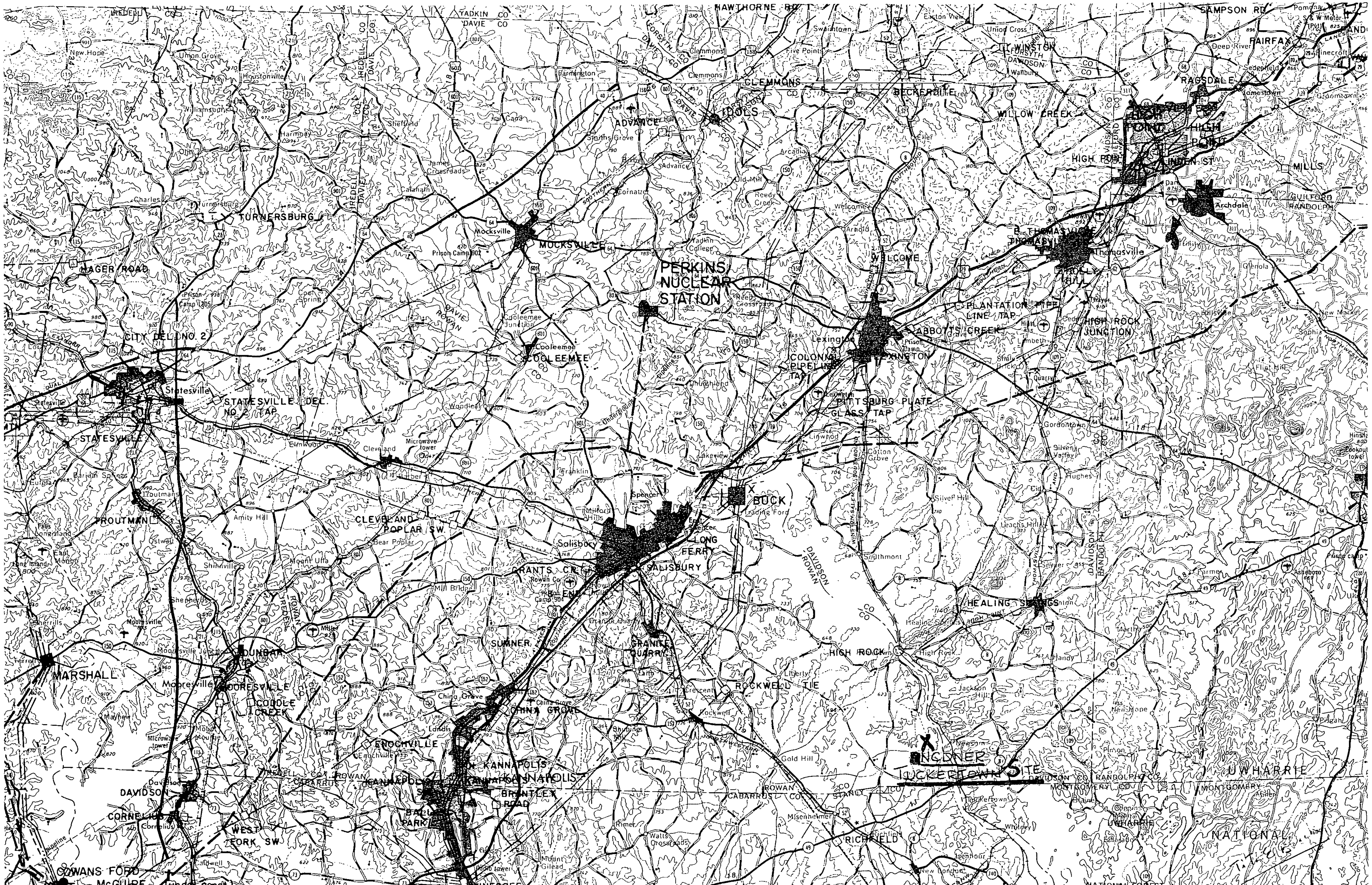
Current reserves for 1983-1988, based on Perkins commercial operation in 1983, 1985, and 1987 and scheduled retirements are as follows:

1983	13.1	1986	14.8
1984	14.9	1987	13.9
1985	15.9	1988	12.8

TUCKERTOWN SITE

Reserves based on a two year delay of each 1280 mw units for the 1983-1990 period and scheduled retirements are as follows:

1983	5.1	1987	7.7
1984	7.4	1988	7.0
1985	8.9	1989	12.4
1986	8.2	1990	11.7



AREA TOPOGRAPHIC MAP

DUKE POWER CITIZENSHIP SERVICE

PERKINS NUCLEAR STATION
FIGURE 1

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10.0 PLANT DESIGN ALTERNATIVES

Duke Power Company plays an important role in the development of the social and economic welfare of its customers. Duke recognizes its obligations to supply the electric power needed to maintain a high standard of public health, safety and comfort, and also to improve the overall quality of life of the customers it serves. The Perkins Nuclear Station in Davie County not only supplies electrical energy to the residential, commercial and industrial consumers in the Duke Service Area, but is also expected to provide a stimulus to the economy of the Davie County area through increased employment and tax revenues.

It must be recognized that any act of man has some impact on the environment. The United States Congress in enacting the National Environmental Policy Act of 1969 and the United States Court of Appeals for the District of Columbia in the 1971 Calvert Cliffs decision emphasized that although adverse impact can be reduced by the allocation of additional resources for environmental protection, the law of diminishing returns applies to the resources expended. These enactments require that benefits and costs be balanced.

Most of the environmental effects of a nuclear power station are associated with the operation of certain identifiable systems. This Chapter discusses the various system alternatives for which the environmental, economic and other costs and benefits are considered in the design process.

The following systems have been examined:

- Cooling System (Exclusive of Intake and Discharge)
- Intake System
- Discharge System
- Chemical Waste Treatment System
- Biocide Treatment System
- Sanitary Waste Treatment System
- Liquid Radwaste Systems
- Gaseous Radwaste Systems
- 2 Transmission Facilities
- Other Systems

For each system, a range of feasible alternatives which appear promising in terms of environmental protection are described.

Monetized costs and environmental effects of each proposed system and its alternatives are estimated. The assumptions and calculations on which these estimates are based can be found in USAEC Regulatory Guide 4.2, "Preparation of Environmental Reports for Nuclear Power Plants," March, 1973, Table 3, unless otherwise noted.

10.1 COOLING SYSTEMS

Because of the nature of the site selected for this station, only a limited
number of cooling system alternatives are feasible. The relatively small
flow in the Yadkin River prohibits the use of a once through cooling system.
1 The only cooling system alternatives are a cooling pond, closed cycle cool-
ing towers, or a closed cycle spray system. A cooling pond is not considered Q10.1.1
feasible at the present site because the topography surrounding the site
does not lend itself to construction of a pond of adequate size to dissipate
the waste heat from these units. Therefore, cooling system alternatives
limited to closed cycle cooling towers or spray system with makeup from the
from the river.

Three alternative closed cycle systems were evaluated in order to select the
most economical in terms of monetary and environmental costs associated with
each. These systems are conventional rectangular mechanical draft cooling
towers, natural draft cooling towers and circular mechanical draft cooling
towers. Wet-dry towers, dry towers, and spray systems are presented but
for reasons discussed they are not considered viable alternatives. Tables Q10.1.4
10.1.0-1 and 10.1.0-3 detail the cost comparisons of the alternatives. Q10.1.3

Effects of icing and salt buildup from cooling tower operation are identi-
fied as potential problems with respect to operation of electrical equipment
on the station yard. Electrical components have been situated at nominally
1000 feet from the cooling towers; this distance was recommended as a work-
ing number in layout considerations. Discussion in Section 5.1.4, however,
specifies limitations on estimates of condensate plume effects in this re-
gard. A physical modeling effort is presently underway aimed at further
delineation of plume behavior at or near the ground. The Morley Company
has been engaged both for use of their facility and for modelling services. Q10.1.2
Results should be forthcoming in the spring of 1975. As to contributions
from cooling tower drift with regard to possible icing or salt buildup, de-
position rates have been calculated in Section 5.1.4. Highest rates are on
the order of 40 pounds/ac. mo. This does not present a buildup problem.
For a postulated wind direction frequency of one percent, this translates
4 to a water accumulation rate of 0.6 inch in 24 hours. This does not pre-
sent an icing problem.

10.1.1 CIRCULAR MECHANICAL DRAFT COOLING TOWERS (PROPOSED SYSTEM)

The proposed cooling system as described in Section 3.4 is circular mechanical draft towers. These are induced draft, crossflow type towers. Twelve towers with 42 bays per tower would be needed. Optimum design dictates a 24 F range and 12 F approach to a 76 F wet bulb. A plant layout showing the circular mechanical draft towers is shown in Figure 3.1.0-2.

10.1.1.1 Economics of Circular Mechanical Draft Tower

Table 10.1.0-1 gives a cost comparison for the three alternate closed cycle cooling systems. Costs include major equipment costs, construction costs, and performance and pumping penalties.

10.1.1.2 Environmental Costs of Circular Mechanical Draft Towers

Environmental costs associated with the circular mechanical draft towers are tabulated in Table 10.1.0-2 and supporting details are presented below.

NATURAL SURFACE WATER BODY

Impingement or Entrapment by Cooling Water Intake Structure (1.1)

Makeup water intake velocities will be held less than 0.5 feet per second. At these velocities, entrapment or impingement of fish is not expected to occur. A full discussion of impingement and entrapment is given in Subdivision 5.1.2.3.

Passage Through or Retention in Cooling Systems (1.2)

Entrainment of aquatic organisms with the makeup water will occur. Since the cooling system is a closed cycle, 100 percent mortality of entrained organisms is assumed. An analysis of the effects on the river of loss of these organisms, which will be the same for all alternatives, is given in Subdivision 5.1.2.3.

Discharge Area and Thermal Plume (1.3)

The maximum thermal plumes expected to occur due to discharge of cooling tower blowdown are shown in Figures 5.1.2-1 and 5.1.2-2 for summer and winter conditions. The areas bounded by the 1 F and 3 F isotherms under summer conditions are .05 and .02 acres, respectively. The isotherms will be larger in winter due to the greater temperature difference between blowdown and ambient river water. The 2 F, 3 F and 5 F isotherms encompass 1.3, 1.0 and .5 acres, respectively. Environmental effects of thermal discharge are presented in Subdivision 5.1.2.2.

Chemical Effluents (1.4)

As discussed in Section 5.4, the chemical discharge plume will closely resemble the thermal plume. Chemical concentrations will be diluted to near ambient levels within a few hundred feet of the discharge point. Discharged chemicals are not expected to be harmful to fish since concentration levels even in the discharge canal are much lower than toxic levels recorded in the literature. Subsection 5.4.3 contains a detailed description of blowdown effects on aquatic biota.

Consumptive Use (1.6)

Maximum consumptive use of the river water will include 108 cfs evaporated during cooling tower operation. This quantity represents about four percent of the average river flow (2850 cfs) at the site. The nearest major industrial water user downstream is N. C. Finishing Company, about 15 river miles downstream. Its intake, however, is located on the backwaters of High Rock Lake and should not be affected by low flows in the river.

The nearest municipal user downstream is the city of Salisbury, located 11 river miles downstream. It has an intake capacity of 18 mgd or 28 cfs. Reduced river flow due to operation of Perkins Station should have little effect on this user downstream since the plant will limit its withdrawal
1 when the river flow is below the minimum flow yet to be established by the Q5.1.4
State of North Carolina.

Plant Construction (1.7)

Plant construction will affect the surface waters in two ways. Intake structure and cofferdam construction will directly cause increased turbidities and silting; and plant and cooling tower construction will indirectly cause increased turbidities due to runoff from construction areas. All cooling system alternatives will require the same intake facilities and environmental effects of these are discussed in Section 10.2. Runoff from construction will include that from the cooling tower construction and will be different for each cooling system alternative since each requires different amounts of land.

Silt traps and revegetation of disturbed areas will be used to minimize increased turbidity and silting due to runoff from construction areas, however, some silting will still occur during periods of high precipitation. Construction area required for circular mechanical draft towers is approximately 103 acres and from this area runoff carrying silt and suspended material may be expected to increase turbidities in the river. Turbid areas should subside with the end of precipitation. Quantification of effects of imposed turbidities on aquatic life will be presented when spring and summer aquatic data are collected.

Impairment of water quality due to chemical spills during cooling tower construction should not be a problem since construction will not be taking place at the water's edge and since any land spills would be confined and clean-up accomplished before the chemicals reached the water.

GROUND WATER

There will be no effects on groundwater (excluding salts) due to construction or operation of the cooling towers.

AIR

Fogging and Icing (3.1)

Fogging and icing effects are discussed in Section 5.1 for mechanical draft towers. It is assumed that for both mechanical draft tower alternatives the fogging and icing effects would be similar. Plume contact with the ground will be limited to within 1/2 mile of the plant. Since there are no highways or water transportation routes within 1/2 mile of the towers, there would be zero hours per year of interference with these forms of transportation. The nearest commercial (having regularly scheduled flights) airport is Smith-Reynolds Airport, Winston-Salem, 25 miles to the Northeast. At this distance, reduced air traffic or interference from cooling tower fogging would be negligible.

Damage to vegetation would also be limited to within 1/2 mile of the towers. Since the majority of the area within 1/2 mile is within the site boundary, the effects of icing on plants is considered negligable.

Chemical Discharge to Ambient Air (3.2)

Not applicable.

Radionuclides Discharged to Ambient Air (3.3)

Not applicable.

LAND

Site Selection (4.1)

The amount of land affected by construction and operation of the circular mechanical draft towers will total approximately 103 acres. Of this amount, 40 acres will be for construction laydown and staging and will be revegetated after construction. About 63 acres will be required permanently for installation of the cooling towers and associated piping. Approximately 55 percent of the total required land is forest land, 40 percent is open pastures and farmland, and 5 percent has other uses.

Construction Activities (Including Site Preparation) (4.2)

Disruptive activities associated with constructing the cooling system will be minimized since the site is in a relatively sparsely populated area. (Section 2.2, Demography). The movement of men, material and machines associated with building the circular mechanical draft cooling towers will be small compared with that for the overall construction of the plant. Cooling tower components will be moved by rail or truck with no disruption to local traffic.

Accessibility to historical or archelogical sites will not be hindered due to construction activities.

Since approximately 57 acres of forest and 41 acres of pasture land will be affected by construction of the cooling towers, some wildlife will be destroyed and some will be relocated to neighboring habitats. Quantification of the effects of these relocations on neighboring habitats will be presented when site wildlife studies are completed.

Land erosion potential will be proportional to the cut and fill operations and other construction activities. Potentially 103 acres of land could be exposed to erosion due to construction of the cooling towers.

Plant Operation (4.3)

Maximum noise levels which must be met by the cooling tower manufacturer are presented in Subsection 5.1.5. Actual noise levels are expected to be lower than these levels. Additional attenuation is expected due to surrounding vegetation so that noise levels offsite are not expected to be a problem. The visual impact of circular mechanical draft towers will be small due to their low profile and surrounding vegetation. However, plumes will be visible for several miles at times of high humidity and low temperatures. Frequency of occurrence of visible plumes is shown in Figures 5.1.4-1 and 5.1.4-2.

Salts Discharged from Cooling Towers

4 Assuming a conservative drift rate of 0.005 percent of the circulating water volume, salt deposition rates were calculated using the method described in Subsection 5.1.4. Maximum deposition rate for the proposed system is 40 lb/acre-month. At the nearest site boundary (approximately 2000 feet) this rate would drop to 2 lb/acre-month. Salt tolerances of area vegetation are not known, therefore, effects have not been quantified.

10.1.2 RECTANGULAR MECHANICAL DRAFT COOLING TOWERS

The closed-loop cooling system described in Section 3.4 could use rectangular mechanical draft cooling towers as an alternative. Mechanical draft towers of the size needed to cool 2,274,000 gpm of cooling water would be induced draft design using one or more fans to force air movement over a counterflow fill arrangement. Twelve towers are necessary with 8 cells per tower. Each tower is 522 feet long by 72 feet wide by 57 feet high.

Optimum design dictates a 24 F range and 12 F approach to a 76 F wet bulb. A plant layout for Perkins Station with rectangular mechanical draft towers is shown in Figure 10.1.2-1.

10.1.2.1 Economics of Rectangular Mechanical Draft Towers

Table 10.1.0-1 gives a cost comparison for the three alternative closed cycle cooling systems. Costs include major equipment costs, construction costs, and performance and pumping penalties.

10.1.2.2 Environmental Costs of Rectangular Mechanical Draft Towers

Environmental costs associated with the rectangular mechanical draft towers are tabulated in Table 10.1.0-2 and supporting details are presented below.

NATURAL SURFACE WATER BODY

Impingement or Entrapment by Cooling Water Intake Structure (1.1)

Maximum make-up flow for the rectangular mechanical draft alternative is approximately 52,300 gpm or 116 cfs compared to 120 cfs for the proposed system. The intake structure for this alternative is the same as that described in Section 3.4. Since make-up requirements and intake velocities (<0.5 fps) are approximately the same as for the proposed cooling system, neither impingement nor entrapment of fish will be a problem as explained in Section 5.1.

Passage Through or Retention in Cooling Systems (1.2)

With make-up flow and intake design the same as for the proposed cooling system, the effects of entrainment of organisms would be the same as described in Section 5.1.2.3.

Discharge Area and Thermal Plume (1.3)

Blowdown requirements for rectangular mechanical draft towers would be similar to those for the proposed cooling system. Also since the rectangular towers would also have a guaranteed 12 F approach, blowdown temperatures would be the same as for the proposed system. Therefore, discharge area and thermal plume considerations would be the same as for the proposed system.

Chemical Effluents (1.4)

Chemical concentration of blowdown water would be the same for rectangular mechanical draft towers as for the proposed system.

Radionuclides Discharged to Water Body (1.5)

Radionuclide discharges to the river will be independent of the cooling system chosen.

Consumptive Use (1.6)

Consumptive use of the river water will include 105 cfs evaporated during cooling tower operation. This quantity is essentially the same as for the proposed system. Therefore downstream effects due to water consumption would be the same.

Plant Construction (1.7)

Effects of plant construction on the surface waters should be the same for rectangular mechanical draft cooling towers as for the proposed cooling system, except that 169 acres of land will be affected during tower construction. This is about 66 acres larger than the area affected by construction of the proposed towers, therefore potential silting and increased turbidities would be larger. Quantification of effects on aquatic life will be presented when spring and summer aquatic data are taken.

GROUND WATER

There will be no effects on groundwater (excluding salts) due to construction or operation of the cooling towers.

AIR

Fogging and Icing (3.1)

As described in Section 5.1, fogging and icing effects would be essentially the same for any mechanical draft tower chosen; therefore, fogging and icing from rectangular mechanical draft towers would be essentially the same as for proposed cooling system.

Chemical Discharge to Ambient Air (3.2)

Not applicable.

Radionuclides Discharged to Ambient Air (3.3)

Not Applicable.

LAND

Site Selection (4.1)

The amount of land affected by construction and operation of the rectangular mechanical draft towers will total approximately 169 acres. Of this amount, 40 acres will be for construction laydown and staging and will be revegetated after construction. About 129 acres will be required permanently for installation of the cooling towers and associated piping. About 55 percent of the total required land is forest land, 40 percent is open pastures and farmland, and 5 percent has other uses.

Construction Activities (Including Site Preparation) (4.2)

Construction activities for rectangular mechanical draft towers would be essentially the same as for the proposed cooling system. However, since the number of acres of land required for construction will be slightly more, the effects on wildlife will be increased. Quantification of effects will be presented when wildlife studies in the site are completed.

The amount of land which could be potentially exposed to land erosion due to construction of rectangular mechanical draft towers is 169 acres.

Plant Operation (4.3)

The noise from operation of rectangular mechanical draft towers would be essentially the same as for circular mechanical draft towers (proposed system). Both would be required to meet the noise criteria listed in Subsection 5.1.5.

The visual impact of rectangular mechanical draft towers will be small due to their low profile and surrounding vegitation. However, plumes will be visible for several miles at times of high humidity and low temperatures. Frequency of occurrance of visible plumes would be approximately the same as for the proposed system. These frequencies are given in Figures 5.1.4-1 a nd 5.1.4-2.

Salts Discharged from Cooling Towers

Drift effects from rectangular mechanical draft towers are expected to be the same as they would be for the proposed system. These effects include salt deposition which is discussed in Subsection 5.1.4.

10.1.3 NATURAL DRAFT COOLING TOWERS

Natural draft cooling towers are an alternative to the proposed cooling towers described in Section 3.4. In a natural draft tower air flow is induced by the difference in density between the warmed air inside the tower and the cooler ambient air at the top of the tower. One tower is required for each unit. Each tower would employ a crossflow fill section. The towers are 496 feet in diameter and 519 feet high. Optimum design is for a 28 F range and 18 F approach to a 76 F wet bulb. A plant layout showing natural draft towers is shown in Figure 10.1.3-1.

10.1.3.1 Economics of Natural Draft Cooling Towers

Table 10.1.0-1 gives a cost comparison for the three alternate closed cycle cooling systems. Costs include major equipment costs, construction costs, and performance and pumping penalties.

10.1.3.2 Environmental Costs of Natural Draft Towers

Environmental costs associated with the natural draft towers are tabulated in Table 10.1.0-2 and supporting details are presented below.

NATURAL SURFACE WATER BODY

Impingement or Entrapment by Cooling Water Intake Structure (1.1)

Maximum make-up flow for the natural draft alternative is 51,472 gpm or 114 cfs. This compares with 119 cfs for the proposed system. The intake structure for this alternative is the same as that described in Section 3.4. Since make-up requirements and intake velocities ($\leq$ 0.5 fps) are approximately the same as for the proposed cooling system, neither impingement nor entrapment of fish will be a problem as explained in Section 5.1.

Passage Through or Retention in Cooling Systems (1.2)

With make-up flow and intake design the same as for the proposed cooling system, the effects of entrainment of organisms would be the same as described in Section 5.1.2.3.

Discharge Area and Thermal Plume (1.3)

Thermal plume areas for the natural draft towers will be somewhat different from those of the proposed system. Since natural draft towers operate at a higher approach temperature, the temperature of the blowdown water will be warmer than for mechanical draft towers. The approach temperature for the natural draft tower is 18 F. Adding this to the maximum expected wet bulb temperature of 78 F (as was done in Subsection 5.1.2) the maximum blowdown temperature is 96 F compared to 90 F for the proposed system. A similar higher blowdown temperature would occur under winter conditions also. The computer program described in Subsection 5.1.2 was run using 96 F as the summer discharge temperature and 75 F as the winter discharge temperature. The same ambient river temperatures as reported in Figures 5.1.2-1 and 5.1.2-2 were used. The blowdown rate for natural draft towers would be approximately the same as for the proposed system, so 10 cfs was again used as a representative discharge flow. The predicted isotherm shape for natural draft tower blowdown are similar to those reported in Figures 5.1.2-1 and 5.1.2-2, however due to the warmer temperatures the isotherm areas are larger for natural draft towers. Isotherm areas are calculated to be .19 and .03 acres for the 1 F and 3 F isotherms under summer conditions, and 1.7, 1.4, and 0.8 acres for the 2 F, 3 F, and 5 F isotherms under winter conditions.

Chemical Effluents (1.4)

Since thermal plumes are larger with natural draft towers, chemical plumes will also be larger. However, the concentration of discharged chemicals will be the same, therefore potential effects on fish or aquatic life would be the same as for the proposed system.

Radionuclides Discharged to Water Body (1.5)

Radionuclide discharges to the river will be independent of the cooling system chosen.

Consumptive Use (1.6)

Consumptive use of the river water with natural draft towers will be essentially the same as for the proposed cooling system.

Plant Construction (1.7)

Construction effects on the surface water will be somewhat less for natural draft towers since they require a total of 95 acres of land for construction which is less than for the proposed system. Silting and turbidities due to runoff from this construction would have essentially the same effect on the river as the proposed system. All other effects on the surface waters due to cooling tower construction will also be the same.

GROUND WATER

There will be no effects on groundwater (excluding salts) due to construction or operation of the cooling towers.

AIR

Fogging and Icing (3.1)

For an analysis of fogging and icing from natural draft towers, refer to "Plant Operation (4.3)" below.

Chemical Discharge to Ambient Air (3.2)

Not applicable.

Radionuclides Discharged to Ambient Air (3.3)

Not applicable.

LAND

Site Selection (4.1)

The amount of land affected by construction and operation of the natural draft towers will total approximately 95 acres. Of this amount, 40 acres will be for construction laydown and staging and will be revegetated after construction. About 55 acres will be required permanently for installation of the cooling towers and associated piping. About 55% of the total required land is forest land, 40% is open pastures and farmland, and 5% has miscellaneous uses.

Construction Activities (Including Site Preparation) (4.2)

Construction activities associated with constructing natural draft towers will be the same as for the proposed system with the following exceptions. Movements of men, materials, and machines will probably be greater for natural draft towers.

Approximately 52 acres of forest and 38 acres of pasture land will be affected by construction of the natural draft towers.

Potentially 95 acres of land could be exposed to erosion due to construction of the natural draft cooling towers.

Plant Operation (4.3)

Noise associated with operation of natural draft towers is considered negligable since there are no fans required. The only noise of any consequence is that of falling water and it is not considered detrimental.

The visual impact of natural draft towers will be much greater than for the proposed cooling system due to the greater heights of the hyperbolic shells.

The length and frequency of visible plumes associated with natural draft towers were found to be similar to those of the proposed system. Similarity was assumed between natural draft and mechanical draft towers at Perkins from a more or less qualitative comparison of Duke Power Company's Cliffside Station plume length frequencies to plume length data at the TVA Paradise Plant in Kentucky (from three hyperbolic natural draft towers; since August, 1970). This followed from a consideration of average plume lengths and lengths occurring less than one percent of the time. A reasonable correspondence was found after accounting for difference in evaporation rate. Regional climatologies for each plant of surface temperature, dew point, wind speed[1] and maximum mixing height[2] show similarity with respect to indices of diffusion and background moisture. Therefore the plume length and frequencies presented in Figures 5.1.4-1 and 5.1.4-2 are considered representative of natural draft towers as well as mechanical draft towers.

With respect to plume contact at the ground from natural draft towers, experience at Paradise would suggest an extremely low rate of occurrence at Perkins.

Cooling tower operation should not affect wildlife. Qualification of this opinion will be provided when wildlife studies being performed now are complete.

2 Salts Discharged From Cooling Towers

For natural draft towers at Perkins Nuclear Station, drift effects are evaluated from analyses of a reference tower (drift rate 0.00375%) cited in the Forked River Nuclear Station Environmental Report. Extrapolation to Perkins can be accomplished by adjusting total flow and solids content of the circulating coolant in the reference tower. The Forked River natural draft reference tower was analyzed as to tower wake effect, drift rate, drift droplet size distribution and fall speeds of drift droplets. Maximum short period (8 hour) air concentrations of tower salt were estimated at 10 micrograms per cubic meter within 1.55 miles of the tower. For Perkins natural draft towers, with a heat load requiring four Forked River sized towers instead of one and a salt concentration of 1150 PPM (solids content) as versus 45,000 PPM, the maximum short term air concentration translates to 1.03 micrograms per cubic meter. Air concentrations of salt on an annual basis, therefore, will not be appreciable in magnitude, being a fraction of the short period maximum. Fall speeds applicable to the reference tower ranged from 0.9 to 35 cm per second. Assuming high relative humidity and fall speeds characteristic of largest drop sizes, a maximum deposition rate (8 hours) for Perkins can be postulated at 8.80 lbs. per acre per month. This
2 compares to 40 lb/acre-month for the proposed system.

10.1.4 WET - DRY COOLING TOWERS

Wet-dry towers are currently being tested by several manufacturers, but they were not considered practical at Perkins Nuclear Station for two reasons. There are no known wet-dry towers currently in operation of the size needed at Perkins. Therefore the technology has not been proven to the point where they are considered a viable alternative. Also, the advantages to be gained by wet-dry towers, if they were proven, are in the areas of reduced fogging, icing, and water consumption. None of these problems is of sufficient magnitude at Perkins to justify a much higher cost for wet-dry towers.

10.1.5 DRY COOLING TOWERS

Dry cooling towers are not considered as an alternate for the Perkins Nuclear Station for the following reasons:

a) The turbine exhaust pressure is predicted as 6 to 8 inches Hg. absolute during the summer months. The turbine manufacturers presently do not market a 1300 MW nuclear unit for these exhaust pressures. To operate at these pressures would require multiple units with all the associated equipment for multiple turbine-generators.

b) The investment cost for a mechanical draft dry tower is approximately 3 times greater than a wet mechanical draft tower. (3)

c) With dry cooling towers, generation costs would be approximately 16% higher than with wet cooling towers. This would result from a much higher capital cost for the dry cooling equipment, plus the high capacity and energy penalties. (4)

10.1.6 CLOSED CYCLE SPRAY SYSTEMS

Closed cycle spray systems were not considered as an alternate cooling means because of the large land requirements requried for canals or spray ponds for which there are no multiple uses except as a cooling medium.

10.2 INTAKE SYSTEMS

1 The proposed water intake system is composed of four parts; a river intake structure, piping from the river intake structure to the Nuclear Service 1 Water Pond and to the Radwaste discharge line, the Nuclear Service Water Pond which serves as a sedimentation basin and a makeup intake structure to take water to the plant from the Nuclear Service Water Pond. This is described in more detail in Sections 3.4 and 3.5. In this section the river intake structure, the piping to the Nuclear Service Water Pond and piping to the 1 Radwaste discharge line are the only parts of the system that are discussed since the remainder of the system is the same for the proposed and the alternative systems.

10.2.1 RANGE OF ALTERNATIVES

1 The following river intake facilities are considered:

A. Bankside river intake structure (proposed)
B. Off-river intake structure on an open-ended approach canal
1 C. Perforated pipe intake with off-river pump structure
D. Infiltration bed intake with off-river pump structure Q 10.2.1

2 Q 10.2.1

In the process of considering alternative intake systems, six methods for screening fish and debris are considered and are as follows:

A. Vertical traveling screens (proposed)
B. Fixed screens
C. Revolving drum screens
1 D. Psychological screens Q 10.2.1
E. Perforated pipe
F. Infiltration bed

The first four screening systems are applicable to intake structures with integral screening devices.

10.2.2 ALTERNATIVE INTAKE SYSTEMS

2 #### 10.2.2.1 Bankside River Intake Structure (Proposed) Q 3.4.4

The proposed bankside structure incorporates the "best available technology" for conventional cooling water intake structures as proposed by the U. S. Environmental Protection Agency.[1] The structure is located on the outside of a curve in the Yadkin River at a point where the bank and channel consist mainly of rock. A reinforced concrete wall or similar structure located upstream and downstream of the intake form an artificial vertical bank and insures continuous flow past the face of the vertical traveling screens 3 which are set flush with the shoreline. These screens protect fish and other swimming organisms from harm by the intake pumps and at the same time prevent debris from entering the pump well and pumps. The 8 foot wide and 10 foot wide screens are sized for the 41 cfs makeup pumps and the 50 cfs radwaste dilution pumps, respectively, such that maximum screen approach velocity is less than 0.5 fps for all river flows above El. 632, the minimum river surface elevation. Trash and debris flushed from the screens will be collected for disposal in an approved landfill or disposed of by

other commercial means. Trash racks will be located approximately 5 feet in front of the traveling screens. These racks will provide protection for the traveling screens from large floating objects to an elevation of about 645 ft. Protection above this elevation will be provided by the high water concrete skimmer wall. Between the trash racks and the traveling screens is located a 3 foot wide fish bypass area. This area will have bar racks on the upstream side and will be open or have widely spaced bars on
3 the downstream side. Fish entering this area will be able to swim along the face of the screens and re-enter the river. The effect of the river current at the face of the traveling screens and the low approach valocity to these screens should provide minimal fish impingement. The concrete apron extending in front of the structure will insure river bed stability and will prevent excessive sediment buildup in front of the structure from deposition of river bed load. For a plan and section of the bankside river intake see figure 10.2.1-1. For location and additional details see figure
2 3.4.1-1. Q 10.2-1

1 10.2.2.2 Off-River Intake Structure on an Open-Ended Approach Canal Q 10.2.1

The river intake structure, located at the end of an intake canal, is similar to the proposed bankside structure. A submerged weir and training wall is located at the canal entrance, and the intake structure is equipped with trash racks and traveling screens to handle debris as with the proposed
1 system. The submerged weir is necessary to route stream bed load by the structure. Use of the approach canal without the weir would result in extreme silting of the canal. Q 10.2.1 The velocity in the seven hundred foot long canal is less than .5 fps and will allow most fish that swim in to also swim out. The canal will allow some silt to settle before it reaches the intake structure and will require periodic silt removal during operation. By use of the canal, the intake structure is located closer to the plant yard resulting in better protection from flood waters, shorter piping system, lower pumping cost, improved construction conditions and easier access. For location and details see Figures 10.2.1-2 and 10.2.1-3.

10.2.2.3 Perforated Pipe Intake With Off- River Pump Structure

The perforated pipe intake with off-river pump structure consists of a perforated pipe intake located in the river channel, piping to a pump structure, the pump structure, and the intake water pumps including piping for backwashing the perforated pipe. The currents of the river carry both fish and debris past the openings in the perforated pipe. Inlet velocities of less than .5 fps assure sufficient protection for all fish against impingement on the pipes. Stability for the channel in this area is provided by a thick concrete mat which anchors the pipes in the river. This concrete mat is anchored into the rock underlying the river bed. Protection from floodwater debris loading is given by stiffened and streamlined pipe heads.
1 Seven, three foot diameter steel pipes carry water to the pumping structure. Q 10.2.1 These pipes are fully encased in concrete in the river channel. The concrete pumping structure supports the intake pumps and is located approximately 150 feet from the water's edge. The frequency of backwashing the perforated pipes is determined by head loss due to debris loading. The location is at the same point of the river as the proposed intake system, see Section 3. For details see Figure 10.2.1-4.

10.2.2.4 Infiltration Bed Intake With Off-River Pump Structure

The infiltration bed intake with off-river pump structure consists of an infiltration bed, piping to the pump structure, the pump structure, and the intake water pumps including piping for backwashing the infiltration bed. Negligible intake velocities assure no impingement of free swimming organisms. Backwashing of the bed forces entrapped sediment and debris up
1 into the river current, allowing it to continue downstream. Water from Q 10.2.1
numerous smaller perforated pipes in the bed is collected into seven, three foot diameter steel pipes. These pipes carry the water to the pumping structure. These pipes are fully encased in concrete in the river channel. The concrete pumping structure supports the intake pumps and is located approximately 150 feet from the water's edge. The frequency of backwashing the perforated pipes is determined by head loss due to debris loading. The location is at the same point of the river as the proposed intake system, see Section 3. For details see Figure 10.2.1-5.

10.2.3 SCREENING ALTERNATIVES

10.2.3.1 Vertical Traveling Screens (Proposed)

The screen is an endless belt of 3/8 inch mesh panels which travel vertically to pass the panels through a backwash jet spray for cleaning. The debris is washed into a trough and collected at one end of the structure. The collected debris will be transported away from the structure for appropriate disposal. The mesh is sized by the maximum particle size which can be tolerated through the system and by the size of the smallest fish to be protected.

10.2.3.2 Fixed Screens

This system is practicable only where suspended debris is negligible, so that cleaning requirements are minimal. When the screen is lifted out for spray cleaning, a backup screen must be dropped into place just behind the screen raised for cleaning.

10.2.3.3 Revolving Drum Screens

The normal operation of this system prevents fish from entering the system but discharges debris into the downstream flow.

10.2.3.4 Psychological Screens

These systems, such as electrically charged screens, air bubble screens, sound screen, and light screens, aid somewhat in diverting fish away from the intake but do not prevent debris from entering the structure.

10.2.3.5 Perforated Pipe

This system consists of perforated pipe placed in the river channel and oriented in such a manner that the passing current will sweep debris and most
2 1 suspended solids downstream. Approximately 25 percent of the pipe area is Q 10.2.1
utilized for intake of water. Debris larger than the 3/8 inch wide inlet slots are excluded from the pipe.

10.2.3.6 Infiltration Bed

This system consists of perforated pipe embedded in a gravel bed beneath
2 1 the river bottom. The size of particle screened depends upon gradation Q
of the filter medium and pipe perforation size. Removal of trapped particles 10.2.1
is accomplished by backwashing the system and allowing the river flow to
carry particles downstream.

10.2.4 MONETIZED COST

The monetized cost of the proposed and the alternative systems are tabulated on an incremental basis in Table 10.2.4-1. These systems are compared on the basis of assuming a fixed amount of energy generated for distribution outside the plant. Since the operating costs of all systems are approximately equal, the effect on the plant capacity factor is the same. The various items and components used in determining the monetized cost of each system are as follows:

10.2.4.1 Bankside River Intake Structure

3 Costs of this system include the concrete apron river intake structure
including pumps and screens, piping to the Nuclear Service Water Pond and
to the Radwaste discharge line, access road, construction cofferdam, and
excavation.

1 10.2.4.2 Off-River Intake Structure on an Open-Ended Approach Canal

Costs of this system include the submerged weir, training wall, canal, intake structure including pumps and screens, piping to the Nuclear Service Water Pond and to the Radwaste discharge line, access road, periodic silt removal operation, and cofferdams for canal entrance facilities.

10.2.4.3 Perforated Pipe Intake With Off-River Pump Structure

Costs of this system include perforated pipe, concrete foundation, piping to
pump structure, the pumping structure including pumps and backwash piping,
piping to the Nuclear Service Water Pond and to the Radwaste discharge line,
1 access road and construction cofferdam. Q 10.2.1

10.2.4.4 Infiltration Bed Intake With Off-River Pump Structure

Costs of this system include washed crushed stone, perforated pipe and headers, piping to the pump structure, the pumping structure including pumps and backwash piping, piping to the Nuclear Service Water Pond and to the Radwaste discharge line, access road, and construction cofferdam.

10.2.5 ENVIRONMENTAL EFFECTS

This subsection discusses the estimates of environmental effects associated
1 with the intake systems. These effects are summarized in Table 10.2.4-1.

10.2.5.1 Natural Surface Water Body

Fish Entrapment

The bankside river intake structure incorporates several ideas intended to reduce environmental damage due to fish entrapment or impingement. Its location on the outside of a curve in a rocky river channel insures river channel stability and sweeping currents past the structure. Location of the traveling screens flush with the shoreline and provisions for a fish bypass area directly in front of these screens enable fish to escape the low screen approach velocity of 0.5 fps or less and easily return to the river. For these reasons the bankside structure will have negligible effect on fish
3 entrapment or impingement.

The alternative off-river intake structure incorporates a submerged weir and training wall which directs the river stream away from the intake waterway. This device should aid in carrying fish past the entrance. Most fish that enter the canal will be able to swim against its current of less than 0.5 fps and re-enter the flow of the river just as they would at any other inlet on the river. The intake structure has an inlet velocity of less than 0.5 fps and also has bar racks to help keep larger fish and debris out. The traveling screens keep all but the smallest fish from entering the pump well.

The alternate perforated pipe intake with off-river pump structure utilizes river currents to sweep fish past the slotted openings in the pipe. With an inlet velocity of less than .5 fps no problem with fish entrapment is foreseen. Q 10.2.1

The alternate infiltration bed intake with off-river pump structure utilizes low inlet velocities during intake of river water. Due to these low velocities no problem is foreseen with fish entrapment.

Entrainment of Plankton

The first three alternatives will entrain approximately the same number of plankton. The infiltration bed intake will provide some limited protection to planktonic and benthos organisms. The exact degree of protection is dependent on filter gradation. See sections 2.7 and 5.11 for additional information concerning plankton entrainment.

1 River Turbidity Q 10.2.1

The first two alternatives cause no increase in river water turbidity during plant operation. Due to backwashing requirements, increased turbidity will occur for both the perforated pipe intake and infiltration bed intake. The perforated pipe backwash interval is expected to be infrequent with only some minor turbidity resulting. The infiltration bed backwash will be almost continuous with a marked increase in river turbidity below the site.

Construction

Bankside River Intake Structure

A cellular sheet pile cofferdam or similar structure will be
3 built out from the river bank so that the intake structure
is built in the dry with no adverse effect on the river water during construction. A major portion of the slope protection around the structure will be completed before the cofferdam is removed. No permanent or temporary adverse effects on the river are expected.

1 Off-River Intake Structure on an Open-Ended Approach Canal Q 10.2.1

Since the structure is connected to the river by the canal, it can be built in the dry with no effect on the river. Construction of the canal entrance facilities requires less temporary river protection than the proposed facility, since the canal can also be built in the dry before it is connected to the river channel. When the mouth of the canal is opened, the turbidity of the river will be slightly increased for only a short time with no permanent adverse effect on the river.

Perforated Pipe Intake With Off-River Pump Structure

A cellular sheet pile cofferdam or similar structure will be built out from the river bank so that the anchorage system, concrete mat, perforated pipe, and piping to the pump structure can be built in the dry with no adverse effect on the river water during construction. No temporary adverse effects on the river are expected.

1 Infiltration Bed Intake With Off-River Pump Structure Q 10.2.1

A cellular sheet pile cofferdam or similar structure will be built out from the river bank so that the perforated pipe, gravel filter, and piping to the pump structure can be built in the dry. Slightly less than one acre of the river bottom will be excavated approximately 6 feet deep for use as the filter bed. Due to the large cofferdam size for this alternate some additional scour of the river bottom is anticipated adjacent to the cofferdam. No permanent effects on the river are expected.

10.2.5.2 Land

Construction Activities

The effect of increased noise and movement of men, materials, and machines during construction of each alternative is essentially the same as that of construction of the remainder of the plant. This is discussed in Section 4.1.

Plant Operation

Any slight increase in the noise level by any alternative will be caused mainly by operation of makeup water pumps and is not expected to adversely affect the surrounding area.

10.2.6 CONCLUSION

All intake facilities are considered using factors previously discussed, operating experience at existing intake facilities, and river characteristics.

10.2.6.1 <u>Bankside River Intake Structure (Proposed)</u>

The bankside river intake structure incorporates the "best available technology"[1]
for the intake of river water. The facility requires approximately one acre
of land and disrupts less than one half acre of river bottom during construction.
It's location on the outside of a curve with traveling screens flush with the
shoreline, provisions for a fish bypass, and screen approach velocities
below 0.5 fps will keep impingement and entrapment at a minimum. River channel
stability is assured by the bankside location and rocky river bottom. The
3 concrete apron also helps to insure channel stability as well as minimize
sediment buildup in front of the structure from deposition of river bed
load. Long term operating experience with this type of intake facility
allows prediction of maintenance and operating characteristics. The
proposed intake structure represents a combination of objectives intended to
provide an economical and practical means of intaking river water and at the
same time minimal impact on the environment. Model tests will be performed
and structure configurations will be modified or refined to achieve these
1 objectives. The bankside river intake structure represents the best Q
combination of features designed to achieve the aforementioned functional and 10.2.1
environmental objectives and is therefore the proposed facility.

10.2.6.2 <u>Off River Intake Structure on an Open-Ended Approach Canal</u>

The off river intake structure on an open-ended approach canal has essentially the same environmental effects as the proposed alternative. The facility requires four acres of land and does not disrupt more than one half acre of river bottom during construction. Problems with silt are anticipated in the canal and periodic dredging operations are required. Possible problems with river channel stability and silt removal operations are the primary reasons for not proposing this system.

10.2.6.3 <u>Perforated Pipe Intake With Off-River Pump Structure</u>

The perforated pipe intake with off river pump structure provides negligible effects on fish and plankton. Turbidity of the river may increase slightly during backwash operations. The facility requires approximately one acre of land and disrupts less than one half acre of river bottom during construction. River currents should keep problems with silt to a minimum. Debris may cause some damage to the intake during flood conditions. The presence of the perforated pipe in the channel will cause localized stream flow alterations which may effect sediment distribution in the channel bottom. No effective means is available to inspect and repair the perforated pipe intake and no operating experience is available for prediction of such maintenance. Lack of operating experience, possible damage by debris, and lack of inspection and maintenance capability are the primary reasons for not proposing this system.

10.2.6.4 Infiltration Bed Intake With Off-River Pump Structure

The infiltration bed intake with off-river pump structure provides negligible Q 10.2.1
1 effects on fish and plankton. Heavy sediment load in the river will require frequent backwashing which will cause a significant increase in turbidity downstream of the intake. The facility requires one and one half acres of land for operation. Approximately one acre of this total is river bed. During construction approximately one and one half acres of river bottom are disrupted. Additional scour may also result from use of the large cofferdam. No operating experience is available with this system and no backwash system has been demonstrated which will effectively cleanse such an infiltration bed on a turbid river. Additional problems include possible scour of the bed by river currents. For the above reasons this system is not proposed.

10.3 DISCHARGE SYSTEMS

Q10.3.1

The proposed closed-cycle system employing cooling towers is the only feasible cooling system for the proposed site. Evaporation from the cooling towers discharges to the atmosphere. Blowdown from the cooling towers and radwaste dilution water are discharged to the Yadkin River. This discharge will meet the thermal and chemical requirements of state and federal regulations as discussed in Chapter 5. Figure 3.4.1-1 shows the location of the Blowdown and Radwaste Discharge Structure.

10.3.1 RANGE OF ALTERNATIVES

The following discharge systems are considered:

A. Bankside single port discharge system (proposed for cooling tower blowdown effluent)

B. Bankside multiple port discharge system (proposed for diluted radwaste effluent)

C. River bottom multiple port diffuser system

D. River bottom single port diffuser system.

10.3.2 ALTERNATIVE DISCHARGE SYSTEMS

10.3.2.1 Bankside Single Port Discharge System (Proposed for Cooling Tower Blowdown Effluent)

The bankside single port discharge system consists of a single pipe anchored through a concrete headwall and emptying into the river at or about the water surface of the river. The discharge pipe is sized for an effluent velocity of approximately 5 fps. The structure is located approximately 300 feet below the River Intake Structure to prevent recirculation of blowdown through the intake. The proposed discharge structure is shown in Figure 10.3.2-1.

10.3.2.2 Bankside Multiple Port Discharge System (Proposed for Diluted Radwaste Effluent)

The bankside multiple port discharge system consists of three pipes anchored through a concrete headwall and emptying into the river at or about the water surface of the river. The varied entrance angles of the pipes assure proper mixing of the discharge with the river. The discharge pipes are sized for an effluent velocity of approximately 7 fps. The structure is located approximately 300 feet below the River Intake Structure to prevent any recirculation through the river intake. See Figure 10.3.2-1 for details of the proposed discharge structure.

10.3.2.3 River Bottom Multiple Port Diffuser

The river bottom multiple port diffuser system consists of a discharge pipe

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located on the river bottom with exit nozzles designed to produce even equal velocity flows during discharge of liquid waste materials. The location of the discharge perpendicular to the direction of flow and downstream of the River Intake Structure assures positive mixing of the discharge with the river.

10.3.2.4 River Bottom Single Port Diffuser System

The river bottom single port diffuser consists of a single exit pipe anchored to the river bottom. Discharge will be perpendicular to river flow.

10.3.3 ENVIRONMENTAL EFFECTS

This subsection discusses the estimates of environmental effects associated with the discharge systems.

10.3.3.1 Natural Surface Water Body

Fish Migration

The discharge of both the blowdown and radwaste systems empties into the river through a bankside structure at the edge of the river channel. The systems are, therefore, not expected to hamper fish migration.

Construction

The construction methods for each of the alternative discharge systems are approximately the same. Sheet pile cofferdams or similar type structures will be built out from the river bank so the discharge structure can be built in the dry with no adverse effect on the river water during construction. A major portion of the slope protection around the structure will be completed before the cofferdam is removed. No permanent or temporary adverse effects on the river are expected.

River Bed Scour

Preliminary studies of the discharge area indicate that scouring will not be a problem to the rocky river bottom. If further studies in the area indicate that such is not the case, the bottom will be stabilized to prevent detrimental scouring by the use of concrete or rock riprap.

10.3.3.2 Land

Construction Activities

The effect of increased noise and movement of men, materials, and machines during construction is essentially the same as that of construction of the remainder of the plant. This is discussed in Section 4.1.

Plant Operation

No increase in noise level is expected from either discharge structure.

10.3.4 CONCLUSION

All discharge systems are considered using factors previously discussed, mixing requirements and river characteristics.

10.3.4.1 Bankside Single Port Discharge System (Proposed for Cooling Tower Blowdown Effluent)

The bankside single port discharge will provide negligible effects on the river and the surrounding environment. The economics and the simplicity of the bankside structure with its adequate dispersion pattern (Section 5.1.2.1) lend themselves favorably to a blowdown discharge application. The large volume of diluted radwaste discharge makes the single port discharge structure unfavorable for radwaste application. Construction of the bankside structure will require less than one-tenth acre of river bottom. For these reasons, a bankside single port discharge is proposed for cooling tower blowdown effluent.

10.3.4.2 Bankside Multiple Port Discharge System (Proposed for Diluted Radwaste Effluent)

The bankside multiple port discharge structure provides negligible effects on the river and the surrounding environment. Construction of the bankside structure is more economical and requires less cofferdamming than a river bottom structure. The structure will be essentially maintenance free since siltation and floating debris are not expected to be a problem at the bankside location. Construction of the structure will require less than one-tenth acre of river bottom. The required mixing of the radwaste discharge dictates the use of a multi-port system. For these reasons, the bankside multi-port discharge system is proposed for the diluted radwaste effluent.

10.3.4.3 River Bottom Multiple Port Diffuser

The river bottom multiple port diffuser will aoomplish a similar degree of mixing as a bankside multiple port diffuser. The river bottom structure, however, is not as economical to construct and will require much more cofferdamming than the bankside structure. Construction of the river bottom structure will disrupt one-half acre of river bottom. Siltation and floating debris could create maintenance problems. For these reasons, this river bottom system is not proposed.

10.3.4.4 River Bottom Single Port Diffuser

The river bottom single port diffuser provides negligible effects on the river and the surrounding environment. Its capabilities for mixing are approximately equal to the bankside single port discharge. The bankside structure is easier and more economical to construct, requiring less cofferdamming and disrupting less river bottom. Therefore the single port river bottom diffuser is not proposed.

10.4 CHEMICAL WASTE TREATMENT

The proposed water use plans and resulting chemical discharges are discussed in Sections 3.3 and 3.6. Effects of these discharges are discussed in Section 5.4. The applicant believes that the proposed treatment methods are sufficient to insure protection of the environment, but is aware that discharge limitations promulgated under the authority of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) may require different levels of treatment. Alternative chemical waste treatment systems are presently being studied. Possible alternatives include:

A. Flocculation and Filtration. This process could be used to remove suspended solids from the Waste Water Treatment System effluent and the cooling tower blowdown. Chemical additions would form a sludge which would settle out and be reduced to a filter cake for dry disposal by landfill. The remaining dissolved solids concentration would make the effluent unsuitable for make-up so it would still be discharged. The net effect of the process would be to reduce suspended solids but increase dissolved solids in the station discharges.

3

B. Reverse Osmosis, Demineralization and Evaporation. A system using these processes could be designed to take the effluent from Alternative A and produce a recyclable make-up water and concentrated waste for landfill disposal. Make-up requirements for the station would be reduced essentially to the quantity required to replace evaporative losses. The technological ability to combine these processes into a reliable power station system has not yet been demonstrated. Serious problems in solid waste disposal of the concentrate must also be considered.

Capital and operating costs of these alternatives are not currently available, but Alternative B would obviously be extremely expensive when the size of the waste stream is considered (6.5 MGD, average for cooling tower blowdown plus Waste Water Treatment System discharge). Alternatives A and B would also be costly, and would provide little environmental advantage. Since the discharges released under the proposed system will produce no significant adverse environmental effects, more elaborate treatment systems cannot be justified.

10.5 BIOCIDE TREATMENT

10.5.1 EFFECTS OF CONDENSER TUBE CLEANING

In cooling tower systems approximately 1% of the water evaporates for each 10°F cooling in the remaining water. As water vapor and dissolved carbon dioxide pass from the liquid phase into the vapor phase of the cooling tower plume, calcium carbonate alkalinity increases in the liquid phase. The Langelier Index of calcium carbonate stability shifts towards deposition of calcium carbonate scale in areas of heat transfer such as condenser tubes unless corrective treatments are employed. These scale deposits are porous. They harbor microorganisms and protect the growth from the action of biocides until the scale is cleaned away.

Mechanical cleaning of condenser tubes is discussed in Subdivision 3.6.1.1. Continuous cleaning exposes microorganisms to biocides. It optimizes control with smaller amounts and less frequent use of biocides, thus causing a smaller ecological impact.

Without mechanical cleaning of condenser tubes, deposits form in tubes.
Deposits shelter microorganisms. Growth at exponential rates increase a mass
of zoogleal slime that decreases the concentration of dissolved oxygen in
2 moisture beneath the deposit. Concentration cell corrosion increases. As
deposits grow in condenser tubes heat transfer decreases, the heat rate of the
unit increases, and the cost of power production increases.

Without continuous mechanical cleaning of condensers, tube deposits are removed manually when the equipment is shut down. Manual cleaning methods incur extended outages and fixed capital cost factors that increase the unit cost of power.

Without continuous mechanical cleaning of condenser tubes, the concentration and frequency of biocidal treatments have to be increased. The negative ecological impact of discharging more biocidal waste is larger.

10.5.2 BIOCIDE ALTERNATIVES

10.5.2.1 Non-oxidizing Biocides

Compounds of mercury, copper, and chlorophenols could not be considered for biocidal use in cooling systems because of adverse environmental effects. Among the broad range non-oxidizing microbiocides that could be used as alternates to the use of chlorine, Duke considered the following materials.

Acrolein
Organo-metallic-quaternary mixtures
Phenate blends
Methylene bis-thiocyanates with sulfones
Amine-phenol mixtures
Quaternary amine-organo tin mixtures
Dodecylguanidine salts.

Of these choices, the salts of dodecylguanidive hydrochloride are favored because of these characteristics:

1. Usage in the paper industry and in power plant cooling tower systems provides a record of satisfactory broad range performance at moderate rates of usage.

2. Effective up to pH 10.

3. Biodegradable by bacteria common to soils and to river mud.

10.5.2.2 Oxidizing Biocides

Among oxidizing bioicides considered, ozone is of interest because it can be generated on site electrically.

Ozone can break down refractory organic wastes that have resisted treatment in biological waste treatment plants upstream. Ozone can decrease the concentration of BOD, COD, cyanides, phenols, color and odor in water. Ozone destroys bacterial and viral organisms more rapidly than chlorine does. Ozone does not form chlorinated compounds that may be more toxic than the compound was before chlorination. Ozone can increase dissolved oxygen in water.

Chlorination is the biocidal treatment of choice because of a well established technology for safe and efficient use, for biological effectiveness, and for favorable cost. Chlorination may be accomplished by the use of chlorine gas or sodium hypochlorite.

Gaseous chlorine forms both hypochlorous acid, the biocidally effective compound, and hydrochloric acid when the gas dissolves in water. In cooling tower chlorination with gas the hydrochloric acid serves two valuable functions by neutralizing alkalinity and lowering the pH of the cooling water.

1. The speed of the biocidal action of chlorine is enhanced at the lower pH which favors ionization of hypochlorous acid. Alkali hypochlorites predominate at higher pH ranges and are less effective as biocides.

2. The Langelier Index shifts away from the scale forming range. Sulfuric acid is widely used in cooling tower water treatment to adjust the Langelier Index. Hydrcchloric acid replaces an equivalent amount of the ecologically less desirable sulfuric acid when chlorine gas is used to treat cooling water.

Cooling tower chlorination equipment can be placed on the opposite side of the towers away from the station in areas that are 1500 to 2000 feet from the station. The probability of gas leaking and affecting station functions are remote.

To eliminate the remote danger of gas leakage, the applicant proposes to use sodium hypochlorite solution generated in electrolytic cells on site. Accumulator tanks will store NaOCl solution between daily intermittent treatments. Waste water discharges shown in Table 3.6.2-1 include the effects of using sulfuric acid required by substituting alkaline NaOCl solution in place of the acidic solution of gas in water.

Sodium hypochlorite solution is the form in which biocidal chlorine will be used. Salts of dodecylguanidine hydrochloride are the preferred alternate biocide. Other biocides will continue to be evaluated.

10.6 SANITARY WASTE SYSTEM

An alternate system for the temporary treatment system used during construction is the use of sand filters instead of prefabricated extended areation type sewage treatment plants. Sand filters will not be used for the construction period as they require much more land area for the high flow rate given in Section 3.7.

4 An alternate system for the permanent treatment system used after construction is sewage lagoons, where waste water will be disposed of by evaporation. The evaporation rate for this area is expected to be 46 in. per year. If the evaporation rate cannot meet the demand, other means of disposal must be provided.

10.7 LIQUID RADWASTE SYSTEMS

Design objectives and technical specifications are in accordance with "as low as practical" requirement of 10CFR20 and 10CFR50. Since these conditions are met, no further consideration was given to the reduction of radiological impacts by formulating alternative plant designs. All releases from liquid radwaste systems require deliberate operator action.

10.8 GASEOUS RADWASTE SYSTEMS

Design objectives and technical specifications are in accordance with "as low as practical" requirement of 10CFR20 and 10CFR50. Since these conditions are met, no further consideration was given to the reduction of radiological impacts by formulating alternative plant designs.

10.9 TRANSMISSION FACILITIES

All logical line routes are studied as to their possible impact on the scenic, recreational, and historical features of the area surrounding Perkins Nuclear Station.

It is determined that the selected routes are least detrimental to these features and are both economically and environmentally acceptable.

2 The alternative transmission routes are shown on the map in Figures 3.9.1-1 and 3.9.1-2. Q3.9.5

Two routes are considered for the Marshall to Beckerdite 230 kV fold-in. The route running along Dutchman's Creek is rejected because of its longer length which would require more land in the right of way.

Both routes considered for the Winecoff to Beckerdite 230 kV fold-in avoid the Cooleemee Plantation, located off of Highway 64 in Davie County, but one route is rejected on the grounds of its possible visual impact on the town of Tyro, N. C.

The alternate McGuire to Pleasant Garden 525 kV fold-in is rejected because of three river crossings, two of which are in a designated natural and scenic area. Also, the route passes near Boone's Cave State Park located in Davidson
2 County. (See Figure 10.9.0-1.) Q3.9.1

The estimated line cost of each line and its alternative are as follows:

	Selected*	Alternative*
Marshall-Beckerdite Fold-In		
1974 Cost	$ 4,798,666	$ 4,712,883
1981 Cost	$ 7,485,919	$ 7,352,097
Winecoff-Beckerdite Fold-In		
1974 Cost	$ 7,102,952	$ 7,611,621
1981 Cost	$11,080,605	$11,874,129
McGuire-Pleasant Garden Fold-In		
1974 Cost	$ 4,339,631	$ 3,616,360
2 1986 Cost	$ 8,505,677	$ 7,088,066

*Estimated line cost includes rebuilding of existing transmission lines but does not include transformers, switchgear, etc.

Tables 10.9.0-1 and 10.9.0-2 show the environmental comparisons of the transmission lines and their alternates. Table 10.9.0-1 starts with number 4.5 because it was prepared in accordance with Table 4 (Basic Tabulation to be Used in Comparing Alternative Plant Systems pages 4.2-58 to 4.2-61) of the AEC Regulatory Guide 4.2 - Preparation of Environmental Reports for Nuclear Power Plants. On page 4.2-61 of the AEC guide, Table 4 deals with transmission lines from section 4.5 to 4.7 Table 10.9.0-1 is prepared based on the numbers in Table 4. Q10.9.1 Q10.9.2

The columns labeled Alternative A in Tables 10.9.0-1 and 10.9.0-2 represent the selected transmission corridors. Q10.9. Q10.9.

The dash marks in Table 10.9.0-1 indicate that the information desired could not be calculated or did not apply to Duke Power's right-of-way policies. The zeros indicate that no plant or animal species would become rare or endangered or be significantly affected by the construction and operation of the transmission lines. Parts of Table 10.9.0-1 are discussed in the sections of the Perkins Environmental Report dealing with transmission facilities. Table 10.9.0-1 itself was prepared in accordance with Table 4 of the AEC Regulatory Guide 4.2 and is used to compare the selected and alternative transmission routes described in Section 10.9. Q10.9.

10.10 OTHER SYSTEMS

Other plant systems which have an associated adverse environmental impact include the emergency diesel engines, auxiliary steam boilers and miscellaneous solid wastes.

Perkins Nuclear Station maintains six diesel engines for emergency use during outside power loss. The engines are required for safety reasons and are not expected to be used during normal station operation except for routine testing.

An oil fired auxiliary steam boiler is used to supply steam for plant operations when steam is not available by extraction from the turbine. The auxiliary boilers are used for initial station startup and during station shutdown. The boiler is supplied with low sulphur distillate oil to meet North Carolina emission standards for control of gaseous sulphur dioxide emissions.

Trash from the plant, including solid, non-radioactive chemical waste, is disposed of offsite in disposal areas meeting local and state requirements.

No other system alternatives are identified which have significant adverse environmental impact.

ER Table 10.1.0-1
(Revised 8-14-74)
Perkins Nuclear Station
Cost Comparison - Cooling System Alternatives[1]

	Circular Mech. Draft (Proposed)	Rectangular Mech. Draft	Natural Draft
Cooling Towers[2]	22,859,000	26,733,000	31,422,000
Fan Motors and Switchgear	3,261,000	3,606,000	---
CCW Pumps	3,540,000	3,540,000	3,540,000
CCW Pump Motors	2,762,000	2,762,000	2,762,000
Piping	14,821,000	21,342,000	13,640,000
Penalties[3]	32,813,000	32,664,000	33,361,000
Total	$80,056,000	$90,647,000	$84,725,000

1 Estimated cost in 1981 dollars.

2 Includes Cooling Tower, precast concrete, erection, and basin.

3 Includes capacity lost from fans, pumps, back-pressure, and energy losses from the same. See Table 10.1.0-3 for explanation of penalties used.

ER Table 10.1.0-2
Perkins Nuclear Station
Cooling System Alternatives

Alternatives	Units	A Proposed	B Rectangular Mechancial Draft Cooling Tower	C Natural Draft Cooling Tower
Incremental Cost (See Table 10.1.0-1)		Base	+ $10,591,000	+ $4,669,000
Capacity Factor		76%	76%	76%
Reference Section		10.1.1	10.1.2	10.1.3
Environmental Costs	Units	Magnitude	Magnitude	Magnitude
1. Natural Surface Water Body				
1.1 Impingement or entrapment by cooling water intake structure				
1.1.1 Fish		None	Same as Proposed	Same as Proposed
1.2 Passage through or retention in cooling system				
2 1.2.1 Phytoplankton	Numbers Per Day	10^{14}	Same as Proposed	Same as Proposed
Zooplankton	Numbers Per Day	10^{8}		
1.2.2 Fish - adults		unknown	Same as Proposed	Same as Proposed
ichthyoplankton		unknown		
1.3 Discharge area and thermal plume				
1.3.1 Water quality, excess heat, winter conditions	isotherms, acres, acre-feet	2F 1.3 1.5 3F 1.0 1.2 5F 0.5 0.5	Same as Proposed	2F 1.7 3.2 3F 1.4 2.6 5F 0.8 0.83
1.3.2 Water quality, oxygen availability	acre-feet <5 mg/l	None	Same as Proposed	Same as Proposed

Environmental Costs	Units	A Magnitude	B Magnitude	C Magnitude
1.3.3 Fish (Non-migratory)	lb/yr	unknown	Same as Proposed	Same as Proposed
1.3.4 Fish (migratory)		None present	Same as Proposed	Same as Proposed
1.3.5 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)		unknown	Same as Proposed	Same as Proposed
1.4 Chemical effluents				
1.4.1 Water quality, chemical	cfs for dilution to level not lethal to fish	Discharge concentration not lethal to fish	Same as Proposed	Same as Proposed
1.4.2 Aquatic organisms		No adverse effect	Same as Proposed	Same as Proposed
1.4.3 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)		No adverse effect	Same as Proposed	Same as Proposed
1.4.4 People	Lost user days	0	Same as Proposed	Same as Proposed
1.5 N.A.				
1.6 Consumptive use (average evaporative losses)				
1.6.1 People	gal/min gal/yr % of annual flow	36,810 1.7×10^{10} 2.8	Same as Proposed	Same as Proposed

ER Table 10.1.0-2
Perkins Nuclear Station
Cooling System Alternatives

Environmental Costs	Units	A Magnitude	B Magnitude	C Magnitude
1.6.2 Agriculture		No adverse effect	Same as Proposed	Same as Proposed
1.6.3 Industry		No adverse effect	Same as Proposed	Same as Proposed
1.7 Plant construction (including site preparation)				
1.7.1 Water quality, physical		Increased turbidity - not quantified	Same as Proposed	Same as Proposed
1.7.2 Water quality, chemical		No adverse effect	Same as Proposed	Same as Proposed
1.8 Other impacts		None	Same as Proposed	Same as Proposed
1.9 Combined or interactive effects		None	Same as Proposed	Same as Proposed
1.10 Net effects		None	Same as Proposed	Same as Proposed
2. Groundwater				
2.1 Raising/lowering of ground water levels				
2.1.1 People		No adverse effect	Same as Proposed	Same as Proposed
2.1.2 Plants		No adverse effect	Same as Proposed	Same as Proposed

ER Table 10.1.0-2
Perkins Nuclear Station
Cooling System Alternatives

Environmental Costs	Units	A Magnitude	B Magnitude	C Magnitude
2.2 Chemical contamination of ground water (excluding salt)				
2.2.1 People		No adverse effect	Same as Proposed	Same as Proposed
2.2.2 Plants		No adverse effect	Same as Proposed	Same as Proposed
2.3 Radionuclide contamination of ground water				
2.3.1 People		No effect	Same as Proposed	Same as Proposed
2.3.2 Plants and animals		No effect	Same as Proposed	Same as Proposed
2.4 Other impacts on ground water		None	Same as Proposed	Same as Proposed
3. Air				
3.1 Fogging and icing (caused by evaporation and drift)				
3.1.1 Ground transportation		No adverse effect offsite	Same as Proposed	Same as Proposed
3.1.2 Air transportation		No adverse effect	Same as Proposed	Same as Proposed
3.1.3 Water transportation		No effect	Same as Proposed	Same as Proposed
3.1.4 Plants		No adverse effect	Same as Proposed	Same as Proposed

ER Table 10.1.0-2
Perkins Nuclear Station
Cooling System Alternatives

Environmental Costs	Units	A Magnitude	B Magnitude	C Magnitude
3.2 Chemical discharge to ambient air				
3.2.1 Air quality, chemical		No chemical discharge other than salt	Same as Proposed	Same as Proposed
3.2.2 Air quality, odor		No odors	Same as Proposed	Same as Proposed
3.3 Not Applicable				
3.4 Other impacts on air		None	Same as Proposed	Same as Proposed
4. Land				
4.1 Site selection				
4.1.1 Land, amount for cooling system	Acres			
	Forest	57	93	52
	Open pasture and farmland	41	68	38
	Other uses (roads, transmission lines, etc)	5	8	5
4.2 Construction activities (including site preparation)				
4.2.1 People (amenities)		Insignificant compared to overall construction	Same as Proposed	Same as Proposed

Environmental Costs	Units	A Magnitude	B Magnitude	C Magnitude
4.2.2 People (accessibility of historical sites)		No adverse effects	Same as Proposed	Same as Proposed
4.2.3 People (accessibility of archeological sites)		No adverse effects	Same as Proposed	Same as Proposed
4.2.5 Land (erosion) due to cooling system construction	Potential area in acres	103	169	95
4.3 Plant operation				
4.3.1 People (amenities)	Maximum decibels at 250 ft. from Cooling Towers	65-84 depending on frequency	65-84 depending on frequency	Less than proposed system
4.3.2 People (aesthetics)		Plumes will be visible	Same as Proposed	Plumes will be visible and large towers will be visible
4.3.3 Wildlife	Birds displaced	unknown	Same as Proposed	Same as Proposed
	Mammals displaced	unknown	Same as Proposed	Same as Proposed
4.3.4 Land, flooding		None	None	None
4.4 Salts discharged from cooling towers				
4.4.1 People	Max deposition - site boundary lb/acre-mo	10	Similar to proposed system	Less than from proposed system
		No adverse effect	No adverse effect	No adverse effect
4.4.2 Plants and animals		unknown	unknown	unknown
4.4.3 Property resource		No adverse effects	Same as Proposed	Same as Proposed

ER Table 10.1.0-3
(Revised 8-14-74)
Perkins Nuclear Station
Estimated Capacity and Energy Penalties for Each Cooling System

	Penalty Factor	Circular M.D. Cooling Towers kw	Circular M.D. Cooling Towers $x1000	Rectangular M.D. Cooling Towers kw	Rectangular M.D. Cooling Towers $x1000	Natural Draft Cooling Towers kw	Natural Draft Cooling Towers $x1000
Capacity Penalties							
Fans	$361.60/kw[a]	19,456	7,035	21,515	7,780	---	---
Pumps	$361.60/kw[a]	25,235	9,125	22,957	8,301	21,435	7,751
Back Pressure	$282.60/kw[b]	39,816	11,252	39,816	11,252	76,003	21,478
	$ 75/kw[c]	4,197	315	4,197	315	10,125	759
Energy Penalties							
Fans	$ 93/kw[d]	19,456	1,809	21,515	2,001	---	---
Pumps	$ 115/kw[e]	25,235	2,902	22,957	2,640	21,435	2,465
Back Pressure	$36,750/BTU/KWH[f]	10.2/BTU/KWH	375	10.2/BTU/KWH	375	24.7BTU/KWH	908
Total			32,813		32,664		33,361

Notes:

[a] Cost of lost capacity at capital cost of Perkins Station.

[b] Cost of lost capacity at capital cost of a base load fossil plant.

[c] Cost of lost capacity at 50% of combustion turbines per kw.

[d] Fuel and powerhouse operation, insurance and maintenance costs of $115 per kw at 67% fan use. Includes cooling tower operation and maintenance at 25% of fuel costs.

[e] Fuel and powerhouse operation, insurance and maintenance costs.

[f] Capitalized value for increase in heat rate of 1 BTU/KWH.

ER Table 10.2.4-1
Perkins Nuclear Station
Comparison of Intake Systems

ALTERNATIVE SYSTEMS		PROPOSED	OFF-RIVER	PERF. PIPE	INFILTRATION
Incremental Capital Costs	Present Worth	0	$116,446	$ 91,170	$330,170
Environmental Costs	Units	Magnitude	Magnitude	Magnitude	Magnitude
1. Natural Surface Water Body					
a) Fish Impingement	% Population	Negligible	Negligible	Negligible	Negligible
b) Entrainment of Various Life Stages of Fish	% Population	Negligible	Negligible	Negligible	Negligible
c) Entrainment of Plankton	% Population	Negligible	Negligible	Negligible	Negligible
d) Discharge Temperatures	Degrees (F)	Not Applicable	Not Applicable	Not Applicable	Not Applicable
2. Land					
a) Construction					
1) River Bottom Disrupted	Acres	0.5	0.5	0.5	1.5
2) Total Acreage Required	Acres	1	4	1	1.5
b) Construction Activities	--	Not Significant	Not Significant	Not Significant	Not Significant
c) Plant Operation	--	Not Significant	Not Significant	Not Significant	Not Significant

ER Table 10.9.0-1 (Sheet 1 of 3)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Plant Systems

			Marshall-Beckerdite Alternative A		Marshall-Beckerdite Alternative B	
		Units	Magnitude	Page	Magnitude	Page
	4.5 Transmission Route Selection					
	4.5.1 Land, Amount	Miles	2.7		3.5	
		Acres	87.4		115.2	
2		Current Market Value	949.33		992.56	
	4.5.2 Land Use and Land Value	Miles	1.4		1.8	
		Acres	45.2		59.8	
		$	0		0	
	4.5.3 People (Aesthetics)					
	Major Road Crossings	Number	1		1	
	Major Water Crossings	Number	0		0	
	Crest, Ridge Crossings	Number	1		1	
	Long Views	Number	1		1	
	4.6 Transmission Facilities Construction					
2	4.6.1 Land Adjacent to Right of Way	Miles	2.7		3.5	
	4.6.2 Land Erosion	Tons/Acre/Yr.	-		-	
	4.6.3 Wildlife	Number	0		0	
	4.6.4 Flora	Number	0		0	
	4.7 Transmission Line Operation					
	4.7.1 Land Use	%	0		0	
		$	-		-	
	4.7.2 Wildlife	Qualified Opinion	See Attachment 1			

ER Table 10.9.0-1 (Sheet 2 of 3)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Plant Systems

		Winecoff-Beckerdite			
		Alternative A		Alternative B	
	Units	Magnitude	Page	Magnitude	Page
4.5 Transmission Route Selection					
4.5.1 Land, Amount	Miles	5.5		6.3	
	Acres	181.3		205.8	
2	Current Market Value	611.11		665.13	
4.5.2 Land Use and Land Value	Miles	3.1		3.3	
	Acres	102.7		109.3	
	$	0		0	
4.5.3 People (Aesthetics)					
Major Road Crossings	Number	0		1	
Major Water Crossings	Number	1		1	
Crest, Ridge Crossings	Number	0		0	
Long Views	Number	0		0	
4.6 Transmission Facilities Construction					
2 4.6.1 Land Adjacent to Right of Way	Miles	5.5		6.3	
4.6.2 Land Erosion	Tons/Acre/Yr.	-		-	
4.6.3 Wildlife	Number	0		0	
4.6.4 Flora	Number	0		0	
4.7 Transmission Line Operation					
4.7.1 Land Use	%	0		0	
	$	-		-	
4.7.2 Wildlife	Qualified Opinion	See Attachment 1			

ER Table 10.9.0-1 (Sheet 3 of 3)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Plant Systems

	Units	McGuire-Pleasant Garden Alternative A Magnitude	Alternative A Page	Alternative B Magnitude	Alternative B Page
4.5 Transmission Route Selection					
4.5.1 Land, Amount	Miles	7.9		7.8	
	Acres	362.0		357.4	
2	Current Market Value	611.81		600.97	
4.5.2 Land Use and Land Value	Miles	5.8		5.9	
	Acres	267.4		272.1	
	$	0		0	
4.5.3 People (Aesthetics)					
Major Road Crossings	Number	0		0	
Major Water Crossings	Number	1		3	
Crest, Ridge Crossings	Number	0		2	
Long Views	Number	2		3	
4.6 Transmission Facilities Construction					
2 4.6.1 Land Adjacent to Right of Way	Miles	7.9		7.8	
4.6.2 Land Erosion	Tons/Acre/Yr.	-		-	
4.6.3 Wildlife	Number	0		0	
4.6.4 Flora	Number	0		0	
4.7 Transmission Line Operation					
4.7.1 Land Use	%	0		0	
	$	-		-	
4.7.2 Wildlife	Qualified Opinion	See Attachment 1			

ER Table 10.9.0-2 (Sheet 1 of 9)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Transmission Systems

		Marshall-Beckerdite			
		Alternative A		Alternative B	
	Units	Magnitude	Page	Magnitude	Page
		70%		70%	
1. Land Use (Rank alternative routes in terms of amount of conflict with present and planned land use.)	Number	0		0	
2. Property Values (Rank alternative routes in terms of total loss in property values.)	$	0		0	
3. Multiple Use (Rank alternative routes in terms of envisioned multiple use of land preempted by rights of way.)	Number	5		5	
2 4. Length of New Rights of Way Required	Miles	2.7		3.5	
5. Number and Length of New Access and Service Roads Required	Miles (temporary)	2.7		3.5	
6. Number of Major Road Crossings in Vicinity of Intersection or Interchanges	Number	0		0	
7. Number of Major Waterway and Railroad Crossings	Number	0		0	
8. Number of Crest, Ridge, or Other High Point Crossings	Number	1		1	
9. Number of "Long Views" or Transmission Lines Perpendicular to Highways and Waterways	Number	1		1	

ER Table 10.9.0-2 (Sheet 2 of 9)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Transmission Routes

		Units	Marshall-Beckerdite Alternative A Magnitude 70%	Alternative A Page	Marshall-Beckerdite Alternative B Magnitude 70%	Alternative B Page	
	10. Length of Above Transmission Line in or through the Following Visually Sensitive Areas						
	10.1 Natural Water Body Shoreline	Miles	0		0		
	10.2 Marshland	Miles	0		0		
	10.3 Wildlife Refuges	Miles	0		0		
	10.4 Parks	Miles	0		0		
	10.5 National and State Monuments	Miles	0		0		
	10.6 Scenic Areas	Miles	0		0		
	10.7 Recreation Areas	Miles	0		0		
	10.8 Historic Areas	Miles	0		0		
	10.9 Residential Areas	Miles	0		0		
2	10.10 National Forests and/or Heavily Timbered Areas	Miles	1.4		1.8		
	10.11 Shelter Belts	Miles	0		0		
2	*10.12 Steep Slopes (35% or greater)	Number	0		0		Q3.9.4
	10.13 Wilderness Areas	Miles	0		0		
	10.14 to (Other Sensitive or Critical Areas, 10.20 Specify)	Miles	0		0		

ER Table 10.9.0-2 (Sheet 3 of 9)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Transmission Routes

		Marshall-Beckerdite			
		Alternative A		Alternative B	
	Units	Magnitude	Page	Magnitude	Page
		70%		70%	
2 10.21 Total Length through Sensitive Areas (Sum 10.1-10.20)	Miles	1.4		1.8	
10.22 Total Net Length through Sensitive Areas (Sum 10.1-10.20 Eliminate Duplication)	Miles	1.4		1.8	

2 * In the AEC Regulatory Guide 4.2 - Preparation of Environmental Reports for Nuclear Power Plants, the term "steep slope" is not defined. However, during the AEC visits to the Perkins & Cherokee sites, a slope of 35 percent was selected for use in comparing the selected and alternate transmission lines. This percentage was agreed on by both the AEC and Duke Power Company. Q10.9.5

ER Table 10.9.0-2 (Sheet 4 of 9)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Transmission Routes

		Units	Winecoff-Beckerdite Alternative A Magnitude	Alternative A Page	Winecoff-Beckerdite Alternative B Magnitude	Alternative B Page
			70%		70%	
1.	Land Use (Rank alternative routes in terms of amount of conflict with present and planned land use.)	Number	0		0	
2.	Property Values (Rank alternative routes in terms of total loss in property values.)	$	0		0	
3.	Multiple Use (Rank alternative routes in terms of envisioned multiple use of land preempted by rights of way.)	Number	5		5	
4.	Length of New Rights of Way Required	Miles	5.5		6.3	
5.	Number and Length of New Access and Service Roads Required	Miles (temporary)	5.5		6.3	
6.	Number of Major Road Crossings in Vicinity of Intersection or Interchanges	Number	0		0	
7.	Number of Major Waterway and Railroad Crossings	Number	1		1	
8.	Number of Crest, Ridge, or Other High Point Crossings	Number	0		0	
9.	Number of "Long Views" or Transmission Lines Perpendicular to Highways and Waterways	Number	0		0	

2

ER Table 10.9.0-2 (Sheet 5 of 9)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Transmission Routes

		Units	Winecoff-Beckerdite Alternative A Magnitude 70%	Alternative A Page	Winecoff-Beckerdite Alternative B Magnitude 70%	Alternative B Page	
	10. Length of Above Transmission Line in or through the Following Visually Sensitive Areas						
	10.1 Natural Water Body Shoreline	Miles	0		0		
	10.2 Marshland	Miles	0		0		
	10.3 Wildlife Refuges	Miles	0		0		
	10.4 Parks	Miles	0		0		
	10.5 National and State Monuments	Miles	0		0		
2	10.6 Scenic Areas	Miles	.2		.1		
	10.7 Recreation Areas	Miles	0		0		
	10.8 Historic Areas	Miles	0		0		
	10.9 Residential Areas	Miles	0		.1		
2	10.10 National Forests and/or Heavily Timbered Areas	Miles	3.1		3.3		
	10.11 Shelter Belts	Miles	0		0		
2	*10.12 Steep Slopes (35% or greater)	Number	2		1		Q3.9.4
	10.13 Wilderness Areas	Miles	0		0		
	10.14 to (Other Sensitive or Critical Areas, 10.20 Specify)	Miles	0		0		

ER Table 10.9.0-2 (Sheet 6 of 9)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Transmission Routes

			Winecoff-Beckerdite			
			Alternative A		Alternative B	
		Units	Magnitude	Page	Magnitude	Page
			70%		70%	
10.21	Total Length through Sensitive Areas (Sum 10.1-10.20)	Miles	3.3		3.5	
10.22	Total Net Length through Sensitive Areas (Sum 10.-10.20 Eliminate Duplication)	Miles	3.1		3.4	

* In the AEC Regulatory Guide 4.2 - Preparation of Environmental Reports for Nuclear Power Plants, the term "steep slope" is not defined. However, during the AEC visits to the Perkins and Cherokee sites, a slope of 35 percent was selected for use in comparing the selected and alternate transmission lines. This percentage was agreed on by both the AEC and Duke Power Company. Q10.9.5

ER Table 10.9.0-2 (Sheet 7 of 9)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Transmission Routes

			McGuire-Pleasant Garden			
			Alternative A		Alternative B	
		Units	Magnitude	Page	Magnitude	Page
			70%		70%	
1.	Land Use (Rank alternative routes in terms of amount of conflict with present and planned land use.)	Number	0		0	
2.	Property Values (Rank alternative routes in terms of total loss in property values.)	$	0		0	
3.	Multiple Use (Rank alternative routes in terms of envisioned multiple use of land preempted by rights of way.)	Number	5		5	
2 4.	Length of New Rights of Way Required	Miles	7.9		7.8	
5.	Number and Length of New Access and Service Roads Required	Miles (temporary)	7.9		7.8	
6.	Number of Major Road Crossings in Vicinity of Intersection or Interchanges	Number	0		0	
7.	Number of Major Waterway and Railroad Crossings	Number	1		3	
8.	Number of Crest, Ridge, or Other High Point Crossings	Number	0		2	
9.	Number of "Long Views" or Transmission Lines Perpendicular to Highways and Waterways	Number	2		3	

ER Table 10.9.0-2 (Sheet 8 of 9)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Transmission Routes

		Units	McGuire-Pleasant Garden Alternative A Magnitude 70%	Alternative A Page	McGuire-Pleasant Garden Alternative B Magnitude 70%	Alternative B Page	
	10. Length of Above Transmission Line in or through the Following Visually Sensitive Areas						
	10.1 Natural Water Body Shoreline	Miles	0		0		
	10.2 Marshland	Miles	0		0		
	10.3 Wildlife Refuges	Miles	0		0		
	10.4 Parks	Miles	0		0		
	10.5 National and State Monuments	Miles	0		0		
	10.6 Scenic Areas	Miles	.2		.4		
	10.7 Recreation Areas	Miles	0		0		
	10.8 Historic Areas	Miles	0		0		
	10.9 Residential Areas	Miles	0		0		
2	10.10 National Forests and/or Heavily Timbered Areas	Miles	5.8		5.9		
	10.11 Shelter Belts	Miles	0		0		
2	*10.12 Steep Slopes (35% or greater)	Number	1		4		Q3.9.4
	10.13 Wilderness Areas	Miles	0		0		
	10.14 to (Other Sensitive or Critical Areas, 10.20 Specify)	Miles	0		0		

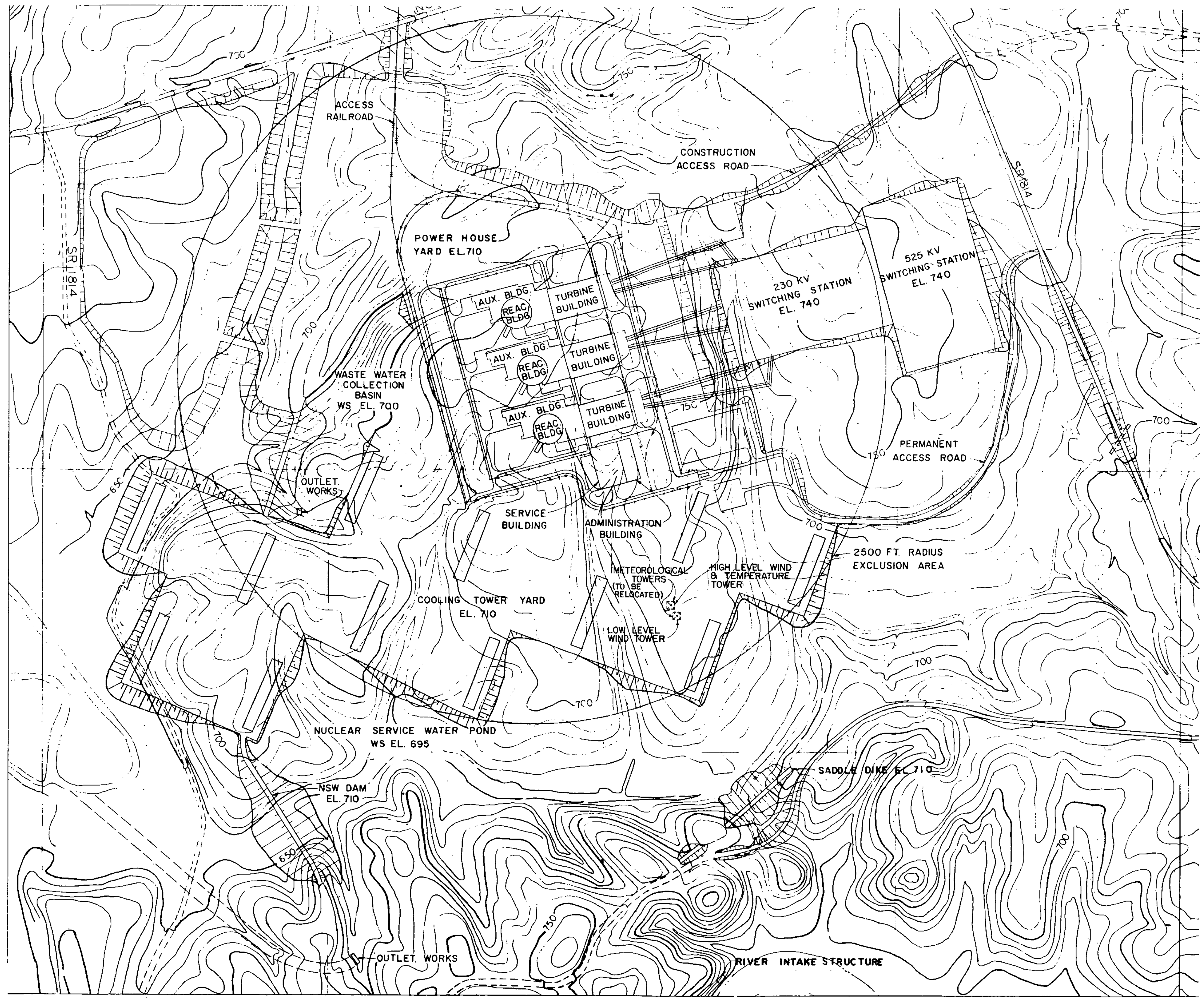
ER Table 10.9.0-2 (Sheet 9 of 9)
Perkins Nuclear Station
Basic Tabulation to be Used in Comparing Alternative Transmission Routes

		Units	McGuire-Pleasant Garden Alternative A Magnitude	Alternative A Page	Alternative B Magnitude	Alternative B Page
			70%		70%	
10.21	Total Length through Sensitive Areas (Sum 10.1-10.20)	Miles	6.0		6.3	
10.22	Total Net Length through Sensitive Areas (Sum 10.1-10.20 Eliminate Duplication)	Miles	5.8		5.9	

2

* In the AEC Regulatory Guide 4.2 - Preparation of Environmental Reports for Nuclear Power Plants, the term "steep slope" is not defined. However, during the AEC visits to the Perkins and Cherokee sites, a slope of 35 percent was selected for use in comparing the selected and alternate transmission lines. This percentage was agreed on by both the AEC and Duke Power Company. Q10.9.

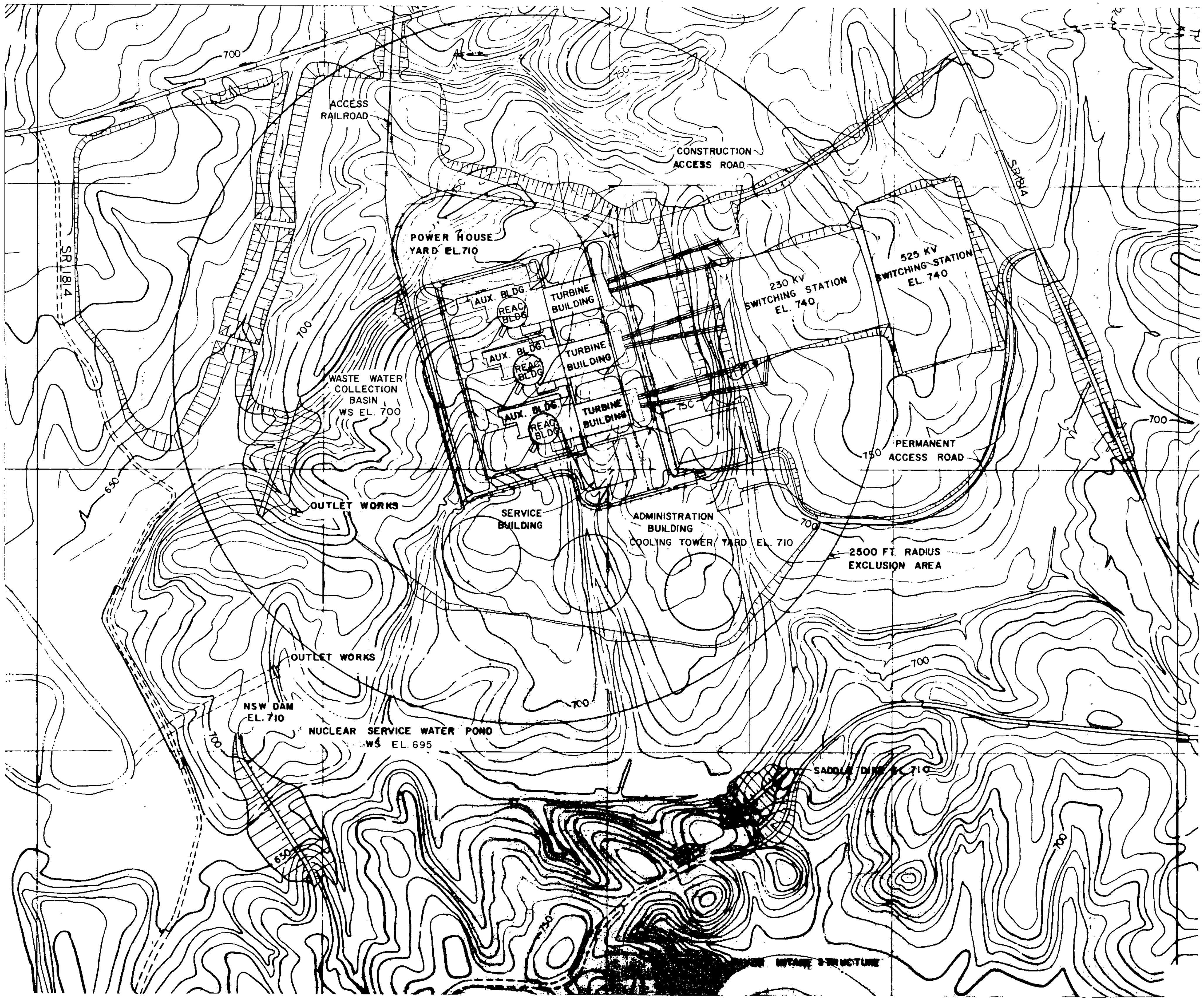
2



COOLING TOWER ALTERNATIVE
RECTANGULAR MECHANICAL DRAFT

PERKINS NUCLEAR STATION

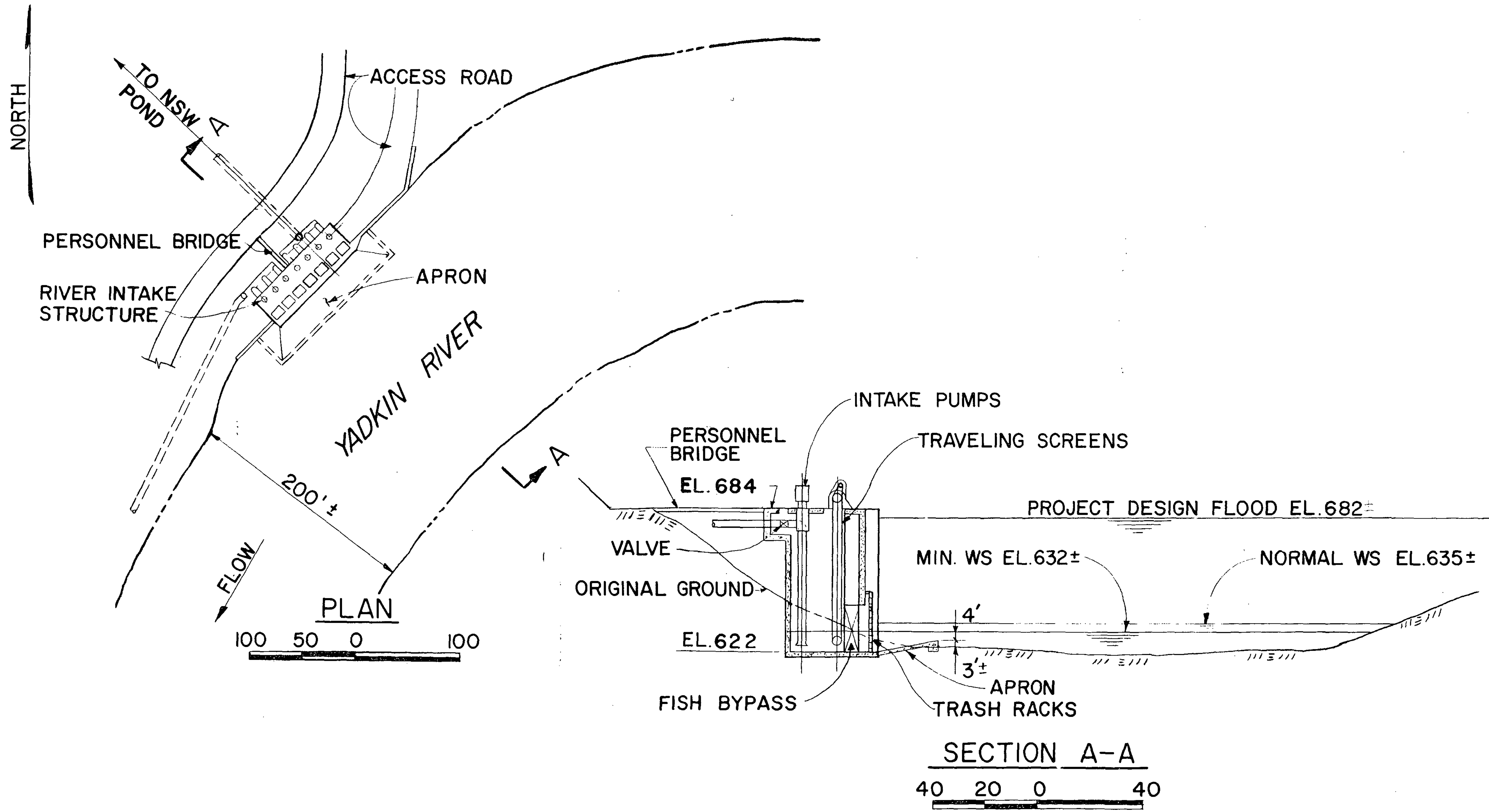
ER Figure 10.1.2-1
Amendment 1



COOLING TOWER ALTERNATIVE
NATURAL DRAFT

PERKINS NUCLEAR STATION

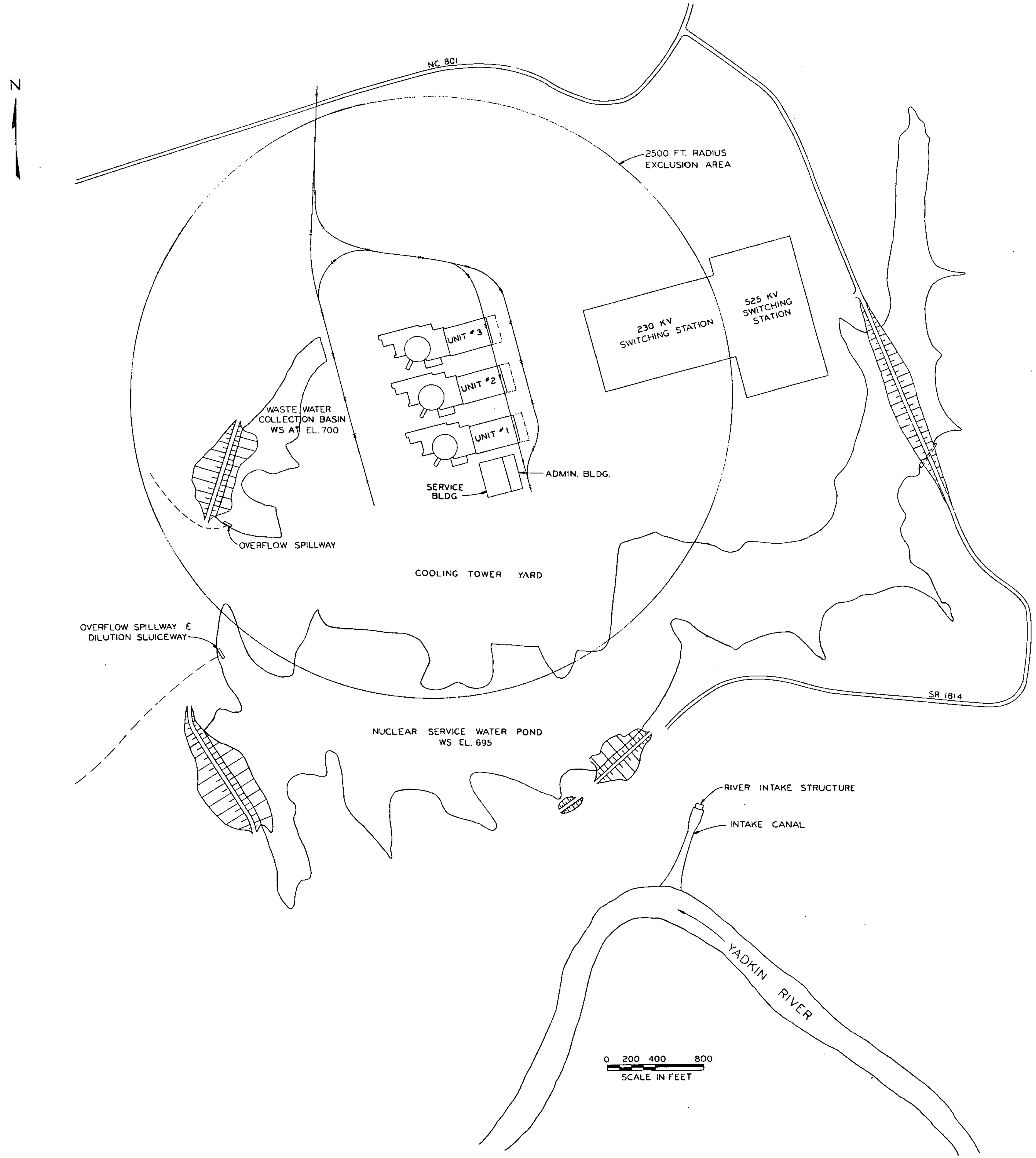
ER Figure 10.1.3-1
Amendment 1



INTAKE STRUCTURE

PERKINS NUCLEAR STATION

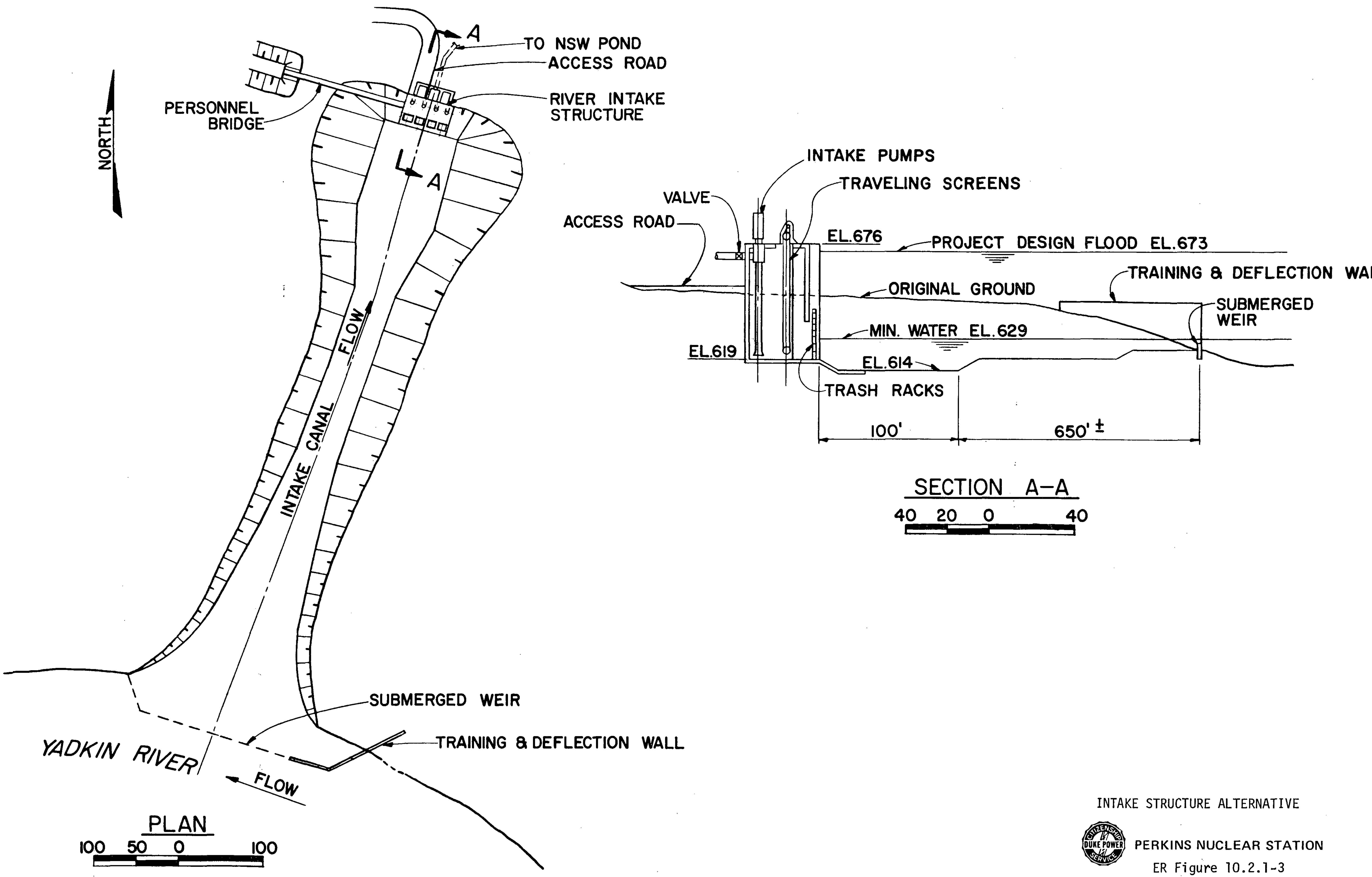
ER Figure 10.2.1-1
Amendment 2
Amendment 3



INTAKE STRUCTURE ALTERNATIVE,
GENERAL AREA MAP

PERKINS NUCLEAR STATION

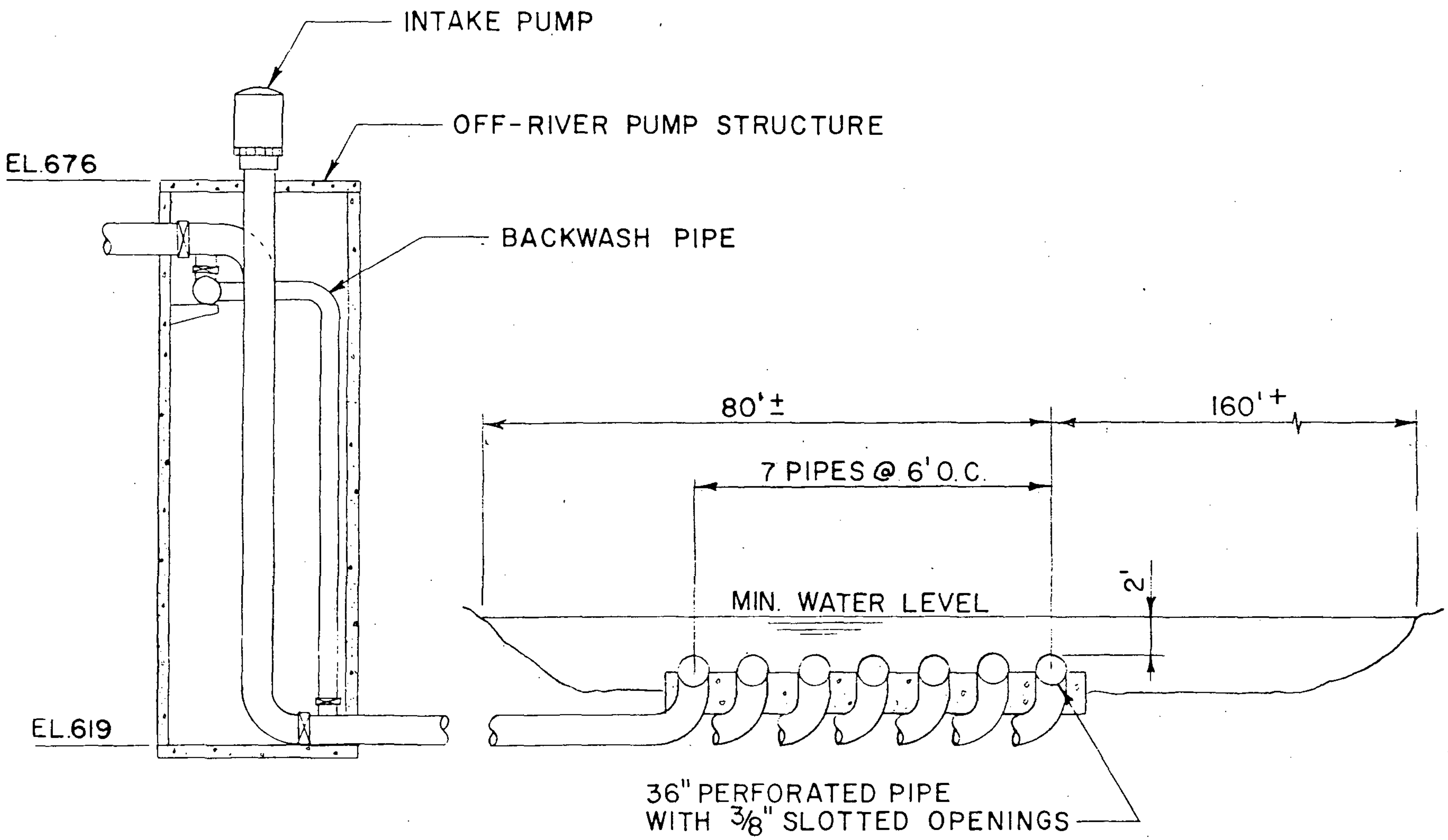
ER Figure 10.2.1-2



INTAKE STRUCTURE ALTERNATIVE

PERKINS NUCLEAR STATION

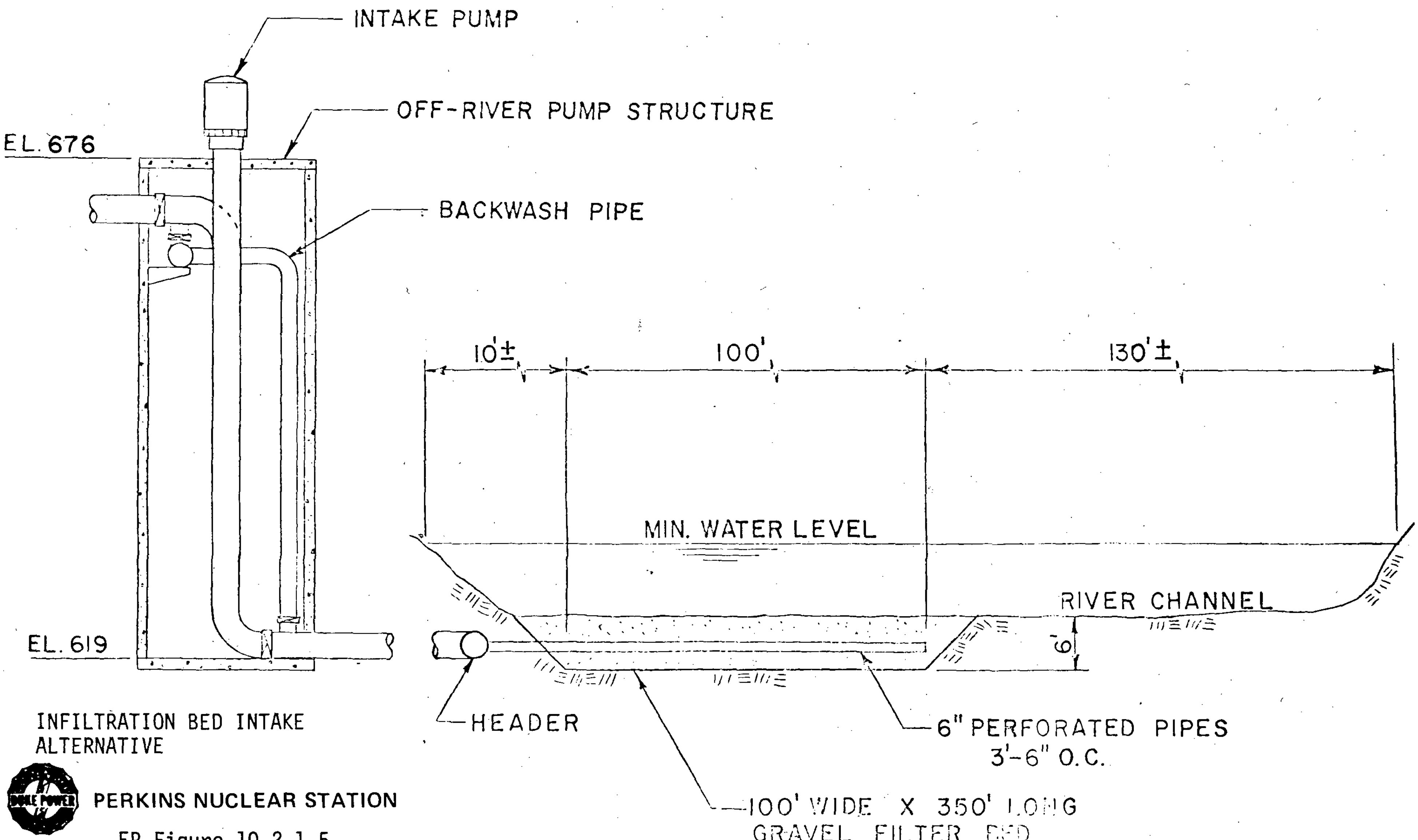
ER Figure 10.2.1-3



PERFORATED PIPE INTAKE
ALTERNATIVE

PERKINS NUCLEAR STATION

ER Figure 10.2.1-4
Amendment 1
(New)

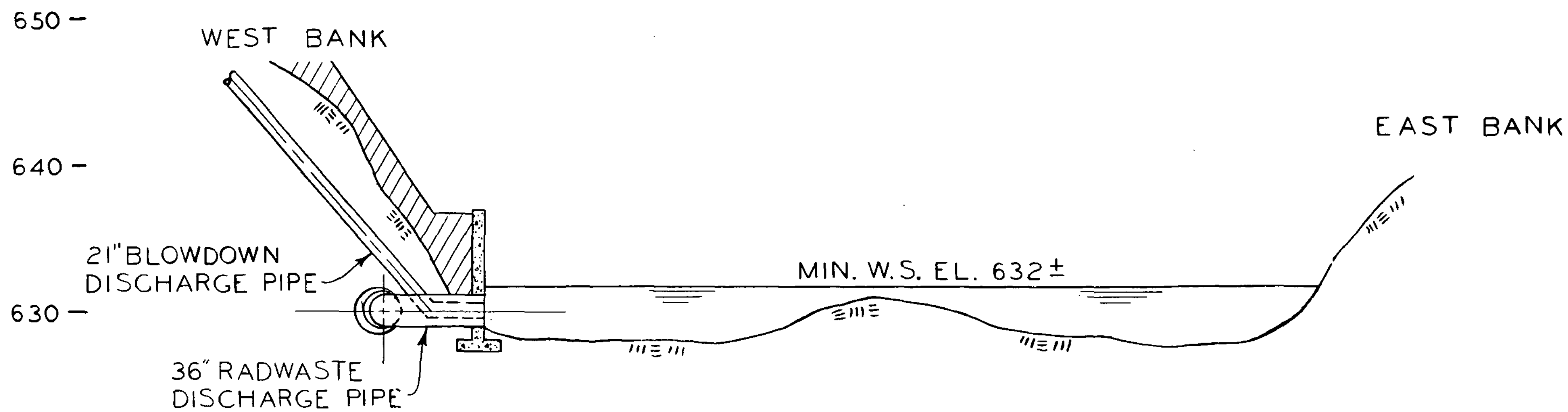


INFILTRATION BED INTAKE
ALTERNATIVE

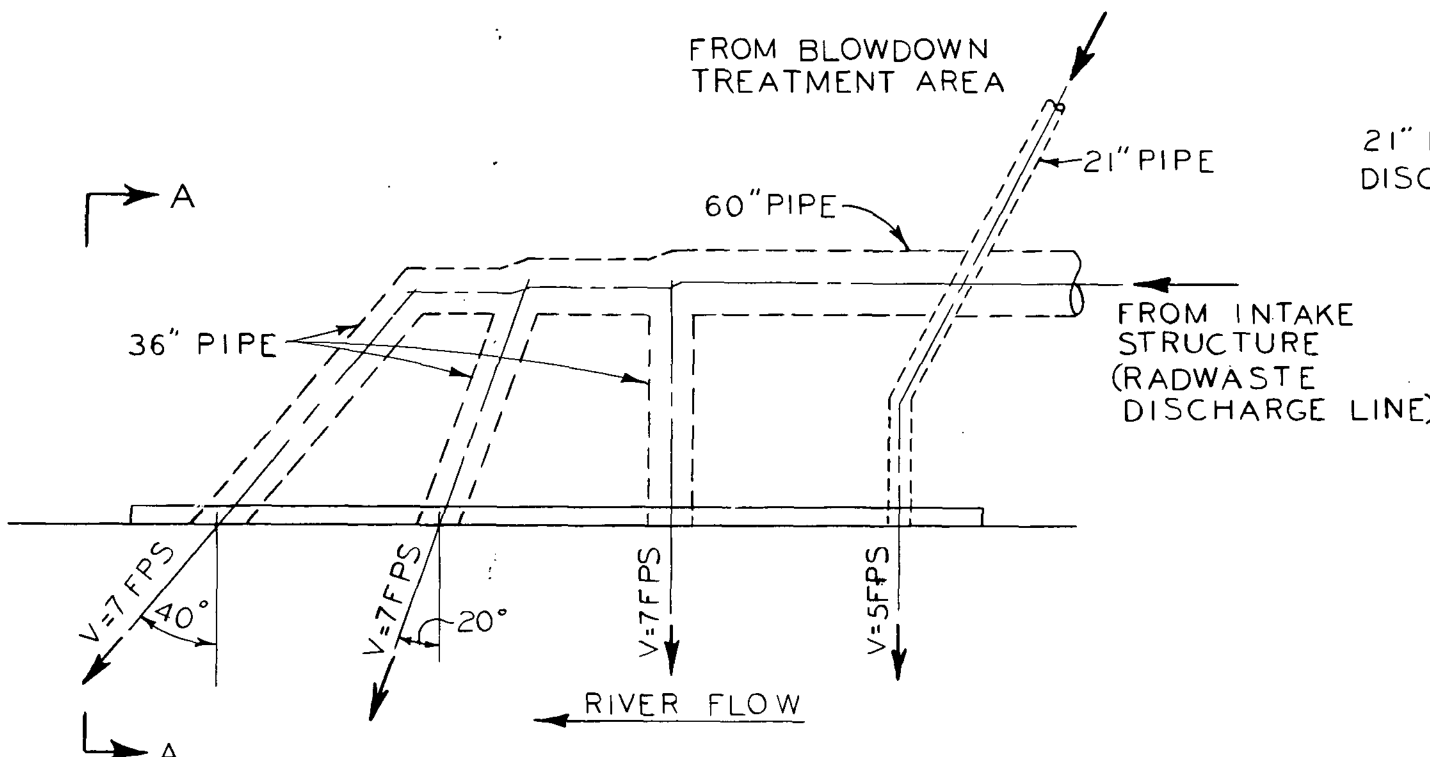
PERKINS NUCLEAR STATION

ER Figure 10.2.1-5

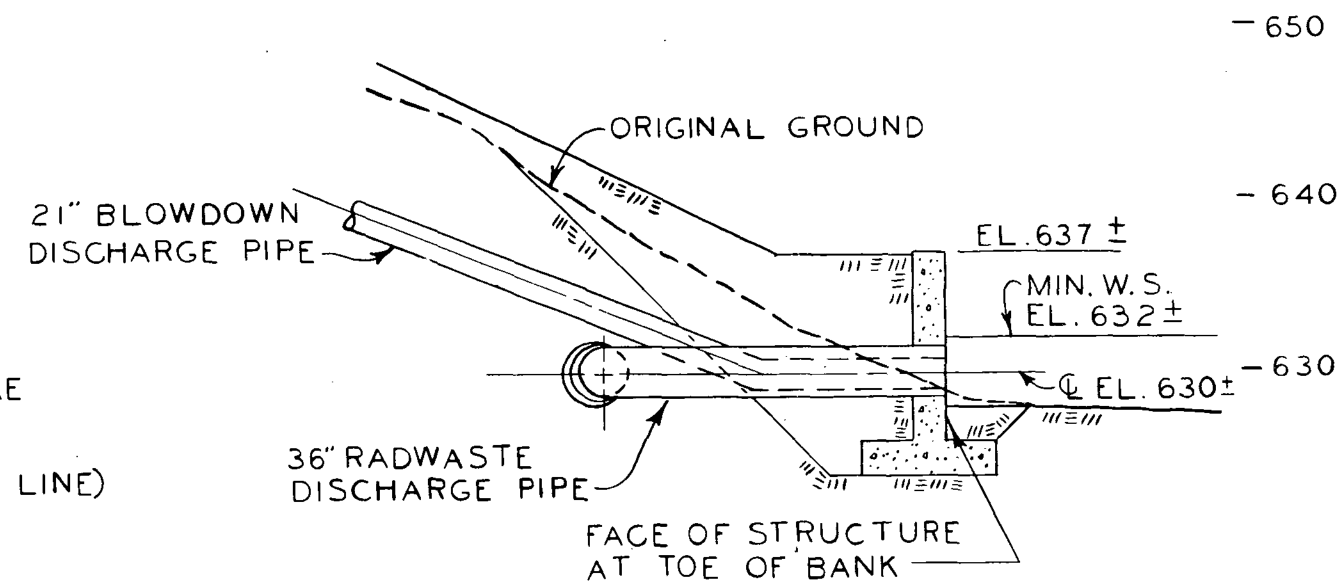
Amendment 1
(New)



CROSS SECTION OF YADKIN RIVER
AT BLOWDOWN & RADWASTE DISCHARGE STRUCTURE
SCALE: 1"=10'V: 1"=30'H



PLAN
DISCHARGE STRUCTURE
SCALE: NONE



SECTION A-A
SCALE 1"=10'

BLOWDOWN AND RADWASTE DISCHARGE
STRUCTURE

PERKINS NUCLEAR STATION

ER Figure 10.3.2-1
Amendment 2
(New)

1. Based on present population patterns and land development in the Davie-Davidson County area, the actual corridor location probably will not vary more than half a mile from the selected routes shown.

2. Transmission line routes are not surveyed and show only general line location that is subject to change.

3. This map was received on August 9, 1974, from:

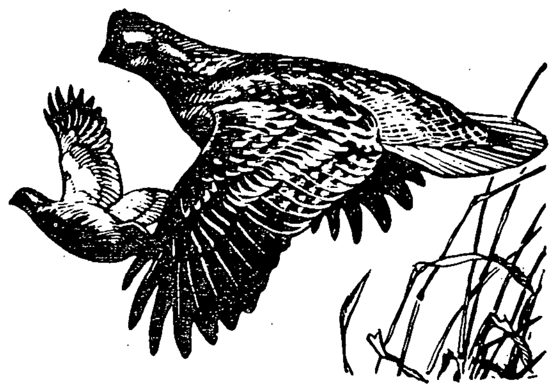
   Mr. Alan R. Eakes
   Landscape Architect
   Division of State Parks
   Department of Natural and Economic Resources

McGUIRE - PLEASANT GARDEN FOLD - IN RELATION TO BOONES CAVE STATE PARK

PERKINS NUCLEAR STATION

ER Figure 10.9.0-1
Amendment 2
(New)

Power Line Wildlife



by Charlie Woodhouse
District Biologist
Staff Photos

"SON, you folks are welcome to plant anything you want on these rights of way, except trees. But we are just not interested in planting. We are in the business of distributing electricity—not feeding wildlife."

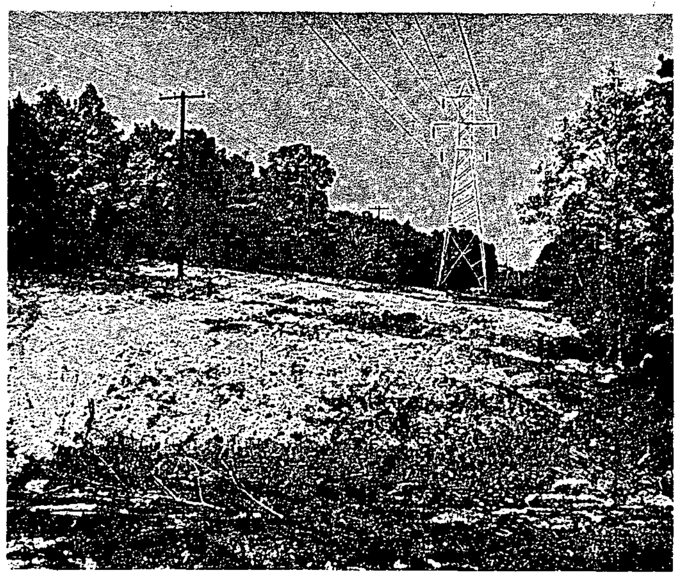
• • • • •

"Based on our experience of three years in seeding rights of way, we made the decision to *seed all rights of way scheduled to be disked or bulldozed.*" Perhaps the words from the old song, "you've come a long way, baby, but you still got a long way to go" aptly describe the situation on power line right of way management in North Carolina. The first statement above, or a reasonable facsimile thereof, was made to the author by an official of a major power company about 15 years ago. The second statement was made by Mr. E. B. Shuler, Manager, Transmission Line Department, Duke Power Company in 1970.

Considerable time has elapsed between these two statements and considerable events have transpired in the area of rights of way management. In 1964 the Wildlife Resources Commission initiated a program of demonstration plantings which was accomplished through the cooperation of the Soil and Water Conservation districts, utility companies, wildlife clubs, and many individuals throughout the state. The two main objectives of this program were 1) to show the power companies that they could maintain rights of way more economically by establishing permanent type, low-growing vegetation, and 2) determine the best combination of these plants to retard woody plant growth and provide improved habitat for wildlife.

The demonstration plantings clearly showed that rights of way *can* be maintained more economically be seeding than by other presently used methods. The best combination of plants we have used so far is a mixture of tall fescue and sericea lespedeza in the main part of the area with a continuous 10 to 12 foot wide strip of VA-70 type shrub lepedeza along one side.

Through contacts with Wildlife Resources Commission personnel, Mr. Horace Cloninger, right of way supervisor for Duke Power Company became



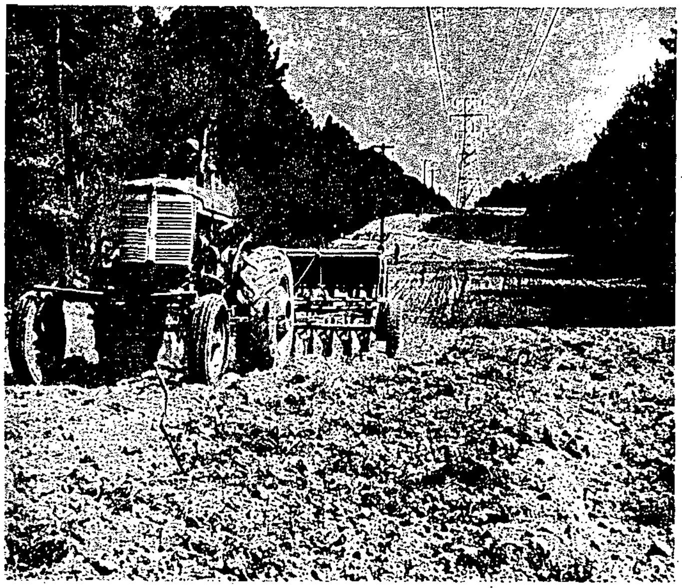
The power line right-of-way above has been bulldozed clean by maintenance crews, resulting in soil erosion and rapid regrowth of undesirable vegetation. Compare this with the right-of-way below which has been seeded to low-growing, sprout-growth retarding wildlife food plants.

interested in our demonstration plantings. In 1965 he began experimenting with some seeding on company-owned lands and by 1968 the decision had been made to seed all rights of way scheduled to be disked or bulldozed. Using a combination of fescue and sericea lespedeza Duke Power Company is presently seeding 2,000 to 3,000 acres per year. This procedure tends to retard and eliminate much woody plant growth. The undesirable brush that does come through can be controlled by rapid brush cutting by machine about every five years. Well established plantings are top-dressed the second year by applying 200 pounds of 18-48-0 fertilizer per acre by helicopter. The cost of such a program has figured out about as follows so far.

Seeding operation	$ 87.00 acre
Mowing	21.00 acre
Topdressing	15.50 acre
	$123.50 acre
Divided by 5(years)	$24.70 acre per year

Compare this with the yearly average cost of other means of maintenance, such as:

Chemical treatment	$48.00 acre
Bulldozing	70.00 acre
Hand cutting	55.00 acre



Standard farm equipment is used to prepare and seed the right-of-way at the proper time. Below, the author examines an excellent shrub lespedeza planting on a Duke Power Company line. These seed were provided by the N. C. Wildlife Resources Commission.

This method of right of way maintenance employed by Duke is obviously great for the company and is also pretty good for wildlife. The missing ingredient here is a dependable, permanent food supply. This can be provided with the addition of a strip of shrub lespedeza as mentioned above. It is perhaps too much to expect of the company to do this on their own, as it requires a separate seeding operation. The Resource Conservation and Development group supplied the "missing link" by having a man out with a cyclone seeder when the company was seeding rights of way in Alamance and Guilford counties, resulting in several miles of properly balanced food and cover plantings.

It is hoped that sometime in the near future a cooperative program can be worked out between the power companies and the Wildlife Resources Commission to include wildlife food plants in all rights of way seeding operations. Meanwhile, wildlife's thanks and congratulations to an outfit that dares to walk where others fear to tread—Duke Power Company!

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LIST OF TABLES

11.0 SUMMARY BENEFIT-COST ANALYSIS

Chapters 8, 9, and 10 discuss expected social, economic, and environmental affects of the proposed Perkins Nuclear Station and compare it with the various site-plant and system alternatives. This Chapter summarizes the benefits and costs of the proposed facility and its alternatives and demostrates that the costs associated with the construction and operation of the facility are more than offset by the production of low cost electricity.

11.1 SITE-PLANT ALTERNATIVE SCHEMES

Site-plant alternative schemes discussed in Section 9.3 include alternatives of site, fuel, cooling, plant, and land use alternatives available as viable alternatives. Other non-viable alternatives are also briefly discussed in Section 9.1. These alternatives include location of the site with respect to load; type of fuel and cost; transportation, primarily of bulk fuel; method of waste heat dissipation; and licensibility.

11.1.1 SITE-FUEL ALTERNATIVES

The only viable fuel alternative to uranium for the required generating capacity is coal. However, due to additional land use requirements, associated transportation and operation costs, additional fuel costs, and the necessary additional capital investment for coal handling and pollution abatement, the nuclear station is more desirable.

11.1.2 PLANT ALTERNATIVES

In an attempt to design and construct the required generating capacity in a relatively short time frame, and with optimum use of engineering and construction manpower, a decision was made to utilize standardized nuclear units. Each of the six Project 81 units are to be identical. A wide range of heat dissipation alternatives is evaluated (Section 10.1). The direct dissipation of heat to the Yadkin River, natural and mechanical draft dry cooling towers and spray ponds are rejected for economic, environmental, and technological reasons after a very preliminary review. Three other cooling systems are considered in detail, natural draft wet cooling towers, rectangular mechanical draft wet cooling towers, and circular mechanical draft wet cooling towers. The proposed circular mechanical draft wet cooling towers was selected after evaluation of environmental and economic factors.

Other station subsystems were addressed in Chapter 10. No single alternative is identified which provides more adequate protection of indigenous social, environmental, and economic values than the proposed design. The economic and environmental impact of each viable alternative is discussed in detail after a preliminary engineering analysis species the sensitive functions and areas of concern.

11.1.3 SITE ALTERNATIVES

The alternative sites considered in Section 9.3 are viable. Cost-effectiveness comparison of the site-plant alternative schemes shows that while the coal-fired, closed cycle cooled stations have lower capital investment costs, the lake cooled nuclear fueled alternative schemes have the lowest operation cost. However, lake cooling was discarded due to doubtful timely licensibility and the use of closed cycle wet cooling towers is proposed. The site alternative schemes question then becomes a fuel alternative question.

The proposed sites are developed for closed cycle cooling, which increases their positive licensibility and at the same time saves other sites where once through lake cooling may be used for future generating stations.

11.1.4 RADIOLOGICAL DISCHARGE ASSESSMENT

The radiological impact on man and biota from operation of the selected scheme results in doses less than the limits specified in Appendix I, 10 CFR 50. Therefore, there is no significant radiological impact advantage gained by selecting any other alternative liquid or gaseous radwaste systems.

11.1.5 WATER USE ASSESSMENT

Possibly the most important factor to consider in assessing the water use impact of the station design alternatives is the net consumptive water use. In this case, the chosen scheme has the highest net consumption. It is higher than would be caused under a lake cooling design. The intake of biota into the river Intake Structure is affected by station operation and river flow.

11.1.6 LAND USE ASSESSMENT

The impact of the proposed scheme due to land use change and aesthetics is considered to result in the most important environmental affect to land use assessment. The adverse impact of losing the current usage of the land to the project is more than balanced by the increased income gained by way of property taxes. The fuel choice saves the use of approximately 1900 acres; however, the proposed heat dissipation system utilizes about 200 acres that would not be required if an existing lake site had been chosen.

11.2 SUMMARY DESCRIPTION OF THE PROPOSED SITE

The proposed nuclear generating facility is located in central North Carolina, southeast of Mocksville. The facility consists of three units having identical pressurized water reactors and nuclear steam supply systems furnished by Combustion Engineering, Inc. Each nuclear steam supply system is designed for a power output of 3,817 Mwt the license application rating. The equivalent warranted gross and approximate net electrical outputs of each unit are 1,345 Mwe and 1,280 Mwe, respectively. The overall design specifications of the units are similar to those of several projects currently under review by the U.S.A.E.C.

It is important to realize that associated with an electrical energy generating facility, certain environmental impacts will occur and the viable management alternatives are limited. There is no way to build or operate a power plant, or any other industrial facility without some trade-off.

Condenser cooling water for the proposed facility is provided by a closed cycle system which utilizes wet mechanical draft cooling towers to dissipate thermal energy to the atmosphere. Makeup for the system is pumped from the Yadkin River.

A summary cost description of the project is presented in Table 11.2.0-1, while a summary cost description of the transmission hook-up is presented in Table 11.2.0-2.

11.2.1 IMPORTANT BENEFITS OF THE PROPOSED FACILITY

The benefits accuring to the public from the construction and operation of Perkins Nuclear Station are discussed in Chapter 8 and summarized in this Section. The objectives of the facility are discussed in Section 1.1, wherein power requirements for the Duke service area are presented.

11.2.2 VALUE OF DELIVERED PRODUCTS

The expected annual generation of 25.6-billion killowatt-hours of electrical energy will generate $353-million of revenue based on 1973 rates.

The production of the electrical energy benefits the service area by meeting the continued load growth as discussed in Section 1.1 and planned retirement presented in Table 1.1.2-2.

11.2.3 INCOME AND EMPLOYMENT

Plant construction is planned to take about twelve years, requiring an
3 2 average 1,482 employees per year. The actual value of wages paid and
materials purchased during the construction period is estimated to be
$1885-million. Approximately $335-million of this is for labor.

The greatest economic benefit locally is expected to result from operation
2 of the facility. Direct employment at the station is estimated to be 250
Additional jobs are expected to be created indirectly as a result of
station operation and employment.

11.2.4 TAXES

Perkins Nuclear Station is expected to have a significant effect on the local tax base and the amount of taxes to be paid by local residents. Federal, state and local taxes paid due to operation of the facility are
3 estimated to be $72-million annually and $61-million annually, respectively.

11.3 BASIS FOR SELECTION OF BENEFITS

The important benefits expected to result from the construction and operation of the proposed Perkins Nuclear Station are value of delivered
2 products, employment, and tax revenues, as discussed in previous Subsections. The monetary value of these three categories is substantial. Increased employment and tax revenue benefit a large cross section of people, both locally and regionally. The supply of adequate capacity to the Duke System has an intangible value to the public exceeding the revenue from the sale of the electric energy product. These are considered to be the most important benefits associated with the station, therefore, on the basis of both their total value and the number of persons affected.

A summary tabulation of the economic benefits attributed to the construction and operation of the plant is given in Table 8.1.1-1.

11.4 BALANCE OF BENEFITS AND COSTS

The benefits expected to result from the construction and operation of the proposed Perkins Nuclear Station are summarized in Table 8.1.1-1. In addition to the tabulated benefits, there is the recognized, but unquantifiable, benefit of having adequate modern capacity to satisfy future power demands.

Balanced against these benefits are certain identifiable economic and environmental costs incurred due to construction and operation of the facility. These costs are summarized in Table 11.2.0-1. The economic costs of the facility are classified as a required financial commitment and can be directly compared with quantified benefits. Conversely, the environmental costs represent areas of concern which may exhibit a noticeable effect but must be considered in the context of trade-offs made to achieve a minimal total impact and in the same context of the actual departure from variations already existent in the environment.

In light of these trade-offs necessary to achieve minimal total impact, and the small added burden to variations of environmental conditions, it is concluded that the benefits outweigh the environmental and economic costs incurred in construction and operation of Perkins. It is believed that the Perkins Nuclear Station, as designed, meets all applicable regulations and protects indigenous environmental and social values at minimum costs.

ER Table 11.2.0-1 (Sheet 1 of 5)
Perkins Nuclear Station
Environmental Cost Description Summary

2 | Capital Cost - $2,341,885,000

Environmental Effects	Units	Magnitude	Section
1. NATURAL SURFACE WATER BODY			
1.1 Impingement or entrapment of fish by cooling water intake structure		Field studies in progress	5.1.2.3
1.2 Passage through or retention in cooling system			
1.2.1 Phytoplankton	Number per day	4×10^{14}	5.1.2.3
Zooplankton	Number per day	6.8×10^{7}	
1.22 Fish - adults ichthyoplankton		Field studies in progress	5.1.2.3
1.3 Discharge area and thermal plume			
1.3.1 Water quality, excess heat, winter conditions	Isotherms, 2F Acres, 3F Acre-Feet, 5F	1.3 1.5 1.0 1.2 0.5 0.5	10.1
1.3.2 Water quality, oxygen availability	Acre-Feet 5 mg/l	None	10.1
1.3.3 Fish (Non-migratory)	Lb/yr	Field studies in progress	10.1
1.3.4 Fish (migratory)		Non Present	10.1
1.3.5 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)		Field studies in progress	10.1
1.4 Chemical effluents	cfs for dilution	Discharge concentrating	
1.4.1 Water quality, chemical	level not lethal to fish	not lethal to fish	3.3
1.4.2 Aquatic organisms		No adverse effect	3.3

ER Table 11.2.0-1 (Sheet 2 of 5)
Perkins Nuclear Station
<u>Environmental Cost Description Summary</u>

Environmental Effects	Units	Magnitude	Section
1.4.3 Wildlife (including birds, aquatic and amphibious and reptiles)		No adverse effect	3.3
1.44 People	Lost user days	0	3.3
1.5 Radionuclides discharged to water body			
1.5.1 Aquatic organisms		No adverse effect	5.2
1.5.2 People, external		No adverse effect	5.3
1.5.3 People, ingestion		No adverse effect	5.3
1.6 Consumptive use (average evaporative losses)			
3 2 1.6.1 People	Gal/min. Gal/yr % of annual flow	37,385 2.0×10^{10} 2.9	3.3
1.6.2		No adverse effect	3.3
1.6.3		No adverse effect	3.3
1.7 Plant construction (including site preparation)			
1.7.1 Water quality, physical		Increased turbidity not quantified	4.1.4.1
1.7.2 Water quality, chemical		No adverse effect	4.1.4.1
1.8 Other impacts			
1.8.1 Low Flow	7 day, 10 year;cfs	625	2.5.1
1.9 Combined or interactive effects			
1.9.1 Combined low flow and biocides		Minimal	3.6.2
1.10 Net effect		Minimal	4.1
2. GROUNDWATER			
2.1 Raising/lowering of ground water levels			
2.1.1 People		No adverse effect	4.1.4.2
2.1.2 Plants		No adverse effect	4.1.4.2
2.2 Chemical contamination of groundwater (excluding salt)			
2.2.1 People		No adverse effect	2.5.4
2.2.2 Plants		No adverse effect	2.5.4

Amendment 2
Amendment 3

Perkins Nuclear Station
Environmental Cost Description Summary

Environmental Effects	Units	Magnitude	Section
2.3 Radionuclide contamination of groundwater			
2.3.1 People		No effect	5.3
2.3.2 Plants		No effect	5.2
2.4 Other impacts on groundwater		None	2.5.4
3. AIR			
3.1 Fogging and icing (caused by by evaporation and drift		No adverse effect off site	10.1
3.1.1 Ground transportation		No adverse effect	10.1
3.1.2 Air transportation		No adverse effect	10.1
3.1.3 Water transportation		No adverse effect	10.1
3.1.4 Plants		No adverse effect	10.1
3.2 Chemical discharge to ambient air			
3.2.1 Air quality, chemical		No chemical discharge other than salt	3.6.1
3.22 Air quality, odor		No odors	3.6.1
3.3 Radionuclides discharged to ambient air and direct radiation from radioactive materials			
3.3.1 People, external		No adverse effect	5.3
3.3.2 People, ingestion		No adverse effect	5.3
3.3.3 Plants and animals		No adverse effect	5.2.1
3.4 Other impacts on air		None	5.2
4. LAND			
4.1 Site Selection			
4.1.1 Land Amount	Acres	2258.9	4.3.1
4.2 Construction activities (including site preparation)			
4.2.1 People (amenities)		No adverse effect	4.1.2
4.2.2 People (accessibility of historic sites)		No adverse effect	4.1.2
4.2.3 People (accessibility of archeological sites)		No adverse effect	4.1.2
4.2.4 Wildlife		Insignificant permanent adverse effects	4.1.3.3

Perkins Nuclear Station

Environmental Cost Description Summary

	Environmental Effects	Units	Magnitude	Section
	4.2.5 Land, erosion (due to construction)	Tons/acre/yr	Max 115	4.1.3.1
4.3	Plant operation			
	4.3.1 People (Amenities)	Max decibels 250 feet from cooling towers, depending upon frequency	65-84	5.1.5
	4.3.2 People (aesthetics)		Plumes will be visible	5.1.4
	4.3.3 Wildlife	Birds and mammals displaced	Unknown	
	4.3.4 Land, flood control		None	
4.4	Salts discharged from cooling towers			
	4.4.1 People	Max deposition-site boundary. Lb/(acre-month)	10, No adverse effect	10.1
	4.4.2 Plants and animals		Unknown	
	4.4.3 Property resources		No adverse Effect	10.1
4.5	Transmission route selection			
	4.5.1 Land, amount	Miles,	16.1	10.9
		Acres,	630.7	
2		Current Market Value	415,240.90	
	4.5.2 Land use and land value	Miles,	10.3	10.9
		Acres,	415.3	
		Dollars	0.0	
	4.5.3 People (aesthetics)			
	Major road crossings	Number	1	
	Major water crossings	Number	2	
	Crest, ridge crossings	Number	1	
	Long views	Number	3	
4.6	Transmission facilities construction			
2	4.6.1 Land adjacent to right of way	Miles	16.1	10.9
	4.6.2 Land erosion	Tons/acre/yr	-	10.9
	4.6.3 Wildlife	Number	0	10.9
	4.6.4 Flora	Number	0	10.9
4.7	Transmission Line operation			
	4.7.1 Land use	Percent	0	10.9
		Dollars	-	
	4.7.2 Wildlife	See Attachment 1	Table 10.9-1	10.9
4.8	Other land impacts			
	4.8.1 Access road	Miles	0.20	4.1.1.4

ER Table 11.2.0-1 (Sheet 5 of 5)
Perkins Nuclear Station
Environmental Cost Description Summary

Environmental Effects		Units	Magnitude	Section
	4.8.2 Railroad	Miles	6.34	4.1.1.4
4.9	Combined or interactive effects 4.9.1 Total land use (Permanent Facilities)	% of total land	41.95	4.3.1
4.10	Net effects		No significant permanent adverse effects	4.0

ER Table 11.2.0-2
Perkins Nuclear Station
Cost Description of Proposed Transmission Hook-Up

		Units	Magnitude	Section
4.5	Transmission Route Selection			3.9.2
4.5.1	Land, Amount	Miles	16.1	
		Acres	630.7	
		Current Market Value	415,240.90	
4.5.2	Land Use and	Miles	10.3	
		Acres	415.3	
		$	0	
4.5.3	People (Aesthetics)			
	Major Road Crossings	Number	1	
	Major Water Crossings	Number	2	
	Crest, Ridge Crossings	Number	1	
	Long Views	Number	3	
4.6	Transmission Facilities Construction			4.2
4.6.1	Land Adjacent to Right of Way	Miles	16.1	
4.6.2	Land Erosion	Tons/Acre/Yr.	-	
4.6.3	Wildlife	Number	0	
4.6.4	Flora	Number	0	
4.7	Transmission Line Operation			5.8.2
4.7.1	Land Use	%	0	
		$	-	
4.7.2	Wildlife	Qualified Opinion	See Attachment 1	

2

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12.0 ENVIRONMENTAL APPROVALS AND CONSULTATIONS

This chapter provides an assessment of all licenses, approvals, permits, and certifications required for the Perkins Nuclear Station for the protection of the environment.

12.1 LICENSES AND APPROVALS REQUIRED

The construction and operation of Perkins Nuclear Station in North Carolina requires the procurement of numerous federal, state, and local licenses.

Table 12.1.0-1 lists the permits, certifications required, anticipated
2 submittal dates, and dates the permits are required, based on the project Q12.0.1
schedule and environmental impact concerned.

12.1.1 FEDERAL AGENCIES

3 The Nuclear Regulatory Commission (NRC)

The Energy Reorganization Act of 1974 gives the NRC regulatory jurisdiction over the design, construction, and operation of the plant specifically with regard to the nuclear aspects relating to assurance of public health and safety. Applications for construction and operating licenses are required pursuant to Section 103 of the Act (42 U.S.C. 2134). Periodic surveillance of construction, operation, and maintenance are performed by the
3 Office of Inspection and Enforcement of the Nuclear Regulatory Commission.

The application for a construction license includes submittal of the Preliminary Safety Analysis Report (PSAR) covering preliminary design and safety aspects of the proposed generating facility. Also, an Environmental Report - Construction Stage is prepared in support of the license authorization to construct.

The application for an operating license includes submittal of a Final Safety Analysis Report (FSAR) and Environmental Report - Operating License Stage prior to issuance of the license authorizing Duke to load fuel and begin power operations of the reactors.

Environmental Protection Agency (EPA)

The Federal Water Pollution Control Act Amendments of 1972 created the National Pollutant Discharge Elimination System (Section 402 Public Law No. 92-500, Oct. 18, 1972) authorizing the regional administrator of EPA to issue permits for the discharge of any pollutant into the navigable waters of the U.S., subject to certification (Section 401 P.L. 92-500, Oct. 18, 1972) from the state having jurisdiction that the discharge will comply with all applicable water quality standards. North Carolina expects to receive authorization from EPA to administer a state NPDES program. In the interim, an NPDES permit application is submitted to EPA pursuant to Sections 401, 402 of this Act.

The Clean Air Act 1970 authorizes EPA to assure that national air quality standards are maintained under state implementation plans for the control of air pollution. The North Carolina Plan for Implementing National Air Quality Standards was adopted pursuant to Section 110 of the Clean Air Act and approved by the Administrator of EPA on May 31, 1973 (37 FR 10842). (Applications for permit pursuant to the Act and state ambient air quality and performance standards are required where appropriate.)

Federal Aviation Administration (FAA)

The FAA must approve construction of structures (such as reactor buildings, stacks, natural draft cooling towers, or transmission towers) extending into the air for considerations of aviation safety. Notification to the Administrator prior to construction of structures or obstructions 200 feet high or more is required. (Vol XI, Federal Aviation Regulations, Oct., 1969, Part 77, "Objects Affecting Navigable Airspace").

Federal Power Commission (FPC)

Duke is presently not aware of any requirement to obtain authorization from FPC for use of water in construction, operation, and maintenance.

Other Federal Agencies

During the planning and development of this facility, Duke will continue to cooperate with a number of federal agencies having specific areas of environmental interest. Examples include the Fish and Wildlife Service, the Bureau of Outdoor Recreation, the Geological Survey, Corps of Engineers, the Forest Service, and the Soil Conservation Service.

12.1.2 STATE AGENCIES

North Carolina Public Utilities Commission

The Public Utilities Commission in North Carolina requires, prior to beginning construction of an electric generating facility, that the need for the plant be established and a Certificate of Public Convenience and Necessity obtained pursuant to Chapter 287, 1965 Session Laws of North Carolina (G.S. 62-110.1).

North Carolina Department of Natural and Economic Resources

The Department is charged with the administration and regulatory control of water and air pollution. This is implemented by its enforcement arm, the
2 Division of Environmental Management. Certification under Section 401 of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500, Oct. 18, 1972) must be obtained from the state stating that there is reasonable assurance that the discharge will not violate the applicable water quality standards or limitations imposed by the state.

A permit for the discharge of warmed cooling water discharges into the Yadkin River pursuant to Article 21, N.C. G.S. Section 143-215.1(a) must be obtained.

Permits for the construction and operation of impoundments are obtained where applicable to satisfy dam safety requirements where those dams are not subject to other licensing jurisdiction (Chapter 1069, 1967 N. S. Session Laws).

Additional permits are filed before the Division of Environmental Management for the conventional sewage and waste treatment facilities to serve temporary construction buildings and later to serve the plant. Any effluents from these facilities will fully comply with water quality standards of the receiving stream.

Registration of Oil Terminal Facilities (Oil Pollution Control Act, Chapter 534, N. C. Session Laws of 1973) are likewise filed where applicable at the appropriate time.

The North Carolina "Sedimentation Pollution Control Act of 1973" created the North Carolina Sedimentation Control Commission and established certain mandatory standards for land disturbing activity. These include requirements for confining visible siltation to within 25 percent of the area nearest the land disturbing activity, proper grading of slopes to retard erosion and provision of ground cover within 30 days after completion of activity. Further requirements are stipulated for land disturbing activities in progress or disturbed areas existing on July 1, 1974. Where offsite damage is occurring on uncovered areas exceeding one contiguous acre; beginning January 1, 1975 ground cover must be provided to restrain accelerated erosion. Q12.0.3

For all proposed activities advertised for bid, let to contract, or on which work is undertaken on or after March 1, 1975, an erosion plan is required 30 days prior to beginning any land disturbing activity. Q12.0.4

North Carolina State Board of Health

The State Health Department has responsibility in the areas of sanitation, vector control, environmental radioactivity, and other health related matters. Duke has conducted at its hydroelectric reservoirs a vector control program closely coordinated with the North Carolina State Health Department for more than 40 years.

In planning this project, Duke is working cooperatively with the State Board of Health to develop high quality standards of sanitation for adoption by local county health departments to assure a high quality of environmental protection with regard to the stream and stream environs. The Applicant plans to consummate an agreement of cooperation with the Division of Radiological Health with respect to radiological matters.

Other State Agencies

Duke is cooperating with several additional agencies in the state for coordination of the proposed generating facility. These include North Carolina Wildlife Resources Commission, Department of Recreation and Division of State Parks.

Also, coordination with such agencies as the Highway Commission on moving heavy loads and the State Highway Patrol regarding emergency plans and others are undertaken.

The North Carolina Wildlife Resources Commission has two projects which could possibly be implemented on Duke property at the Perkins site. One is a wood duck nest-box building program. The wooded bottomlands on the Q12.0.2

Yadkin near the Perkins site could be suitable as wood duck nesting habitat. The state also distributes seed (millet) for planting in bottomlands which are flooded during the winter as waterfowl feeding areas. Appropriate water for such habitat management may be present in the Perkins - High Rock Lake area. Q12.0.2

12.1.3 LOCAL AGENCIES

Davie County Manager

Plans for Perkins Nuclear Station have been discussed with the County Manager. Duke plans to continue in full cooperation and will send copies of application papers Duke files with the AEC to the County Manager.

Davie County Health Department

Approval for building conventional sewage facilities and use of county sanitary landfill is required prior to operation of subject facilities.

12.2 CONSULTATIONS HELD

Duke Power Company has conducted an active public information program to inform and solicit ideas and comments from the public, particularly the citizens of Davie County and surrounding areas near the proposed Perkins Nuclear Station site.

In all public meetings held, Duke presented an orientation of the project in which the long-range plans and general philosophy on building and operating a nuclear generating station were described. Principal items presented were: concern for the environmental impact (non-radiological
2 and radiological), need for the new facility, site selection process and plant description, capability of preventing or minimizing accidents, fuel processing and waste storage capabilities and general areas of interest affecting the social and economic viability of the area.

Public Participation Meetings have been held at the Duke District Offices in Salisbury, Winston-Salem, and Mocksville, North Carolina, from January 28 through February 4, 1974. Subsection 12.2.1 lists attendees of these meetings and the significant topics discussed.

12.2.1 PUBLIC PARTICIPATION MEETINGS - PERKINS NUCLEAR STATION

<u>January 28, 1974 - Salisbury, N. C.</u>

Attendees:

Dr. Jay A. Buxton
Biology Department
Catawba College
Salisbury, N. C.

Mr. Grover Holt, President
Rowan Tech Student Body
Rowan Technical Institute
Salisbury, N. C. 28144

Mr. John Burns
Engineering Technology
Rowan Technical Institute
Salisbury, N. C.

Topics Discussed:

1) Fuel, reprocessing, and waste storage.

2) Plant description.

<u>January 29, 1974 - Mocksville, N. C.</u>

Attendees:

Mr. and Mrs. Richard Hendrix
Route 2
Advance, N.C.

Mr. Gene Smith
Clerk-Treasurer
Mocksville, N. C.

Mr. and Mrs. Pete Kontos
Advance, N. C.

Mr. Johnny Marklin (town board)
Mocksville, N. C.

Mr. George Martin
Martin and Martin Attorneys
Mocksville, N. C.

Mr. James W. Wall
Davie County High School
Mocksville, N. C.

Mr. Harry Murray (town board)
Mocksville, N. C.

Mr. and Mrs. K. B. Groves
Advance, N. C.

Mr. and Mrs. Ronnie Shoaf
Advance, N. C.

Mr. and Mrs. Tom Hauser
Advance, N. C.

Mr. and Mrs. David Springer
Mocksville, N. C.

Mr. Andrew Lagle, Chairman
Davie County Planning Board
Mocksville, N. C.

Mr. and Mrs. Clyde Glascock
(town board)
Mocksville, N. C.

Mr. Ken Boger
Davie County High School
Mocksville, N. C.

Mr. and Mrs. Brady Angell
Mocksville, N. C.

Topics Discussed:

1) Need for the new generating facility.

2) Environmental impact (radiological).

<u>January 30, 1974 - Winston-Salem, N. C.</u>

Attendees:

Dr. Gerald W. Esch
Biology Department
Wake Forest University
Winston-Salem, N. C.

Dr. Ralph D. Amen
Biology Department
Wake Forest University
Winston-Salem, N. C.

Mr. Sam Angotti
Winston-Salem Chamber of Commerce
Winston-Salem, N. C.

Dr. Ronald W. Dimock
Biology Department
Wake Forest University
Winston-Salem, N. C.

Dr. Peter D. Weigl
Biology Department
Wake Forest University
Winston-Salem, N. C.

Mr. Charles B. Wade, Jr.
Senior Vice President
R. J. Reynolds Tobacco Co.
Winston-Salem, N. C.

Mr. Norman W. Hearn
Executive Director
Winston-Salem Chamber of Commerce
Winston-Salem, N. C.

Dr. Isabell Bittinger
Winston-Salem, N. C.

Mr. John C. Kiger, Chairman
County Board of Commissioners
Winston-Salem, N. C.

Topics Discussed:

1) Environmental impact (non-radiological).

2) Radiological impact.

3) Plant description.

<u>January 31, 1974 - Winston-Salem, N. C.</u>

Attendees:

Dr. Richard Sears
Department of Political Science
Wake Forest University
Winston-Salem, N. C.

Mr. James Burrow
for U. S. Representative
Wilmer D. Mizell
Winston-Salem, N. C.

Col. and Mrs. Frank G. Ratliff
Director of Civil Preparedness
Winston-Salem, N. C.

Topics Discussed:

1) Fuel, reprocessing, and waste storage.

2) Need for generating facility.

<u>February 1, 1974 - Mocksville, N. C.</u>

Attendees:

Mr. and Mrs. Andy M. Anderson
Advance, N. C.

Mr. Benjamin Nayder
Advance, N. C.

Mr. and Mrs. Don Wood, President
Chamber of Commerce
Mocksville, N. C.

Mr. and Mrs. David Davis
Mocksville, N. C.

Mr. Ron Vogler
County Manager
Mocksville, N. C.

Mr. Jim Everidge and
Mr. Jeff Wells
Superintendent of Schools
Mocksville, N. C.

Mr. and Mrs. John Bailey
County Commissioner
Advance, N. C.

Mr. Roy Collette
Mocksville, N. C.

Mr. Francis Slate
County Commissioner
Mocksville, N. C.

Mr. Glenn Howard
County Commissioner
Advance, N. C.

Mr. and Mrs. Peter Hairston III
Mocksville, N. C.

Topics Discussed:

1) Plant description.

2) Fuel, reprocessing, and waste storage.

3) Radiological impact.

February 4, 1974 - Salisbury, N. C.

Attendees:

Ms. Edith Holcomb
Salisbury, N. C.

Mr. C. B. Beaver, Jr.
for Earl Haynes, President
Kiwanis Club
Salisbury, N. C.

Topics Discussed:

1) Plant description.

2) Fuel, reprocessing, waste storage.

3) Site selection

February 4, 1974 - Winston-Salem, N. C.

Attendees:

Mr. C. W. Durham
Greensboro, N. C.

Mr. Clyde Harmon
Greensboro, N. C.

Mr. Watson Morris, Executive Director
ECOS, Inc.
Chapel Hill, N. C.

Mr. David Evans
Wake Forest University
Winston-Salem, N. C.

Mr. and Mrs. Kenneth N. Keller
Integon
Winston-Salem, N. C.

Mrs. Sebastian Sommer
Winston-Salem, N. C.

Mrs. Donald Whitener
Winston-Salem, N. C.

Mr. Hugh Whitted III
Winston-Salem, N. C.

Topics Discussed:

1) Fuel, reprocessing, and waste storage.

2) Need for new generating facility.

3) Plant description.

February 5, 1974 - Salisbury, N. C.

Attendees:

Mr. Carl F. Howard
Rowan County Health Department
Salisbury, N. C.

Mr. David Yates McBrayer
State Board of Health, Regional Office
Asheboro, N. C.

Mr. M. O. Caton
N. C. Dept. of Human Resources
Asheboro, N. C.

Mr. Don Duncan
Supt. of Plans
City of Salisbury
Salisbury, N. C.

Mr. Robie L. Nash
Salisbury, N. C.

Mr. William F. Heitman
Rowan County Health Dept.
Salisbury, N. C.

Mr. and Mrs. W. C. Stanback
Stanback Company
Salisbury, N. C.

Mr. E. C. Short
Salisbury, N. C.

Mr. Herb Rhodes
Salisbury, N. C.

Mr. O. K. Beatty
City Council Member
Salisbury, N. C.

Topics Discussed:

1) Fuel, reprocessing, and waste storage.

2) Plant description.

February 5, 1974 - Winston-Salem, N. C.

Attendees:

Mr. Paul W. Spain
Economic Development Department
Winston-Salem, N. C.

Dr. Raymond E. Kuhn
Biology Department
Wake Forest University
Winston-Salem, N. C.

Mr. Forrest McCluney, Plant Manager
Schlitz Brewery
Winston-Salem, N. C.

Mr. Norman Buddine, Chairman
Winston-Salem Chamber of Commerce
Winston-Salem, N. C.

Mr. W. A. Sterling
Schlitz Brewery
Winston-Salem, N. C.

Topics Discussed:

1) Plant description.

2) Environmental impact.

ER Table 12.1.0-1 (Sheet 1 of 3)

Permits Required For
Perkins Nuclear Station
Units 1, 2, 3

Permit/Approval, Certification Description	Anticipated Application Submittal Date	Permit Required Date	Environmental Impact
I. Federal Government			
A. Nuclear Regulatory Commission (NRC)			
1. Construction Permit	4-74	1-76	All Areas
2. Operating License	4-79	4-83	Operational Effects
B. Environmental Protection Agency (EPA)			
1. NPDES Permit	6-75	1-76	Water Quality
C. Federal Aviation Administration (FAA)			
1. Notification of obstruction to navigable airspace	8-75		Air (Ambient)
2.			
D. Federal Power Commission			
1. Construction and Operation of Structures on a Waterway or Stream	8-75		Water Quality
2. Transmission Boundary Lines Clearance	8-75		Air
E. U. S. Corps of Engineers (US COE)			
1. Dredging and Transportation of Dredged Material - Notification	6-75		Water Quality

ER Table 12.1.0-1 (Sheet 2 of 3)

Permits Required for
Perkins Nuclear Station
Units 1, 2, 3

Permit/Approval/Certification Description	Anticipated Application Submittal Date	Permit Required Date	Environmental Impact
II. State of North Carolina			
A. Division of Environmental Management			
1. Construction and Operation Permits a) Wastewater Treatment System b) Nuclear Service Water Pond (NSW) c) Cooling Water Discharge Structure	8-75	1-76	Water Quality
2. 401 Certification	1-75	1-76	Water Quality
3. Sanitary Facilities[1, 2]	8-75[1] 4-79[2]	1-76[1] 4-83[2]	Water Quality
4. Erosion and Sedimentation Control Plan	12-75	1-76	Water Quality
B. Board of Health			
1. Impoundment of Water for Wastewater Treatment System and NSW Pond	8-75	1-76	Water Quality (vector control)
2. Sanitary Facilities[1, 2]	8-75[1] 4-79[2]	1-76[1] 4-83[2]	Water Quality
3. Drinking Water Approval	8-75	1-76	Water Quality
C. Public Utilities Commission			
1. Certificate of Convenience and Necessity	6-75	10-75	Planning Need for Plant

Amendment 2
(Entire Page Revised)
Amendment 3

ER Table 12.1.0-1 (Sheet 3 of 3)

Permits Required For
Perkins Nuclear Station
Units 1, 2, 3

Permit/Approval/Certification Description	Anticipated Application Submittal Date	Permit Required Date	Environmental Impact
III. Davie County and Other Regional Authorities			
A. Davie County Health Department			
1. Sewage Facilities[1, 2]	8-75[1] 4-79[2]	1-76[1] 4-83[2]	Water Quality

NOTES:

1 Temporary Sewage Facilities

2 Permanent Sewage Facilities

Amendment 2
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13.0 REFERENCES

The references for each section are listed under the heading for the chapter and section number and in the order in which they appear in the text of that section. Example:

Chapter 2, Section 3 = 13.2.3

Abbreviations used in this report are alphabetically listed in Section 13.13.

13.1 REFERENCES FOR CHAPTER 1

There are no references at this time.

13.2 REFERENCES FOR CHAPTER 2

13.2.1 REFERENCES FOR SECTION 2.1

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13.6 REFERENCES FOR CHAPTER 6

13.6.1 REFERENCES FOR SECTION 6.1

There are no references at this time.

13.6.1.1 References for Section 6.1.1

There are no references at this time.

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13.10.5 REFERENCES FOR SECTION 10.5

There are no references at this time.

13.10.6 REFERENCES FOR SECTION 10.6

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13.10.7 REFERENCES FOR SECTION 10.7

There are no references at this time.

13.10.8 REFERENCES FOR SECTION 10.8

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13.10.9 REFERENCES FOR SECTION 10.9

There are no references at this time.

13.10.10 REFERENCES FOR SECTION 10.10

There are no references at this time.

13.11 REFERENCES FOR CHAPTER 11

There are no references at this time.

13.12 REFERENCES FOR CHAPTER 12

There are no references at this time.

13.13 LIST OF ABBREVIATIONS

Atomic Energy Commission	AEC
approximate	approx
atmosphere, standard	A
atmospheres	atm
atomic mass units	amu
atomic weight	at. wt
Biochemical Oxygen Demand 5 day, 20°C	BOD
British thermal units	Btu
Chemical Oxygen Demand	COD
Celsius	C
centimeter	cm
centimeter-gram-second	cgs
condenser cooling water	ccw
conventional service water	csw
cubic centimeter	cc or cm^3
cubic foot	ft^3
cubic feet per second	cfs
curie	Ci
cycles per second	cps
Department of Transportation	DOT
decibel	dB
degree	deg
degrees Celsius (centigrade)	C
degrees Fahrenheit	F
degrees Kelvin (absolute)	K
east	E
Fahrenheit	F
feet per second	fps
Figure	Fig.
foot	ft
foot-pound	ft-lb
gallon	gal
gallons per minute	gpm
gallons per day	gpd
gram	gm
hertz (cycles per second)	Hz
horsepower	hp
hour	hr
inch	in.
inside diameter	i.d.
joule	J
kilocalorie	kcal
kilogram	kg
kilometer	km
kilovolt	kV
kilowatt	kW
kilowatt-hour	kWn
logarithm	log
logarithm, natural	ln
Megawatt Days per Metric Ton of Uranium	MWD/MTU
maximum	max
megawatt	MW
meter	m
meter-kilogram-second	mks
mile	mi
miles per hour	mph
millicurie	mCi
milligram	mg
milligram per liter	mg/l
milliliter	ml
milliliter per liter	ml/l
millimeter	mm
millimicron	mu
million gallons per day	mgd
micromho	mmho
millirad	mrad
millirem	mrem
minimum	min
minute	min
north	N
Nuclear Service Water	NSW
number	No.
Occupational Safety and Health Act	OSHA
ounce	oz
outside diameter	o.d.
page	p
pages	pp.
Parts per million	ppm
pound	lb
pound force/pound mass	lbf/lbm
pounds per square inch	psia/psig
pounds per hour	lb/hr
rem	rem
revolutions per minute	rpm
second	sec
section	Sec.
sound pressure level	spl
south	S
square	sq
square centimeter	CM^2
standard temperature and pressure	STP

trace	Tr
versus	vs
volt	V
Waste Water Collection Basin	WWCB
watt	W
west	W
year	yr
Title 10 Code of Federal Regulations Part 20	10CFR20
International Congress of Radiation Protection	ICRP