CHAPTER 02 – SITE AND ENVIRONMENT

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2.0 SITE AND ENVIRONMENT

2.1 GENERAL DESCRIPTION AND LOCATION

2.1.1 SITE LOCATION

Three Mile Island is located approximately 2.5 miles south of Middletown, Pennsylvania, at longitude 76°43'30" west and at latitude 40°09'15” north (approximate midpoint of the station). It is one of the largest of a group of several islands in the Susquehanna River and is situated about 900 ft from the east bank. It is elongated parallel to the flow of the river, with its longer axis oriented approximately due north and south. The island is about 11,000 ft in length and 1700 ft in width.

The southeasterly flowing Susquehanna River makes a sharp change in direction, to nearly due south, in the vicinity of Middletown. After this directional change just north of Three Mile Island, the river widens to approximately 1.5 miles.

The station is located on Three Mile Island, which is situated in the Susquehanna River upstream from York Haven Dam, in Londonderry Township of Dauphin County, Pennsylvania, about 2.5 miles north of the southern tip of Dauphin County, where Dauphin is coterminous with York and Lancaster Counties. Its location with respect to regional topographic and cultural features is shown on Figure 2.1-1 and with respect to local features on Figure 2.1-2.

2.1.2 SITE DESCRIPTION

Figure 2.1-3 shows Three Mile Island and the designated Exclusion Area. For accident evaluations, the distance to the Exclusion Area in each direction is used. Those distances may be determined from Figure 2.1-3.

2.1.2.1 <u>Exclusion Area Control</u>

The exclusion area is a 2,000 foot radius from a point equidistant between the center of the TMI-1 and TMI-2 Reactor Buildings. It includes portions of Three Mile Island, the river surface around it, and a licensee owned portion of Shelley Island, as shown on Figure 2.1-3. The site is located on the northern third of Three Mile Island. The licensee directly owns the TMI-1 site and owns or controls all land within the exclusion area. The Exclusion Area Agreement by and among the GPU companies and Exelon provides Exelon with authority, within those parts of the exclusion area for TMI-1 owned and controlled by the GPU companies, to determine and control all activities in the exclusion area, including exclusion of personnel and property from the area, to the extent necessary to comply with the requirements of 10 CFR 100. Exelon owns and controls the remaining portion of Three Mile Island.

York Haven Dam, immediately to the south of the site, has no locks. Thus, no commercial river traffic exists in the area. In the event of an emergency where control of the river in the exclusion area is recommended, the licensee will contact PEMA who will be responsible for controlling or restricting boat traffic in the area to prevent access within the exclusion area.

2 1.2.2 Boundaries For Establishing Effluent Release Limits

The boundary line forming the base for the Technical Specification Limits on the release of gaseous effluents will be as shown on Figure 2.1-3. This boundary line includes portions of the Susquehanna River surface between the east bank of the river and Three Mile Island and between Three Mile Island and Shelley Island. Land surface included within this boundary line is owned or controlled by the licensee. Access to the exclusion area is readily controlled as stated in Subsection 2.1.2.1.

2.2 POPULATION

2.2.1 POPULATION WITHIN 10 MILES

The population within a 10 mile radius of TMI-1 is shown on Figures 2.2-1 through 2.2-5. The current population figures within the 10-mile radius are based upon the 1990 census data, which are the most recent available. The population projections, by decade through 2010, were based on information obtained from State and county planning boards, where available, or on projections estimated from past growth. Note also that the projections were based on 1980 census data.

2.2.2 POPULATION WITHIN 50 MILES

The population within a 50 mile radius is shown on Figures 2.2-6 through 2.2-10. Population figures are based upon the 1980 census data, which are the most recent available (population within 10 miles based on 1990 census data). The population projections, by decade through 2010, were based on information obtained from State and county planning boards where available or on projections estimated from past growth. Counties and communities within a 50 mile radius of TMI are shown on Figure 2.2-11. The populations shown are from the 1990 census data.

2.2.3 LOW POPULATION ZONE

The low population zone for Three Mile Island Unit 1 was chosen as a 2 mile radius from the station. The zone was based on a low 1980 population density of approximately 1805 people in the 2 mile radius together with the highway facilities available for evacuation within a reasonable time, should it become necessary. The current population by sector is shown on the 0 to 10 mile population wheel, Figure 2.2-3. The population in the LPZ has decreased from 2539 (1980 census) to 1598 (1990 census).

2.2.4 TRANSIENT POPULATION

There are no schools or major industries within the low population zone; thus, no significant shift in population is expected to occur on a daily basis in the area.

There is some seasonal shift in population within approximately 5 miles of the station since there are over 100 summer cabins on the islands in the Susquehanna River within 5 miles of the site. The seasonal population has been included in the 0 to 10 mile population distribution described above.

Additional transient shifts in population may occur during the summer due to boating activity on the Susquehanna River in the vicinity of the plant site.

2.2.5 POPULATION CENTER

The nearest population center, as defined in 10CFR100, is Harrisburg, with a 1990 population of 52,376. The center of Harrisburg is located 12 miles northwest of the site.

2.2.6 PUBLIC FACILITIES AND INSTITUTIONS

Public facilities and institutions, including county location and name within a 10 mile radius of Three Mile Island are given in Table 2.2-2.

The following is a summary of the facilities and institutions within a 10 mile radius: (Information based on the 1990 census data)

a. Schools

There are 65 public, private, and parochial schools within 10 miles: 13 in York County; 3 in Cumberland County; 39 in Dauphin County; and 10 in Lancaster County.

The nearest school to the site is the Northumberland Center (Capital Area Intermediate Unit), located in Dauphin County. The school is approximately 13,000 feet from the site.

b. Recreation

Seventeen recreational facilities have been identified within the 10 mile emergency planning zone; 7 in York County; and 10 in Dauphin County.

The nearest public recreational facility is the boat launching facility constructed by Metropolitan Edison Company approximately 8000 feet north from the site in Dauphin County. For more details see Appendix 3 of the Evacuation Travel Time Estimate for the TMI Nuclear Generating Station Emergency Planning Zone, (i.e., Transient and Special Facility Population Data).

c. Hospitals, Nursing Homes, and Similar Facilities

There are 13 facilities located within the 10 mile emergency planning zone, the largest being the Milton S. Hershey Medical Center of the Pennsylvania State University. This hospital and teaching institution is located approximately 10 miles from the site. For more details see Appendix 3 of the Evacuation Travel Time Estimate for the TMI Nuclear Generating Station Emergency Planning Zone, (i.e., Transient and Special Facility Population Data).

2.2.7 BUSINESS FACILITIES WITHIN 5 MILES

Table 2.2-1 lists all industrial and manufacturing facilities within 5 miles of the site. This information is based on the 1990 census data (Reference 29).

TABLE 2.2-1
(Sheet 1 of 1)

INDUSTRIAL AND MANUFACTURING
FACILITIES WITHIN FIVE MILES OF SITE

1. Chloe Textiles
2. Intercon Systems
3. Zeager Brothers, Inc.
4. Olivetti Supplies, Inc.
5. York Haven Power Co.
6. DIE-TECH
7. Brunner Island Station
8. LASCO Bathware
9. Fleetwood
10. Tyson Warehouse
11. American Air Filter

Reference: 1990 Evacuation Travel Time Estimates for Three Mile Island Nuclear Generating Station Plume Exposure Pathway Emergency Planning Zone

Table 2.2-2
(Sheet 1 of 3)
PUBLIC FACILITIES & INSTITUTIONS
WITHIN A 10 MILE RADIUS

LANCASTER COUNTY

Donegal School District

Maytown Elementary School

Elizabethtown Area School District

Elizabethtown Area High School
Elizabethtown Area Middle School
Bainbridge Elementary School
East High Elementary School
Fairview Elementary School
Millroad Elementary School
Rheems Elementary School
St. Peter Parochial School
Mt. Calvary Christian Center

Elizabethtown College

YORK COUNTY

Northeastern School District

Northeastern Senior High School
Northeastern Junior High School
Conewago Elementary School
Mount Wolf Early Learning Center
Orendorf Elementary School
York Haven Elementary School

West Shore School District

Fairview Elementary
Fishing Creek Elementary
Mount Zion Elementary
Newberry Elementary
Red Land High School
Red Mill Elementary
The Circle School

Table 2.2-2
(Sheet 2 of 3)
PUBLIC FACILITIES & INSTITUTIONS
WITHIN A 10 MILE RADIUS
DAUPHIN COUNTY

Middletown Area School District

Alice Demey Elementary School
George D. Mansberger Elementary School
John C. Kunkel Elementary School
Lyall J. Fink Elementary School
Middletown Senior High School
George W. Feaser Middle School
Middletown Christian School
Seven Sorrows BVM School

Lower Dauphin Area School District

Conewago Township Elementary School
Londonderry Township Elementary School
A.B. Nye Elementary School
E.Z. Price Elementary School
South Hanover Township Elementary School
Lower Dauphin Junior High School
Lower Dauphin Senior High School

Derry Township School District

M.S. Hershey Middle School
Hershey Elementary School
Hershey Senior High School
Mountain View Christian School
St. Joan of Arc School
Milton Hershey School

Steelton-Highspire School District

Steelton-Highspire Elementary School
Steelton-Highspire Junior/Senior High School
St. John Newmann Consolidated School

Table 2.2-2
(Sheet 3 of 3)

PUBLIC FACILITIES & INSTITUTIONS
WITHIN A 10 MILE RADIUS

DAUPHIN COUNTY (cont'd)

Central Dauphin School District

Paxtang Elementary School
Chamber Hill Elementary School
Rutherford Elementary School
Southside Elementary
Tri-Community Elementary School
Swatara Junior High School

Town and Country Day School
St. Catherine Laboure School
Lawnton

Capital Area Intermediate Units
Northumberland Center
Camp Harris
Oberlin School
Aspin Center

The Pennsylvania State University at Harrisburg
The Capital College

Harrisburg School District
Foose Early Childhood Center

CUMBERLAND COUNTY

West Shore School District
New Cumberland Middle School
Hillside Elementary School
St. Theresa School

Reference: 1990 Evacuation Travel Time Estimates for Three Mile Island Nuclear Generating Station Plume Exposure Pathway Emergency Planning Zone.

2.3 LAND USE

Land within a 10 mile radius of the site is used primarily for farming. Farm produce includes dairy, tobacco, poultry, vegetable, fruit, alfalfa, soybeans, corn, wheat, and other products. Agricultural characteristics for Dauphin, York, and Lancaster Counties are listed in Table 2.3-1.

The nearest dairy farm is located on Gingrich Road. It is approximately one mile from the center of Three Mile Island Nuclear Station and is known as the Alwine Farm.

A summary of land use for Dauphin County, in which the site lies, and for the two other adjacent counties (York and Lancaster) is as follows:

	Percent of Land Used		
Use	Dauphin	York	Lancaster
Forest	48.7	27.8	16.2
Crops	29.6	45.3	61.8
Pasture	3.6	7.6	3.4
Other	18.1	19.3	18.6

The location of these counties is shown on Figure 2.2-1. Typical industries in the site region are listed in Table 2.3-2. The predominant industrial areas are around Harrisburg and Middletown, up river from the site.

Transportation routes in the site vicinity on the east bank of the river include State Highway 441, a two-lane blacktop road passing north and south, and a Norfolk Southern Railroad one-track line adjacent and parallel to this highway; each is outside the exclusion boundary. On the west bank, there is a multitrack Norfolk Southern Railroad line at the river's edge about l.25 miles west of the site and a blacktop, two-lane road parallel to it. There is no commercial water transportation on the river adjacent to the site. The river is transected south of the site by the York Haven Dam, which does not have locks.

There is no commercial fishing in the Susquehanna River in the vicinity of TMI. Recreational fishermen can expect to catch about 42 species of fish in the Susquehanna River. Species other than those listed in Table 2.3-3 may be taken, but not in significant numbers.

TABLE 2.3-1
(Sheet 1 of 1)

AGRICULTURAL CHARACTERISTICS (AS OF 1987)*

	Lancaster	Dauphin	York
Number of farms (1987)	5,080	790	2,340
Land in farms (acres)	417,296	112,821	299,879
Percent of total land area	68.5	33.4	51.7
Average size of farm (acres)	84	145	130
Value of Products Sold ($)	109,295,000	13,086,000	41,942,000
Field crops ($)	101,635,000	11,761,000	33,161,000
Vegetables ($)	6,019,000	774,000	4,285,000
Fruits & nuts ($)	1,641,000	551,000	4,496,000
Forest products & horticultural products ($)	10,824,000	1,267,000	5,388,000
Poultry & poultry products ($)			
Chickens	21,488,000	1,190,000	1,434,800
Eggs	85,943,000	5,381,000	7,840,000
Milk/Dairy Products($)	203,741,000	14,582,000	30,106,000
Livestock & Livestock Products ($)	201,551,500	17,272,500	38,692,350
Crops Harvested			
Corn (acres) Grain	105,500	26,000	70,000
Silage	75,100	6,700	16,500
Wheat (acres)	17,500	4,000	23,500
Potatoes (acres)	1780	80	2,040
Tobacco (acres)	10,010	20	110

* Source: Statistical Summary 1987-88 and PA Dept. of Ag. Annual Reports; Natl. Ag. Statistics Service U.S. Dept. of Agriculture/PA Dept. of Agriculture Publ. PASS-99

TABLE 2.3-2
(Sheet 1 of 3)

TYPICAL MAJOR* INDUSTRIES WITHIN 10 MILES OF THREE MILE ISLAND

COMPANY	LOCATION/DIRECTION
1. Covenco	Lower Swatara 6-7 miles NW
2. Bethlehem Steel	Steelton 7-8 miles NW
3. SAIC	Londonderry 5-6 miles N
4. AMP Inc.	Lower Swatara 5-6 miles NNW
5. AMP	Swatara 8-9 miles NW
6. Mack Trucks	Lower Swatara 5-6 miles NW
7. Turnpike Ind. Park	Lower Swatara 5-6 miles NW
8. Advanced Conversion	Lower Swatara 5-6 miles NNW
9. Chloe Textiles	Lower Swatara 3-4 miles NNW
10. UPS	Swatara 9-10 miles NW
11. UPS	Lower Paxton 9-10 miles NNW
12. Pa Workers Comp	Harrisburg 8-9 miles NW

* Business with greater than 100 employees

TABLE 2.3-2
(Sheet 2 of 3)
TYPICAL MAJOR* INDUSTRIES WITHIN 10 MILES OF THREE MILE ISLAND

COMPANY	LOCATION/DIRECTION
13. Jackson Manufacturing	Harrisburg 9-10 miles NW
14. Hershey Foods 1	Derry 9-10 miles NNE
15. Hershey Foods 2	Derry 9-10 miles NNE
16. Hershey Foods 3	Derry 9-10 miles NNE
17. Hershey Foods 4	Derry 9-10 miles NNE
18. Hershey Foods 5	Derry 9-10 miles NNE
19. Hershey Foods 7	Derry 9-10 miles NNE
20. Maple Press	Manchester 7-8 miles S
21. Offsite Advantage	Fairview 6-7 miles WNW
22. Admin Center for Education	Fairview 6-7 miles WNW
23. DuPont Electronics	Manchester 9-10 miles S
24. DuPont Electronics	Fairview 5-6 miles W
25. FES, Inc.	Manchester 9-10 miles S

* Business with greater than 100 employees

TABLE 2.3-2
(Sheet 3 of 3)

TYPICAL MAJOR* INDUSTRIES WITHIN 10 MILES OF THREE MILE ISLAND

COMPANY	LOCATION/DIRECTION
26. Trenwyth	Manchester 9-10 miles S
27. Preston Trucking	Manchester 9-10 miles S
28. Progressive Typeset	Manchester 9-10 miles S
29. Pa Auto Dealers Assoc.	Conawago 5-6 miles SSW
30. New Cumberland Depot	Fairview 7-8 miles WNW
31. USA Direct	Manchester 7-8 miles S
32. M&M Mars	Elizabethtown 6-7 miles E
33. Armstrong Industries	E. Donegal 9-10 miles SE
34. Wengers Feed Mill	Mount Joy 7-8 miles E
35. Verdelli Farms	Derry 8-9 miles N
36. Turnpike Commission	Lower Swatara 5-6 miles NW

Reference: 1990 Evacuation Travel Time Estimates for Three Mile Island Nuclear Generating Station Plume Exposure Pathway Emergency Planning Zone.

* Business with greater than 100 employees

TABLE 2.3-3
(Sheet 1 of 2)

FISH SPECIES OF THE SUSQUEHANNA RIVER

Common Name	Scientific Name
Trout	
Brown Trout	Salmo trutta
Pikes	
Northern Pike	Esox lucius
Muskellunge	Esox masquinongy
Minnows	
Goldfish	Carassius auratus
Carp	Cyprinus carpio
Cutlips minnow (rare)	Exoglossum maxillinqua
Golden shiner	Notemigonus crysoleucas
River chub (rare)	Nocomis micropogon
Common shiner	Notropis cornutus
Spottail shiner	Notropis hudsonius
Swallowtail shiner	Notropis procne
Spotfin shiner	Notropis spilopterus
Bluntnose minnow	Pimephales notatus
Blacknose dace (rare)	Rhinichthys atratulus
Longnose dace	Rhinichthys cataractae
Creek chub	Semotilus atromaculatus
Fallfish (rare)	Semotilus corporalis
Comely shiner	Notropis amoenus
Mimic shiner	Notropis volucellus
Suckers	
Quillback	Carpiodes cyprinus
White sucker	Catostomus commersoni
Northern hog sucker	Hypentelium nigricans
Shorthead redhorse	Moxostoma macrolepidotum
Catfish	
White catfish	Ictalurus catus
Black bullhead	Ictalurus melas
Yellow bullhead	Ictalurus natalis
Brown bullhead	Ictalurus nebulosus
Channel catfish	Ictalurus punctatus
Freshwater eels	
American eel	Anquilla rostrata
Herrings	
Gizzard shad	Dorosoma cepedianum

TABLE 2.3-3
(Sheet 2 of 2)

FISH SPECIES OF THE SUSQUEHANNA RIVER

Common Name	Scientific Name
Sunfish and Bass	
Rock bass	Ambloplites rupestris
Redbreast sunfish	Lepomis auritus
Green sunfish	Lepomis cyanellus
Pumpkinseed	Lepomis gibbosus
White crappie	Pomoxis annularis
Black crappie	Pomoxis nigromaculatus
Bluegill	Lepomis macrochirus
Smallmouth bass	Micropterus dolomieui
Largemouth bass	Micropterus salmoides
Perches and Darters	
Tessellated darter	Etheostoma olmstedi
Yellow perch	Perca flavescens
Walleye	Stizostedion vitreum

Other species may be found in the Susquehanna but not in significant numbers.

2.4 AIRPORT TO SITE RELATIONSHIP

There are two airports in the site region, Harrisburg International Airport, formerly called Olmsted State Airport, 2.5 miles northwest, and Capital City Airport, formerly called Harrisburg-York Airport, 8 miles west northwest. The former handles primarily commercial and the latter primarily private aircraft. Runway location and use is discussed in Section 2.4.1, and the probability of airplane strikes on the plant is discussed in Section 2.4.2.

2.4.1 RUNWAY LOCATION AND USE

Harrisburg International Airport is located on the east bank of the river and has only one runway ($130^o/310^o$). Instrument landing approaches to 310^o would align with the runway direction and the aircraft would pass approximately 7500 feet NNE of the site. Aircraft intending to land on 3100 could pass near or over the site prior to turning on final approach; however, this would not be a standard VFR approach. The normal takeoff pattern on 130^o is away from the site, i.e., the aircraft turns to the left after takeoff. Aircraft takeoff and landing patterns in the other respective direction are out of the site area. The missed approach holding pattern for Harrisburg International Airport is also not in the site area.

The Capital City Airport has two runways ($120^o/300^o$ and $80^o/260^o$. Instrument landing approaches to 3000 would align with the runway direction and the aircraft would pass approximately 1/2 mile to the NNE of the site at an elevation of about 2300 feet. Aircraft on VFR intending to land on 300^o could pass near, or over, the site prior to turning on final approach. However, 300^o is seldom used due to high terrain considerations and short length (4000 feet). Occasionally, strong crosswind effects on other landing approaches require the use of this runway. Aircraft departing on 120^o would normally start a right turn approximately 1 to 3 miles from the end of the runway, depending upon type of aircraft. Aircraft takeoff and landing patterns in the other respective directions are out of the site area. The Capital City Airport has one missed approach holding pattern. It is located such that aircraft would pass near the site at an altitude of roughly 3000 feet. However, aircraft in the holding pattern would comprise considerably less than 1 percent of all aircraft instrument approaches. Most aircraft having missed the landing would immediately be vectored by radar to make another approach.

2.4.2 PROBABILITY OF AIRPLANE STRIKES*

2.4.2.1 General

The Three Mile Island Station is 2.5 miles (straight-line distance) from the eastern end of the single runway of Harrisburg International Airport. The station is about 1.5 miles to the southwest of the extended runway center line. The respective locations of the station and the airport and its runway are shown on Figure 2.4-1 of the FSAR. Air traffic patterns in the site area are based on estimates made in 1991.

Estimates of the probability of various types of airplane crashes into the plant and of related fires are given in Table 2.4-1. The development of each estimate is summarized below.

* Note: The original analyses and licensing bases can be found in the PSAR and Update-1 to the UFSAR and is based on the period of record 1956 to 1965.

2.4.2.2 Probability Of Strike By Large Aircraft

Accident records in the annual statistical summaries of U.S. air carrier accidents (Reference 1) and in individual aircraft accident reports available from the National Transportation Safety Board covering about 118 million aircraft movements (landings plus takeoffs) during the 10 year period 1978 through 1987 were examined and are summarized in Tables 2.4-2, 2.4-3, and 2.4-4. This information along with data concerning the number and types of aircraft movements at Harrisburg International Airport were used to estimate the probability of a hypothetical aircraft incident as shown in Items 1 and 2 of Table 2.4-1.

The types of air carrier aircraft used in the aircraft incident study for Harrisburg International Airport in terms of approximate percent of total air carrier movements are:

DC-9	31%
Boeing 727	26%
Boeing 737	17%
Shorts 360	16%
Other	10%
	100%

In addition to air carrier movements, there are some Air National Guard flights from a unit stationed at Harrisburg International Airport (using C-130 and C-5A type aircraft) and some small percentage of transient military flights including helicopters. Also, United Parcel Service (UPS) began daily flights to Harrisburg International Airport using Boeing 757 in October 1989. Even though the accident records available for this study update do not go beyond 1987, this additional information has been incorporated in Section 2.4.2.3; "Probability of a strike by a very large aircraft".

Of all the aircraft using the airport, at the time of evaluation the C5A was the largest type. Table 2.4-5 gives pertinent characteristics of typical air carrier aircraft. Since most of the aircraft movements at Harrisburg International Airport are of the air carrier type, the use of air carrier accident statistics were considered appropriate.

In estimating the probability of an air carrier aircraft strike, it was assumed that there are 80,000 air carrier movements per year at Harrisburg International Airport, which was about five times the 1989 annual rate. During the 10 year period 1979 to 1988, total air carrier movements in the U.S. increased by a factor of about 37 percent. If the national increase in the next ten years is like that in the past ten and Harrisburg International Airport increases at twice that national rate, it would have about 62,000 movements per year by 1999, but would not reach 177,000 movements during the plant lifetime if movements continued to increase by the same increment each year. Even if a doubling of the movements in five to ten years is assumed and if this very fast increase were achieved and sustained, 177,000 movements per year could be realized by sometime between 1990 and 2000. Since the midpoint of assumed plant life will be about 1994, the assumption of 177,000 air carrier movements a year as a basis for statistical analysis is believed to be reasonable.

Using the data of the National Transportation Safety Board summarized in Table 2.4-2, individual accident briefs were examined to determine the portion of the total fatal accidents which occurred in the proximity of airports (i.e., within a 5 mile radius of the end of the runway being used). The results are summarized in Table 2.4-3. The types of aircraft involved in these accidents are listed in Table 2.4-4.

The accidents which involved one or more fatalities were chosen as the basis for estimating the probability of the types of crashes which could have a significant effect on the plant because the occurrence of fatalities is usually due to high deceleration rates and/or large fires. Nonfatal accidents were not included because examination of the records indicates that those occurring away from the airport runways usually have some direction and altitude control before impact and are of the type in which there is a good chance large structures could have been avoided.

Fatal landing accidents inside the area ± 0.5 mile from the runway extended centerline were excluded.

Fatal takeoff accidents within a radius of 1 mile were excluded. Fatal accidents outside a 5 mile radius were excluded on the grounds that accidents further out were not representative of the type which would affect the plant due to its proximity to the airport.

Random geographic distribution within a 4 mile radius was assumed for the fatal accidents selected as a data base. Random distribution was assumed because the actual distribution with respect to a runway in use appeared to be random.

The estimates of strike probability are based on statistics for the probability of a fatal accident per landing or takeoff for the 10 year period 1978 through 1987, inclusive. Accident statistics for the future will probably be different. However, fatal accident probability per landing and takeoff is expected to decrease in the future because of expected improvements in aircraft and engine reliability, new aircraft testing, navigation equipment and methods, pilot training, and fire control after impact. Further, Harrisburg International Airport has a long runway (8000 ft) which should contribute to the safety of landing and takeoff operations (it is about 1500 ft longer than the main runway at Washington National Airport and has a 1000 ft overrun on each end).

For the reason discussed above, it is probable that the fatal accident probability chosen for the statistical analysis is reasonable and may be conservative.

During the 10 year period 1978 - 1987, there were approximately 59 million aircraft arrivals and 59 million departures. Therefore, the applicable accident frequency (f) is about $4/(59 \times 10^6)$, or 6.8×10^{-8} per departure and $7/(59 \times 10^6)$, or 1.2×10^{-7} per landing considering the selection criteria aforementioned.

The probability of a crash on the station for any one landing or takeoff was taken to be the applicable accident frequency times the ratio of the "target area" of the plant to the "total area" in which the applicable accidents are assumed to happen with random distribution. These areas were estimated as follows:

a. The "target area" for arrival (landing) accidents was assumed to be approximately the horizontal area (on the ground) which would be covered by the plant plus the shadow cast by the largest vertical cross section of the plant (excluding cooling towers) assuming light rays emanate from the plane as it approaches the plant along a line inclined 10 degrees above the horizontal. This angle was chosen as being a typical descent line for airplanes crashing on landing. (If the angle were greater, the area would be less and the probability of a strike would be less.) The area of the shadow so obtained was increased by 50 percent to account for airplanes which might crash in front of the plant and slide into it. The resulting target area for arrival accidents (here called A_a) is about 0.0225 square miles.

b. The "target area" for departure (takeoff) accidents was similarly estimated using a 45-degree approach angle believed typical of departure crashes. This area (here called A_d) was estimated to be 0.0066 square miles.

c. The "total area" for random distribution of departure accidents (here called A_{td}) is $\pi (4)^2 - \pi (1)^2 = 47.1$ square miles. Similarly, the "total area" for arrival accidents (A_{ta}) is approximately $\pi (4)^2 - \pi (0.5)^2 = 49.5$ square miles.

For any one arrival, the probability (P_a) of hitting the plant is:

$$P_a = f_a A_a/A_{ta} = 1.2 \times 10^{-7} \times \frac{0.0225}{49.5} = 5.4 \times 10^{-11}$$

Similarly, for any one departure, the probability of hitting the plant is:

$$P_d = f_d A_d/A_{td} = 6.8 \times 10^{-8} \times 0.0066/47.1 = 9.5 \times 10^{-12}$$

and for both departures and arrivals the average probability is:

$$\frac{Pa \pm Pd}{2} = 3.2 \times 10^{-11}$$

This is equivalent to a recurrence interval of one strike every 3.1×10^{10} years per aircraft movement per year.

If it is assumed that there are about 177,000 aircraft movements a year at Harrisburg International Airport and that half of the takeoffs (44,250) and half the landings (44,250) are from the end of the runway nearest the plant and therefore could affect it, the chance for the plant being hit is:

$$p = 44{,}250\ (P_a+P_d) = 44{,}250\ (5.4 \times 10^{-11} + 9.5 \times 10^{-12}) = 2.8 \times 10^{-6}$$

This is equivalent to a recurrence interval for a crash on the plant of about once in 0.36 million years.

In estimating the effect of impact on the plant, it has been assumed that the impact speed is up to 200 knots. The fact that the speed limit in the geographical area of interest is 180 knots would indicate that the assumption of a 200 knot impact speed is reasonable.

Analyses have been performed to determine the effects of the unlikely event of the simultaneous rupture of four steam lines outside the Reactor Building as a result of an aircraft impact. Blowdown of both steam generators will cause the Reactor Coolant System Temperature to decrease to about 490F at 43 seconds. Reactor trips on high neutron flux or low reactor coolant pressure caused by the initial cooldown.

Both steam generators blow dry in 43 seconds after the ruptures. Since feedwater has been isolated, the accident is terminated, and the core does not return to criticality.

An equilibrium reactor system cooldown and depressurization is achieved by operator-controlled emergency feedwater flow with steam relief out of the steam line breaks.

2.4.2.3 Probability Of A Strike By A Very Large Aircraft [redacted]) At a High Angle ([redacted]) On a Critical Structure

The critical structures referred to in the title of this Subsection are those which are protected for direct strikes of large aircraft as described in Chapter 5.

[redacted]

It is assumed that very large aircraft comprise 3 percent of the total assumed air carrier movements at Harrisburg International Airport or 0.03 x 177,000 = 5310 movements/year.

[redacted]

Flight path angle (relative to the horizontal) was assumed to be randomly distributed from 0° to 20° for landing accidents and 0° to 90° for takeoff accidents. The probability of a strike from selected directional quadrants was assumed to be 40 percent from a quadrant from 300° through north to 30°; 40 percent from a quadrant from 30° to 120°; 10 percent from 120° to 210°; and 10 percent from 210° through 300°.

These percentages were selected by considering the plant location with respect to the airport and surrounding terrain. The horizontal angle of approach in any quadrant was assumed to be random.

The strike probability for large aircraft was taken to be 2.8×10^{-6}/yr based on an assumed virtual target area of 630,000 ft^2 for landing and 185,000 ft^2 for takeoff accidents. About 64 percent of the strike probability was due to landing and 36 percent due to takeoff accidents.

[redacted]

For takeoff accidents, the probability of a very large airplane strike from a given quadrant is:

$$P_T = 2.8 \times 10^{-6} \times 0.03 \times 0.36 \times Q = 3.0 \times 10^{-8}\ Q$$

and for landing accidents it is:

$$P_L = 2.8 \times 10^{-6} \times 0.03 \times 0.64 \times Q = 5.4 \times 10^{-8}\ Q$$

Where Q represents the fraction of total strikes arriving from a given directional quadrant.

(b) (5) [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

The result indicates that the sum of probabilities from all quadrants is about 1.7×10^{-8}/yr.

2.4.2.4 Probability Of Small Aircraft Strike

The amount of general aviation movements in the Harrisburg area has been estimated by reviewing information received directly from airport records. In 1989, there were a total of 124,700 landings plus takeoffs, or 62,350 landings and 62,350 takeoffs at Harrisburg area airports. Of these, about 46 percent occurred at Capital City and 54 percent at Harrisburg International Airport. Typical types of aircraft involved are Beechcraft, Piper, and Cessna. Characteristics of the largest and smallest of each aircraft of these types are given in Table 2.4-6.

Accident data for general aviation operations were obtained from the National Transportation Safety Board Annual Review Reports (Reference 22) and are given in Table 2.4-7. In 1986 and 1987, there were a total of 58,525,000 hours flown under the category of general aviation. In order to relate these data to numbers of landings and takeoffs, it is necessary to make a judgment of the average flight duration. This is assumed to be 1 hour. Thus, the assumed total number of landings plus takeoffs is 11.7×10^{7} for the years 1986 and 1987.

Of the general aviation accidents, only the fatal accidents are considered because in nonfatal accidents the pilot is assumed to have enough control to be able to avoid the plant. Some fatal accidents may also be of this type.

The ranges of interest are 2 to 3 miles for Harrisburg International Airport traffic and 7 to 8 miles for Capital City traffic. From a smooth curve fitted to the data in Table 2.4-7, the respective numbers of accidents are 60 and 15 over the 2 year period for these two ranges.

For Harrisburg International Airport operations, the probability (P_H) of there being a fatal crash within 2 to 3 miles is as follows for any landing or takeoff operation:

$$P_H = \frac{60}{(11.7 \times 10^7)} = 0.51 \times 10^{-6}/\text{operation}$$

The projected number of landing plus takeoff operations at Harrisburg International Airport is 0.54 (124,700) = 67,300 per year. Thus, the probability of there being a fatal airplane crash within the 2 to 3 miles is:

$$0.51 \times 10^{-6} \times 67{,}300 = 0.34 \times 10^{-1}/\text{year}$$

The average "virtual target" area assumed for the plant for landing and takeoff accidents is approximately 0.015 square miles. This is 0.95×10^{-3} times the area within the 2 and 3 mile circles.

Thus, assuming random geographical distribution of the crashes within the 2 to 3 mile radius, the probability that a fatal crash resulting from Harrisburg International Airport operations would strike the Three Mile Island plant in any one year is:

$$P_H = 0.34 \times 10^{-1} \times 0.95 \times 10^{-3} = 0.32 \times 10^{-4}/\text{year}$$

Similarly, the probability ($P_{C/C}$) of a strike by a fatal crash resulting from Capital City operations would strike the Three Mile Island plant in any one year is:

$$P_{C/C} = \frac{15}{(11.7 \times 10^7)} = 0.13 \times 10^{-6}/\text{operation}$$

The projected number of landings plus takeoffs at Harrisburg/York is 0.46 (124,700) = 57,400 per year. Thus, the probability of there being a fatal crash between 7 and 8 miles of the airport is:

$$0.13 \times 10^{-6} \times 57{,}400 = 0.75 \times 10^{-2}/\text{year}$$

The area between the 7 and 8 mile circles is 47.1 square miles so that the Three Mile Island plant occupies only 0.32×10^{-3} times this area. Thus, the probability that a fatal crash resulting from Harrisburg/York operations would strike the Three Mile Island plant in any one year is:

$$P_{C/C} = 0.75 \times 10^{-2} \times 0.32 \times 10^{-3} = 0.24 \times 10^{-5}/\text{year}$$

The combined probability (P) of the Three Mile Island plant being hit by a fatal crash in any one year is then:

$$P = P_H + P_{C/C} = 0.32 \times 10^{-4} + 0.24 \times 10^{-5} = 3.4 \times 10^{-5}/\text{year}$$

The probabilities estimated above are based on the approximate number of general aviation operations in 1989. If general aviation operations in the Harrisburg area increase by a factor of 5 on the average, during life of the plant, and if the accident rates remain the same as assumed, the probability (P'_S) would increase by a similar factor and would be about:

$P'_S = 2 \times 10^{-4}$/year

2.4.2.5 Probability Of Fire From An Aircraft Strike

a. Small Fires

As indicated in Table 2.4-7 for general aviation aircraft, about 32 percent of fatal crashes have postaccident fires. If this ratio is assumed valid for crashes on the plant, then the probability (P) of crash fires would be about:

$P = 2 \times 10^{-4} \times 0.32 = 6.4 \times 10^{-5}$/year

This assumes that the general aviation movement rate is five times the 1989 rate. Examination of Table 2.4-6 indicates these crashes will probably involve less than 400 gallons of fuel and average less than 100 gallons.

b. Medium Fires

Medium fires are taken to be those wherein more than 400 but less than 3000 gallons of fuel are involved. At the present time, about 57 percent of movements at Harrisburg International Airport involve airplanes with a maximum fuel capacity of 3000 gallons, or less. If, however, it is assumed that at the time air carrier movements reach 177,000 per year, 50 percent of the airplanes involved carry less than 3000 gallons when landing or taking off, then the probability (P) of a medium fire is:

$P = 2.8 \times 10^{-6} \times 0.5 = 1.4 \times 10^{-6}$/year

assuming all air carrier crashes on the plant result in fires.

c. Large Fires

Similarly, the probability (P) of large fires (where more than 3000 gallons of fuel are involved) can be estimated assuming 50 percent of air carrier operations have more than 3000 gallons aboard when landing or departing. Thus:

$P = 2.8 \times 10^{-6} \times 0.5 = 1.4 \times 10^{-6}$/year

Improvements in aircraft design, fire prevention systems, and fuel technology, especially for large aircraft, are expected to reduce the probability of postcrash fires in the future. By the time air traffic movement rates reach those assumed in making the probability estimates above, significant improvements should be realized. Thus, from this viewpoint, the probability of postcrash fires, especially for large aircraft, should be less than assumed.

d. Fuel or Fires Affecting Critical Ventilation Openings

The probability of fire or fuel from a small airplane crash affecting the ventilation intake or outlet for the Control Room and other protected areas can be approximated by assuming that the "virtual target" is the area of the opening plus the area around it which could be hit and cause the opening to be subjected to fire or to liquid fuel or vapors at flammable concentrations. The openings are less than 400 ft^2. For a small plane crash carrying an average of about 100 gallons of fuel, it is assumed the fuel-affected area could be about 10 ft x 50 ft or 500 ft^2. This is believed to be a larger area than would be affected on the average.

The "virtual target" area assumed in deriving the probability for a small plane crash in Subsection 2.4.2.4 above is 0.015 $miles^2$ or about 4×10^5 ft^2, and the probability of a crash (at five times present traffic density) is 2×10^{-4}/year. The probability (P) of a strike on the ventilation openings can be estimated by multiplying this probability by the ratio of "virtual target" areas or:

$$P = 2 \times 10^{-4} \times \frac{500}{4 \times 10^5\ Ft^2} = 2.5 \times 10^{-7}/\text{Year}$$

This neglects the effect of protection afforded to the openings by structures which could intercept an approaching aircraft.

Consequently, the probability has been taken as being one half that estimated above or 1.3×10^{-7}/year.

To estimate the probability contribution from large aircraft (air carrier planes), the average amount of fuel carried has been assumed to be 5000 gallons, assuming that only a very few, if any, very large planes (i.e., B747's) will use Harrisburg International Airport.

The area affected by spread of fuel from the crash of an aircraft carrying 5000 gallons is assumed to be about 25 ft x 1000 ft or 25,000 ft^2.

The probability (P) for arriving and departing accidents is given as 2.8×10^{-6}. If these are multiplied by the ratio of the "virtual target" area estimated above to the average virtual target area assumed in deriving the large plane strike probability, the result is an approximate estimate of the probability of fuel or fire from a large aircraft crash affecting critical ventilation openings. Thus,

$$P = 2.8 \times 10^{-6} \times \frac{2.5 \times 10^4}{4 \times 10^5} = 1.8 \times 10^{-7}/\text{year}$$

This also neglects the effect of protection afforded the ventilation openings by structures which could intercept the approaching aircraft. Consequently, the probability is taken to be about one half that estimated above, or 9×10^{-8}/year.

The combined probability (P) for large and small aircraft crashes affecting the ventilation opening is:

$$P = 2.2 \times 10^{-7}/\text{year.}$$

TABLE 2.4-1
(Sheet 1 of 1)
APPROXIMATE PROBABILITIES FOR AIRCRAFT CRASH EFFECTS
ON THE THREE MILE ISLAND PLANT

		Approximate Mean Strike Probability/yr[1]	Approximate Recurrence Interval/yrs
1.	Large aircraft on plant (see Section 2.4.2.2)	2.8×10^{-6}	3.6×10^{5}
2.	Large aircraft [redacted] at high angle ([redacted] on surface of critical structures[2] (see Section 2.4.2.3)	1.7×10^{-8}	5.9×10^{7}
3.	Small aircraft on plant (see Section 2.4.2.4)	2×10^{-4}	5×10^{3}
4.	Fire from an aircraft strike on the plant (see Section 2.4.2.5)		
	Small fires (<400 gal. of fuel)	6.4×10^{-5}	1.6×10^{4}
	Medium fires (400-3000 gal of fuel)	1.4×10^{-6}	7.1×10^{5}
	Large fires (>3000 gal of fuel)	1.4×10^{-6}	7.1×10^{5}
	Fuel or fire affecting critical ventilation openings[3]	2.2×107^{-7}	4.5×10^{6}

1 In making these approximations of strike probability, the effect of overflights has been ignored. In a region of medium air traffic overflight density this probability may be in the range of 10^{-7}/yr for light aircraft and 10^{-8}/yr for large aircraft if the same type of assumptions are used as in devising the probabilities in this table.

2 Critical structures are those protected against strikes of large aircraft and against crash fires. They are discussed in Chapter 5 of the FSAR.

3 Critical ventilation openings are protected against the effects of fuel or fire. The probability represents the chance that fuel or fire will occur in the immediate vicinity of the openings.

TABLE 2.4-2
(Sheet 1 of 1)

SUMMARY OF U.S. AIR CARRIER ACCIDENTS [1,2]

YEAR	TOTAL ACCIDENTS	FATAL ACCIDENTS[3]
1978	22	5
1979	29	5
1980	19	1
1981	26	4
1982	20	5
1983	24	4
1984	17	1
1985	22	7
1986	24	3
1987	36	5

[1] From "Annual Review Aircraft Accident Data, U.S. Air Carrier Operations, Calendar year 1987", National Transportation Safety Board, PB91-119693, NTSB/ARC-90/01

[2] All 14CFR121, 125 and 127 operations.

[3] Fatal accidents are those in which one or more human fatalities occurred.

TABLE 2.4-3
(Sheet 1 of 1)
FATAL ACCIDENTS IN THE PROXIMITY OF AIRPORTS[1,2]
(14CFR121, 125, 127 OPERATIONS)

YEAR	TOTAL	NUMBER ARRIVING	DEPARTURE
1978	2	2	0
1979	3	1	2
1980	0	0	0
1981	0	0	0
1982	3	1	2
1983	1	1	0
1984	0	0	0
1985	4	2	2
1986	0	0	0
1987	2	1	1
	15	8	7

[1] Source: Aircraft Accident Briefs, National Transportation Safety Board, Department of Transportation.

[2] Within a 5 mile radius of the end of the runway being estimated. National Transportation Safety Board started in 1982 compiling data for airport proximity based on the following three categories: on airport, on airstrip, and off airport/airstrip.

TABLE 2.4-4
(Sheet 1 of 1)

TYPES OF AIRCRAFT INVOLVED IN THE FATAL ACCIDENTS LISTED IN TABLE 2.4-3[1,2]

YEAR	AIRCRAFT
1978	B727, B727
1979	L188C, DHC6, DC10
1980	None
1981	None
1982	B737, DC10, B727
1983	Hawker HS748
1984	None
1985	L188A, L188C, L1011, DC9
1986	None
1987	B707, DC9

1 Source: Aircraft Accident Briefs, National Transportation Safety Board, Department of Transportation.

2 Within a 5 mile radius of the end of the runway being estimated. National Transportation Safety Board started in 1982 compiling data for airport proximity based on the following three categories: on airport, on airstrip, and off airport/airstrip.

TABLE 2.4-5
(Sheet 1 of 2)

CHARACTERISTICS OF TYPICAL AIR CARRIER AIRCRAFT[1]

TYPE	MODEL	WEIGHT[2] Maximum Takeoff (lb)	Maximum Landing (lb)	DIMENSIONS Wing Span	Length (Overall)
C-121		135,400			
Conv.	580	58,140	52,000	105'4"	81'6"
DC-9	30	98,000	93,400	93'5"	119'3-1/2"
F-27	J	42,000	40,000	95'2"	77'2"
B-707	331-C)	331,000	247,000	145'9"	162'11"
	320-C)	331,000			
Shorts	360	27,100	26,500	74'9-1/2"	70'9-5/8"
[1] Others-Not Used at Harrisburg International But inOperation in U.S.					
B-737	200	107,000	97,000	93'	100'
B-727	200	169,000	148,000	108'	153'2"
B-720	B	234,000	175,000	130'10"	136'9"
B-707	120B	257,000	190,000	130'10"	145'1"
C-130	E	155,000	130,000	132' 7"	97'9"
Electra (185 Orion)		128,000	91,300	99'8"	116'10"
[1] Other Planned for Operation in U.S.					
DC-10		386,500	?	155'4"	179'8"
B-747		680,000	564,000	195'8"	231'4"
C5A (107-C)		764,500	635,850	222'8-1/2"	245'11

[1] Unless otherwise noted, from Jane's All the World's Aircraft (1967-68 and 1990-91 editions).
[2] Weight for heaviest model.

TABLE 2.4-5
(Sheet 2 of 2)
CHARACTERISTICS OF TYPICAL AIR CARRIER AIRCRAFT[1]

TYPE	MODEL	ENGINES Number	FUEL Gallons	SPEED Cruise	SPEED Stall (Max. No. Flaps Down)	PASSENGERS Max. No.
C-121						
Conv.	580	2	2,800	--		50
DC-9	30	2	2,786	561		90
F-27	J	2	2,786	324		48
B-707	331-C) 320-C)	4	23,855	600	100	202
Shorts	360	2	576	216	--	36

[1] Others-Not Used at Harrisburg International But In Operation in U.S.

TYPE	MODEL	ENGINES Number	FUEL Gallons	SPEED Cruise	SPEED Stall	PASSENGERS Max. No.
B-737	200	2	4,670	600	100	113
B-727	200	3	7,680	592	115	189
B-720	B	4	14,880	557	100	116
B-707	120B	4	17,334	627	110	185
C-130	E	4	9,680	368	--	--
Electra (185 Orion)		4	9,200	476	--	--

[1] Others Planned for Operation in U.S.

TYPE	MODEL	ENGINES Number	FUEL Gallons	SPEED Cruise	SPEED Stall	PASSENGERS Max. No.
DC-10		4		600	100	250
B-747		4	50,320	615	100	490
C5A (107-C)		4	49,000	577	--	--

[1] Unless otherwise noted, from Jane's All the World's Aircraft, (1967-68 and 1990-91 editions).

TABLE 2.4-6
(Sheet 1 of 1)

TYPICAL GENERAL AVIATION AIRCRAFT CHARACTERISTICS[1,2]

Type	Piper		Beechcraft		Cessna	
Model	Cherokee (PA 28-180)	Navajo	Bonanza (V-35)	99	150	421
Weight, lb	2400	6200	3400	10,200	1600	6800
Engines-number	1	2	1	2	1	2
Fuel	50	190	80	374	38	202
Gallons (max.)						
Type	gas	jet	gas	jet	gas	jet
Cruise Speed	152	224	210	250	123	238
Flaps down stall speed	57	77	63	-	48	87

[1] From Jane's All the World's Aircraft, (1967-1968 edition).

[2] Includes Largest and Smallest of each Type.

TABLE 2.4-7
(Sheet 1 of 1)

GENERAL AVIATION
TOTAL FATAL ACCIDENTS IN CONTINENTAL U.S.
(1956-1966 Inclusive)

Phase of Operation (Estimated Distance from Airport)* (miles)		Fatal Accidents
Standing, Taxi, Takeoff, Approach or Landing (0-2)		311
Climb or Descent (2-5)		102
Maneuvering or Cruise (Beyond 5)		470
Other or not reported		44
	Total	927
Fire after impact		296

* Due to change in how General Aviation Accident Data is compiled, assumptions regarding estimated accident distance from airport were made to keep the methodology for this update consistent with the original FSAR.

2.5 METEOROLOGY

2.5.1 GENERAL

General climatic conditions in the site region are characterized by a continental type climate, modified and protected somewhat from more severe weather by the Appalachian Mountain Ridge to the north. Summers tend to be warm and humid, and winters are cool, with frequent periods of precipitation. Severe weather conditions are discussed in Subsection 2.5.2.

An on site meteorological data collection program has been in operation since May 1967. Wind speed and direction have been continuously recorded 100 ft above grade elevation on Three Mile Island; and, 2.5 miles north, at the 25 ft above grade elevation at Crawford Station for a 2 year period of record ending May 1969. Identical data were analyzed to provide a basis for evaluation of routine gas release limits, as described in Subsection 2.5.3. Accident meteorology is described in Subsection 2.5.4. Tables 2.5-1A through 2.5-1D show histograms of the valid wind speed and direction data (an X represents a good data hour) for the Three Mile Island weather tower from May 1967 through May 1969.

Wind roses based on measured data (1967 through 1969) at the site and at Crawford Station are shown on Figures 2.5-1 and 2.5-2, respectively.

2.5.2 SEVERE WEATHER

In more than 75 years of record at the Harrisburg-York Municipal Airport and 56 years of record at the Harrisburg International Airport, the highest and lowest temperatures recorded were 107 and -22F, respectively. Maximum monthly rainfall was 18.55 inches, maximum 24 hour rainfall 12.55 inches, and maximum 24 hour snowfall 24.0 inches. Maximum annual snow accumulation was 81.3 inches.

During the 92 year period 1871 through 1963, 33 hurricane or tropical storm center paths passed within about 100 miles of the site. Most of these were in dissipation stages. The most severe was "Hazel," the center of which passed just west of Harrisburg on October 15, 1954. A peak gust of 80 mph was recorded at the Harrisburg-York Municipal Airport during the passage of Hazel.

In June 1972, Hurricane Agnes passed through causing severe flooding in Harrisburg, Middletown, and surrounding areas.

During the 52 year period from 1917 through June 1969, 22 tornados were reported within a 25 mile radius of the plant site (Reference 2). They are listed in Table 2.5-1. During this same period, four were reported within 10 miles and one within 5 miles of the site. Based on these observations, the probability of a tornado occurring within a 25 mile radius would be about 0.4 per year. However, during the 10 year period 1958 through 1968, the frequency was about 0.7 per year. The higher frequency in the later period probably reflects an improvement in observations rather than a real increase. A small tornado occurred on October 18, 1967, which caused minor damage in Londonderry Township, approximately 3 miles from the plant.

Based on studies by the Weather Bureau (Reference 3) wind speeds 30 ft above the site grade are expected to exceed 78 mph once in 100 years. As used here, wind speed is taken as the average speed during the passage of one linear mile of air past the wind instrument. Taking account of the relationship between maximum wind speeds and short term gusts (Reference 4) it is not expected that gusts will exceed 103 mph at the site more than once in 100 years. The fastest mile wind during 27 years of records at Harrisburg was 68 mph from the west in March 1955.

2.5.3 ANNUAL AVERAGE ATMOSPHERIC DIFFUSION CONDITIONS

Annual average atmospheric diffusion conditions at the site have been developed for use in determining routine gas release limits discussed in Chapter 11. Using 2 years of TMI site data (1967 through 1969), averaged values of X/Q for each direction sector were determined according to the following relationship:

$$X/Q \text{ Sector Average} = 2.03\ (1/x)\ (1/\hat{u})\ \frac{1}{\sigma_z\{x+x'\}}$$

This is an integrated form of the Pasquill diffusion relationship (References 5 and 6) and assumes a ground level source at a virtual source distance x' upwind from the actual source to account for dilution vertically from the building wake.

The symbols have the following meaning:

x = Distance from source (m)

x' = Virtual source distance (m)

X = Average concentration at ground level in a given 22-1/2 degree sector (curies/m^3)

Q = Average release rate (curies/sec)

$\overline{\frac{1}{\hat{u}}}$ = Harmonic mean of the reciprocal of wind speed (sec/m)

$\sigma_z(x+x')$ = Vertical diffusion coefficient (m), evaluated at (x+x')

Using the site data to determine wind speed, atmospheric diffusion, and wind direction, values of X/Q were computed for each of 48 combinations of wind speed and diffusion categories. These values were then time weighted and added in each of the 16 direction sectors to determine the average values. The wind speed (mph) categories were: 1 to 3, 4 to 7, 8 to 12, 13 to 18, 19 to 25, 26 to 32, 33 to 40, and 40+. The stability categories were A through F as discussed below. The type of diffusion condition was assumed to be a function of wind direction range using relationships suggested in Reference 7. It was assumed that the standard deviation of horizontal wind direction is related to Pasquill diffusion conditions as in the following table:

Measured Values of Wind Direction Range Divided by 6	Type of Diffusion Condition
0 to 3.67	F
3.67 to 7.5	E
7.5 to 12.5	D
12.5 to 17.5	C
17.5 to 22.5	B
Greater than 22.5	A

Values for the standard deviation of wind direction were determined by dividing the maximum wind direction range measured over a 1 hr period by a factor of 6, as suggested in Reference 7. The values used for the vertical diffusion coefficient σ_z were taken as a function of distance and diffusion condition as shown in Reference 6. The virtual source distances assumed for diffusion conditions A through F are 100, 100, 100, 300, 400, and 700 meters, respectively.

In evaluating the data, it was found that during periods of low wind speed (usually during nighttime), the wind was unsteady, resulting in large values of wind direction range. These highly variable wind direction measurements probably represent good lateral diffusion conditions (higher values of σ_y); however, the vertical diffusion coefficient may not be conservatively represented. To account for this, any range values exceeding 120° during the daytime with wind speeds less than 3 mph were given a value of 120° corresponding to B type diffusion. For nighttime hours, any range values exceeding 75° with wind speeds less than 3 mph were given a range value of 30° corresponding to E type diffusion. Thus, the valley inversion condition which might be expected to occur under these conditions is conservatively taken into account.

Calm conditions were assumed to have the same diffusion (X/Q) and direction value as the next noncalm hour of data.

Using methods described above, isopleths of average annual (X/Q) were derived. They are shown with respect to the local area around the site on Figure 2.5-3. The nearest uncontrolled land area would have an estimated ground level average annual dispersion factor (X/Q) of about 4.5×10^{-6}.

Figure 2.5-7 shows an isopleth of average annual X/Q based on the methods described above except that delta-T from the north tower and the AEC Safety Guide 23 diffusion categories were used to determine σ_z. The data were from the 1 yr period April 1971 through March 1972. Based on this figure, the nearest uncontrolled land area would have an estimated dispersion factor (X/Q) of about 7.5×10^{-6} sec/m^3.

Summary tables of the reduced data, corrected as discussed above for unsteady conditions, used in this analysis are shown in Tables 2.5-8 through 2.5-13. The measured data are given in Tables 2.5-2 through 2.5-7. The number of calms and time of day during which they occurred are given in Table 2.5-14.

2.5.4 ACCIDENT METEOROLOGY

Accident atmospheric dispersion coefficients (X/Q) have been determined at the Exclusion Area Boundary (EAB), Low Population Zone (LPZ), and various locations of potential contaminant entrance into the Control Room to provide a basis for assessing radiation exposure during accidents described in Chapter 14. Hourly site meteorological data for the years 1992, 1993, 1995, and 1996 were used to determine the dispersion coefficients. The data included wind speed and wind direction collected at the 100-Ft. instrument level and vertical temperature difference determined from the 150-Ft. and 33-Ft. instrument levels. The combined data recovery of speed, direction and delta temperature is indicated below:

Year	Combined Percent Recovery
1992	99.3
1993	99.3
1995	99.2
1996	98.9

2.5.4.1 EAB and LPZ Dispersion Coefficients

Atmospheric dispersion coefficients for the EAB and LPZ were determined utilizing the methodology described in NRC Regulatory Guide 1.145 Revision 1. The analysis (Ref. 32) was performed using the proprietary WINDOW computer code of PLG Inc. and the meteorological data described above. The analysis assumed the total of all releases as ground level releases from point sources at the containment building surface. The effects of building wake and plume meander were evaluated for these releases per R.G. 1.145. Distances to the EAB were determined in accordance with the methods of R.G. 1.145 for each of the 16 direction sectors. The distance measurements excluded the containment radius in each of the sixteen directions. The LPZ distance consisted of a 2-mile radius circle (3218 meters) centered on the containment building.

Wind speed measurements taken at the 100-Ft. instrument level were corrected to 33-Ft. level (10 meters) for use with the R.G. 1.145 equations. The correction was made using the following relation:

$$U_{33Ft} = U_{100Ft} \, (h_{33Ft} / h_{100Ft})^{n}$$

U - wind speed
h - height
n - exponent as function of stability

n = 0.25 for Pasquill Stability Classes A, B and C
n = 0.33 for Pasquill Stability Class D
n = 0.50 for Pasquill Stability Classes E, F and G

The Pasquill diffusion class was determined using vertical temperature difference and the categories given in NRC Regulatory Guide 1.23. Values of σ_y and σ_z were determined as a function of distance and stability class using the standard Pasquill – Gifford curves contained in Figures 1 and 2 of R.G. 1.145.

Cumulative probability distributions were determined in each of the 16 directions using the direction dependent method for the EAB and LPZ distances and the 4-year hourly data. An envelope was constructed around the 16 direction dependent curves to determine the sector with the maximum 0.5% probable value (i.e. the value exceeded no more than 0.5% of the time). An additional cumulative probability distribution was determined for both the EAB and LPZ using the direction independent method for all of the data. The two methods were compared as required by R.G. 1.145 to determine the higher X/Q value. The direction dependent method yielded higher X/Q values for the EAB and LPZ.

The results of the analysis yield the following X/Q values for the time intervals of interest.

EAB

Interval (Hours)	X/Q (sec/m^3)
0-2	8.0E-04

LPZ

Interval	X/Q (sec/m^3)
0-2 Hours	1.4E-04
2-8 Hours	6.0E-05
8-24 Hours	3.9E-05
1-4 Days	1.6E-05
4-30 Days	4.0E-06

2.5.4.2 Control Room Dispersion Coefficients

The site geometry for structures and ventilation intakes relative to the various release locations and potential contaminant entrance pathways into the control room establish several site-specific pathways for the determination of atmospheric dispersion coefficients. These have included releases to the designed control building ventilation system intake (Yard Intake). Yard Intake scenarios evaluate dose release points from the Reactor Building (general location), Unit Vent, Personnel Hatch, Equipment Hatch, and Equipment Airlock. In addition, releases from the containment building to the ventilation exhaust, releases from the auxiliary building to the yard intake, and releases from the borated water storage tank (BWST) vent to the yard intake are evaluated. The methodology for determining the dispersion coefficients is varied and dependent upon the type of release, its relative distance to the intake locations, and the meteorological conditions. The meteorological data described above was used for these analyses. Each release pathway and the methodology used for the determination of the dispersion coefficients are described below.

2.5.4.2.1 Containment Release to Yard Intake

The atmospheric dispersion coefficients for a containment release to the control building ventilation system via the yard intake have been determined using the diffuse leak approach of the ARCON96 computer code. This approach transforms the diffuse release into a virtual point source located upstream of the containment structure. The analysis (Ref. 33) utilizes the NRC recommended 3-sigma approach for conservatively estimating initial diffusion coefficients required by the code for establishing the virtual source distance. The shortest distance between the containment building surface and the yard intake was used as input to the analysis. Release from the containment building was assumed to be ground level.

The results of the analysis are indicated below:

Containment to Yard Pathway

Interval	X/Q (sec/m^3)
0-2 Hours	3.40E-04
2-8 Hours	2.25E-04
8-24 Hours	1.02E-04
1-4 Days	7.61E-05
4-30 Days	4.99E-05

Additional 95% confidence atmosphere dispersion coefficients for the fuel handling accident in the containment involving release through containment venting or open hatches to the control building ventilation system via the yard intake have also been determined using the ARCON96 computer code (Reference 36). These releases can be from the unit vent, personnel hatch, equipment hatch, or emergency air lock with the bounding of these being from the unit vent.

Worst-Case Fuel Handling Accident in Containment to Yard Pathway

Interval	X/Q (sec/m^3)
0-2 Hours	5.34E-04
2-8 Hours	3.10E-04
8-24 Hours	1.36E-04
1-4 Days	9.70E-05
4-30 Days	6.02E-05

2.5.4.2.2 Containment Release to Ventilation Exhaust

The control building ventilation exhaust point normally discharges ventilation system exhaust from the control building to the environment. During postulated failure conditions this discharge point has been determined to be a source of contaminant entrance into the control building ventilation system. To assess the consequences of this point as a contaminant entry location it was necessary to determine a dispersion coefficient for a release from the containment structure to the ventilation exhaust opening.

The analysis (Ref. 34) utilized data sources from wind tunnel experiments to provide a conservative estimate of X/Q values. This method was used in lieu of the ARCON96 or Murphy-Campe methods because of the short distance that exists between the nearest containment release point and entrance to the ventilation exhaust. Both the ARCON96 and Murphy-Campe methods are unsuitable for this short distance and unique arrangement.

The TMI-model evaluates selective release points on the containment surfaces exposed to the environment. A fractional release is determined for each release point representative of a release area. Experimental surface concentration coefficients for buildings are used to determine X/Q. The concentration coefficient, K, is equal to (X/Q) Au, where A is the blockage area and u is wind speed. From a known blockage area associated with wind direction and speed, the sector (X/Q) u value is determined. Using the above hourly meteorological data hourly X/Q's are calculated and the applicable 95th, 90th, 80th, and 60th percentile values are determined. The resulting X/Q values at the respective intervals are as follows:

Containment to Ventilation Exhaust Pathway

Interval	X/Q (sec/m^3)
0-2 Hours	1.96E-03
2-8 Hours	1.96E-03
8-24 Hours	1.37E-03
1-4 Days	9.14E-04
4-30 Days	5.09E-04

2.5.4.2.3 Auxiliary Building Release to Yard Intake

The auxiliary building houses engineered safeguards equipment that has the potential to release contaminants to the building and environment. To assess the radiological impact of any potential releases from the auxiliary building upon the control room, it was necessary to determine an atmospheric dispersion coefficient for this type of release.

The dispersion coefficients were determined using the ARCON96 computer code and a point source release approach. The analysis (Ref. 32) assumed a ground level release from the nearest point of the auxiliary building to the yard intake. The model neglected the enhanced dispersion effects produced by adjacent structures. The resulting X/Q values were determined at the respective intervals of interest:

Auxiliary Building Release Pathway

Interval	X/Q (sec/m^3)
0-2 Hours	3.02E-03
2-8 Hours	2.08E-03
8-24 Hours	1.02E-03
1-4 Days	6.63E-04
4-30 Days	4.37E-04

2.5.4.2.4 Borated Water Storage Tank (BWST) Release to Yard Intake

Engineered safeguards equipment interfaces with the BWST and has the potential to release contaminants to the environment through the tank's vent. An atmospheric dispersion coefficient has been determined for this type of release to assess the radiological impact on the control room.

The model (Ref. 32) utilizes the ARCON96 code to determine the dispersion coefficient from the BWST to the yard intake. The release is assumed to be a vent type release from the tank's vent and is considered a point source in accordance with the ARCON96 methodology. The effects of adjacent structures on the dispersion were neglected for this analysis. The results of the analysis are indicated below:

BWST Release Pathway

Interval	X/Q (sec/m^3)
0-2 Hours	8.45E-04
2-8 Hours	5.23E-04
8-24 Hours	2.49E-04
1-4 Days	1.77E-04
4-30 Days	1.19E-04

2.5.5 Deleted

2.5.6 Deleted

TABLE 2.5-1
(Sheet 1 of 1)

TORNADOS WITHIN 25 MILES OF THREE MILE ISLAND[1]

Date	Time	Location (Closest approach to site,miles)	Approx. Path Length	Direction of Movement
11-17-1918	11:30 PM	N of Harrisburg(10+)	?	?
6-15-1926	3:00 PM	Paradise, Lancaster Co. (25)	2.5 Miles	S
4-25-1929	8:00 PM	Center of York Co. (12)	?	?
6-12-1938	2:30 PM	W. Central Dauphin Co. (15)	10 Miles	SE
7-15-1938	3:45 AM	Southern York Co.(15)	12-13 Miles	NNE
8-13-1944	2:15 PM	Central York Co. (14)	8 Miles	NE
5-22-1949	?	N. Harrisburg (9)	8 Miles	ENE
4-5 -1952	1:15 PM	Steelton (14)	3 Miles	NNE
4-5 -1952	I:15 PM	Wrightsville York Co.(10)	4 Miles	NNE
4-5-1952	1:45 PM	C. of Lancaster (19)	3 Miles	NNE
11-23-1953	2:00 AM	Landisville, Lancaster Co. (15)	3 Miles	NE
6-13-1956	7:45 PM	Central York Co. (14)	4 Miles	E
4-28-1957	8:00 PM	Central Lancaster Co. (25)	?	?
8-21-1957	2:30 PM	Harrisburg (1)	?	?
11-19-1957	2:30 PM	West-Central Lebanon Co(15)	2 Miles	NE
5-26-1961	?	Central Lancaster Co. (25)	?	?
7-29-1961	3:00 AM	Central York Co. (16)	19 Miles	ENE
?-1963	?	North-Central York Co.(7)	13 Miles	ENE
?-1964	?	Central Lebanon Co. (21)	?	?
8-26-1965	?	Northern York Co. (12)	?	?
9-21-1967	6:00 PM	Perry County (25)	Short	?
10-18-1967	Morning	Dauphin County (3)	15 Miles	

[1] For Period 1917 - June 1969

TABLE 2.5-2
(Sheet 1 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group A
(Measured Data)

Wind Speed mph)	Wind Direction Sector							
	N	NNE	NE	ENE	E	ESE	SE	SSE
1 - 3	31	4	6	17	25	33	67	65
4 - 7	9	2	7	0	5	10	13	19
8 -12	10	2	0	0	2	3	1	8
13-18	6	4	0	0	0	0	1	2
19-25	1	1	1	0	0	0	0	0
26-32	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	1	1
Totals	57	12	14	17	32	46	83	95

TABLE 2.5-2
(Sheet 2 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group A
(Measured Data)

Wind Speed mph)	Wind Direction Sector								
	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
1 - 3	60	69	68	48	71	51	65	37	717
4 - 7	24	17	20	15	34	35	55	40	305
8 -12	7	9	10	4	7	13	13	13	102
13-18	2	1	1	0	4	5	10	2	38
19-25	0	0	1	1	0	1	3	0	8
26-32	0	1	0	0	0	0	2	0	3
33-40	0	0	0	0	0	0	0	0	0
40+	1	0	0	0	0	0	0	0	3
Totals	94	97	100	68	116	105	148	92	1176

TABLE 2.5-3
(Sheet 1 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group B
(Measured Data)

Wind Speed mph)	Wind Direction Sector							
	N	NNE	NE	ENE	E	ESE	SE	SSE
1 - 3	14	6	2	11	23	30	37	41
4 - 7	4	0	0	2	11	20	20	16
8 -12	2	0	0	1	0	3	3	7
13-18	1	0	0	0	0	0	3	1
19-25	0	0	0	0	0	0	0	1
26-32	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0
40+	0	0	1	0	0	0	0	0
Totals	21	6	3	14	34	53	63	66

TABLE 2.5-3
(Sheet 2 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group B
(Measured Data)

Wind Speed mph)	Wind Direction Sector								
	S	SSW	SW	WSW	W	WNW	NE	NNW	Totals
1 - 3	36	25	25	36	29	31	25	25	396
4 - 7	28	23	19	14	35	31	32	10	265
8 -12	9	5	12	18	16	23	15	8	122
13-18	2	5	2	4	4	8	2	2	34
19-25	0	1	0	0	1	2	1	1	7
26-32	0	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	0	0	0
Totals	75	59	58	72	85	95	75	46	825

TABLE 2.5-4
(Sheet 1 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group C
(Measured Data)

Wind Speed mph)	Wind Direction Sector							
	N	NNE	NE	ENE	E	ESE	SE	SSE
1 – 3	36	8	6	41	63	37	50	44
4 – 7	17	1	2	15	33	47	42	46
8 –12	13	1	0	3	10	19	10	16
13-18	0	0	0	2	2	7	3	4
19-25	0	0	0	0	0	0	1	1
26-32	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	0	0
Totals	66	10	8	61	108	110	106	111

TABLE 2.5-4
(Sheet 2 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group C
(Measured Data)

Wind Speed mph)	Wind Direction Sector								
	S	SSW	SW	WSW	W	WNW	NW	NNW	Totals
1 - 3	55	48	64	36	34	34	37	48	641
4 - 7	47	49	56	52	62	71	44	55	639
8 - 12	20	18	32	39	58	78	47	36	400
13-18	9	5	10	20	49	40	8	5	164
19-25	1	0	3	4	9	6	5	2	32
26-32	0	0	0	0	0	1	1	0	2
33-40	0	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	1	0	0	1
Totals	132	120	165	151	212	231	142	146	1879

TABLE 2.5-5
(Sheet 1 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group D
(Measured Data)

Wind Speed mph)	Wind Direction Sector							
	N	NNE	NE	ENE	E	ESE	SE	SSE
1 – 3	70	34	32	93	52	44	62	63
4 – 7	76	19	6	65	79	90	70	82
8 –12	55	4	3	16	47	42	51	41
13-18	17	4	0	3	9	13	17	15
19-25	9	1	0	0	5	3	0	2
26-32	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	0	0
Total	227	62	41	177	192	192	200	203

TABLE 2.5-5
(Sheet 2 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group D
(Measured Data)

Wind Speed (mph)	Wind Direction Sector								
	S	SSW	SW	WSW	W	WNW	NW	NNW	Totals
1 - 3	63	65	57	46	43	36	34	44	838
4 - 7	78	73	73	52	130	82	78	70	1123
8 –12	30	38	42	53	115	121	106	86	850
13-18	10	14	10	32	110	126	95	34	509
19-25	0	0	1	7	24	54	35	13	154
26-32	0	0	0	1	2	4	11	0	18
33-40	0	0	0	0	0	1	1	0	2
40+	0	0	0	0	0	0	0	0	0
Totals	181	190	183	191	424	424	360	247	3494

TABLE 2.5-6
(Sheet 1 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group E
(Measured Data)

Wind Speed mph)	Wind Direction Sector							
	N	NNE	NE	ENE	E	ESE	SE	SSE
1 – 3	29	82	86	59	31	22	29	32
4 – 7	78	99	53	106	58	39	55	70
8 –12	64	28	14	24	22	35	33	36
13-18	32	7	4	4	8	6	15	18
19-25	19	1	0	0	3	0	0	3
26-32	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	0	0
Totals	222	217	157	193	122	102	132	159

TABLE 2.5-6
(Sheet 2 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group E
(Measured Data)

Wind Speed (mph)	Wind Direction Sector								
	S	SSW	SW	WSW	W	WNW	NW	NNW	Totals
1 - 3	73	30	17	16	9	27	25	18	585
4 - 7	57	66	29	28	65	72	72	57	1004
8 –12	43	35	11	9	77	156	102	59	748
13-18	12	6	5	9	48	175	116	39	504
19-25	0	1	3	2	19	64	54	11	180
26-32	0	0	0	0	0	9	9	0	18
33-40	0	0	0	0	0	0	1	0	1
40+	0	0	0	0	0	0	0	0	0
Totals	185	38	65	64	218	503	379	184	3040

TABLE 2.5-7
(Sheet 1 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group F
(Measured Data)

Wind Speed mph)	Wind Direction Sector							
	N	NNE	NE	ENE	E	ESE	SE	SSE
1 - 3	7	8	39	4	2	4	10	7
4 - 7	22	32	42	11	8	7	19	12
8 -12	10	16	19	2	1	2	3	8
13-18	6	4	4	0	0	5	3	3
19-25	0	1	0	0	0	0	0	1
26-32	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	0	0
Totals	45	61	104	17	11	18	35	31

TABLE 2.5-7
(Sheet 2 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group F
(Measured Data)

Wind Speed (mph)	Wind Direction Sector								
	S	SSW	SW	WSW	W	WNW	NW	NNW	Totals
1 - 3	25	3	4	2	1	3	1	4	124
4 -7	20	5	3	3	11	17	11	12	235
8 -12	5	4	3	2	14	34	5	7	135
13-18	0	0	0	0	6	27	4	7	69
19-25	0	0	0	0	2	4	3	1	12
26-32	0	1	0	0	1	0	0	0	2
33-40	0	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	0	0	0
Totals	50	13	10	7	35	85	24	31	577

TABLE 2.5-8
(Sheet 1 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group A
(Corrected for Unsteady Conditions)

Wind Speed mph)	Wind Direction Sector							
	N	NNE	NE	ENE	E	ESE	SE	SSE
1 - 3	16	1	1	5	5	7	18	28
4 - 7	9	2	7	0	5	10	13	19
8 -12	10	2	0	0	2	3	1	8
13-18	6	4	0	0	0	0	1	2
19-25	1	0	1	0	0	0	0	0
26-32	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	1	1
Totals	42	9	9	5	12	20	34	58

TABLE 2.5-8
(Sheet 2 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group A
(Corrected for Unsteady Conditions)

Wind Speed (mph)	Wind Direction Sector								
	S	SSW	SW	WSW	W	WNW	NW	NNW	Totals
1 - 3	21	14	18	12	31	21	31	27	256
4 - 7	24	17	20	15	34	35	55	40	305
8 -12	7	9	10	4	7	13	13	13	102
13-18	2	1	1	0	4	5	10	2	38
19-25	0	0	1	1	0	1	3	0	8
26-32	0	1	0	0	0	0	2	0	3
33-40	0	0	0	0	0	0	0	0	0
40+	1	0	0	0	0	0	0	0	3
Totals	55	42	50	32	76	75	114	82	715

TABLE 2.5-9
(Sheet 1 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group B
(Corrected for Unsteady Conditions)

Wind Speed mph)	Wind Direction Sector							
	N	NNE	NE	ENE	E	ESE	SE	SSE
1 - 3	14	5	4	13	23	35	37	35
4 - 7	4	0	0	2	11	20	20	16
8 -12	2	0	0	1	0	3	3	7
13-18	1	0	0	0	0	0	3	1
19-25	0	0	0	0	0	0	0	1
26-32	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0
40+	0	0	1	0	0	0	0	0
Totals	21	5	5	16	34	58	63	60

TABLE 2.5-9
(Sheet 2 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group B
(Corrected for Unsteady Conditions)

Wind Speed (mph)	Wind Direction Sector								
	S	SSW	SW	WSW	W	WNW	NW	NNW	Totals
1 - 3	33	37	36	37	39	19	30	18	415
4 - 7	28	23	19	14	35	31	32	10	265
8 -12	9	5	12	18	16	23	15	8	122
13-18	2	5	2	4	4	8	2	2	34
19-25	0	1	0	0	1	2	1	1	7
26-32	0	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	0	0	1
Totals	72	71	69	73	95	83	80	39	844

TABLE 2.5-10
(Sheet 1 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group C
(Corrected for Unsteady Conditions)

Wind Speed mph)	Wind Direction Sector							
	N	NNE	NE	ENE	E	ESE	SE	SSE
1 - 3	23	4	2	29	41	21	31	30
4 - 7	17	1	2	15	33	47	42	46
8 -12	13	1	0	3	10	19	10	16
13-18	0	0	0	2	2	7	3	4
19-25	0	0	0	0	0	0	1	1
26-32	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	0	0
Totals	53	6	4	49	86	94	87	97

TABLE 2.5-10
(Sheet 2 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group C
(Corrected for Unsteady Conditions)

Wind Speed (mph)	Wind Direction Sector								
	S	SSW	SW	WSW	W	WNW	NW	NNW	Totals
1 - 3	26	32	46	24	21	19	22	28	399
4 - 7	47	49	56	52	62	71	44	55	639
8 -12	20	18	32	39	58	78	47	34	398
13-18	9	5	10	20	49	40	8	5	164
19-25	1	0	3	4	9	6	5	2	32
26-32	0	0	0	0	0	1	1	0	2
33-40	0	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	1	0	0	1
Totals	103	104	147	139	199	216	127	124	1635

TABLE 2.5-11
(Sheet 1 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group D
(Corrected for Unsteady Conditions)

Wind Speed mph)	Wind Direction Sector							
	N	NNE	NE	ENE	E	ESE	SE	SSE
1 - 3	70	34	32	93	52	44	62	63
4 - 7	76	19	6	65	79	90	70	82
8 -12	55	4	3	16	48	43	51	41
13-18	17	4	0	3	9	13	17	15
19-25	9	1	0	0	5	3	0	2
26-32	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	0	0
Totals	227	62	41	177	193	193	200	203

TABLE 2.5-11
(Sheet 2 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group D
(Corrected for Unsteady Conditions)

Wind Speed (mph)	Wind Direction Sector								
	S	SSW	SW	WSW	W	WNW	NW	NNW	Totals
1 - 3	63	65	57	46	43	36	34	44	838
4 - 7	78	73	73	52	130	82	78	70	1123
8 -12	30	38	42	53	115	121	106	86	852
13-18	10	14	10	32	110	126	95	34	509
19-25	0	0	1	7	24	54	35	13	154
26-32	0	0	0	1	2	5	11	0	19
33-40	0	0	0	0	0	1	1	0	2
40+	0	0	0	0	0	0	0	0	0
Totals	181	190	183	191	424	425	360	247	3497

TABLE 2.5-12
(Sheet 1 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group E
(Corrected for Unsteady Conditions)

Wind Speed mph)	Wind Direction Sector							
	N	NNE	NE	ENE	E	ESE	SE	SSE
1 - 3	57	90	93	81	73	59	97	91
4 - 7	78	99	53	106	58	39	54	70
8 -12	64	28	14	24	22	35	33	36
13-18	32	7	4	4	8	6	15	18
19-25	19	1	0	0	3	0	0	3
26-32	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	0	0
Totals	250	225	164	215	164	139	199	218

TABLE 2.5-12
(Sheet 2 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group E
(Corrected for Unsteady Conditions)

Wind Speed (mph)	Wind Direction Sector								
	S	SSW	SW	WSW	W	WNW	NW	NNW	Totals
1 - 3	144	89	74	63	52	84	69	55	1271
4 - 7	57	66	29	28	65	72	72	57	1003
8 -12	43	35	11	9	77	156	102	59	748
13-18	12	6	5	9	48	175	116	39	504
19-25	0	1	3	2	19	64	54	11	80
26-32	0	0	0	0	0	9	9	0	18
33-40	0	0	0	0	0	0	1	0	1
40+	0	0	0	0	0	0	0	0	0
Totals	256	197	122	111	261	560	423	221	3725

TABLE 2.5-13
(Sheet 1 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group F
(Corrected for Unsteady Conditions)

Wind Speed mph)	Wind Direction Sector							
	N	NNE	NE	ENE	E	ESE	SE	SSE
1 – 3	7	8	39	4	2	4	10	7
4 – 7	22	32	42	11	8	7	19	12
8 –12	10	16	19	2	1	2	3	8
13-18	6	4	4	0	0	5	3	3
19-25	0	1	0	0	0	0	0	1
26-32	0	0	0	0	0	0	0	0
33-40	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	0	0
Totals	45	61	104	17	11	18	35	31

TABLE 2.5-13
(Sheet 2 of 2)

WIND VELOCITY DISTRIBUTION VS PASQUILL DIFFUSION GROUP

Three Mile Island Tower
(5/15/67 - 5/14/69)
Diffusion Group F
(Corrected for Unsteady Conditions)

Wind Speed (mph)	Wind Direction Sector								
	S	SSW	SW	WSW	W	WNW	NW	NNW	Totals
1 - 3	25	3	4	2	1	3	1	4	124
4 - 7	20	5	3	3	11	17	11	12	235
8 -12	5	4	3	2	14	34	5	7	135
13-18	0	0	0	0	6	27	4	7	69
19-25	0	0	0	0	2	4	3	1	12
26-32	0	0	1	0	0	1	0	0	2
33-40	0	0	0	0	0	0	0	0	0
40+	0	0	0	0	0	0	0	0	0
Totals	50	12	11	7	34	86	24	31	577

TABLE 2.5-14
(Sheet 1 of 1)

NUMBER OF CALMS VS TIME OF DAY[1]

Hour of the Day	TOTAL
1 AM	30
2	27
3	28
4	42
5	40
6	42
7	47
8	25
9	12
10	5
11	2
12	0
I PM	2
2	6
3	2
4	3
5	3
6	6
7	9
8	18
9	25
10	25
11	29
12	21
	449

NOTES:

[1] Three Mile Island Met Tower-Period of Record 5/67-4/69

TABLE 2.5-15

DELETED

TABLE 2.5-16

DELETED

TABLE 2.5-17

DELETED

TABLE 2.5-18

DELETED

TABLE 2.5-19

DELETED

TABLE 2.5-20

DELETED

2.6 HYDROLOGY

2.6.1 CHARACTERISTICS OF STREAMS IN VICINITY

The major stream affecting the site is the Susquehanna River, having a drainage area at the site of approximately 25,000 square miles. The Susquehanna has a total drainage area of 27,400 square miles, of which 21,000 lie within the State of Pennsylvania. This constitutes approximately 46 percent of the total area of the state, embracing all of 21 and a portion of 22 other counties. Approximately 6200 square miles of the drainage area is in New York State and 200 square miles in western Maryland.

The drainage basin lies in the three main topographic divisions of Pennsylvania: The northern portion of the Allegheny Plateau, the central portion of the Allegheny Mountains, and the lower portion of the rolling Piedmont Plateau.

The main tributaries in the vicinity of the site are the following:

Stream	Drainage Area	Average Flow
Conodoguinet Creek	506 sq.mi	1.20 cfsm
Yellow Breeches Creek	219 sq.mi	1.26 cfsm
Swatara Creek	571 sq.mi	1.66 cfsm
Conewago Creek (East)	52 sq.mi	--
West Conewago Creek	515 sq.mi	1.10 cfsm

The Juniata River enters the Susquehanna River about 25 miles upstream from the site. Its drainage area is about 3404 square miles and its average flow is 1.26 cfsm.

The plant site on Three Mile Island is located approximately 11 river miles downstream from Harrisburg gauging station, which has a continuous period of record since 1890. The drainage area of the Susquehanna River at the Harrisburg gauge is 24,100 square miles. The average river flow per square mile at Harrisburg is 1.42 cfsm. The data for the Harrisburg gauge are assumed to be applicable to the site. Table 2.6-6 is the stage discharge table for the Susquehanna River at the TMINS intake structures.

The Susquehanna River is rather extreme in its flow characteristics, as is evident in the following summary of recorded data at Harrisburg:

Minimum daily flow	1,700 cfs
Average annual discharge	34,000 cfs
Average runoff per square mile	1.41 cfsm
Mean annual flood	300,000 cfs
Maximum flood of record (1972)	1,020,000 cfs

The present uses of the streams in the vicinity are for water supply, both public and industrial, power generation, boating, fishing, and recreation. Sport fishing is done in all streams in the general area of the site. Commercial fishing is not practiced in the area.

Figure 2.6-1 shows the location of lakes and reservoirs within a 50 mile radius of the site. Table 2.6-1 lists all known data for these lakes and reservoirs.

Figure 2.6-2 shows the location of major water supplies within a 20 mile radius of the site which take water from streams in the vicinity or from wells. Table 2.6-2 lists all known data for these water supply systems.

2.6.2 STREAM USERS

2.6.2.1 Upstream Users

No large dams or reservoirs exist immediately upstream from the site. A hydroelectric dam and reservoir on the Susquehanna River in Harrisburg are proposed as discussed in Section 2.6.2.2. The Army Corps of Engineers (ACOE) has constructed the Raystown Lake dam and reservoir project for flood control, low flow augmentation, and recreation, on the Raystown Branch of the Juniata River. Hydraulic studies performed by the Corps indicate that Three Mile Island is too far from the Raystown project for a failure of the dam to pose any threat to the site, even under worst case scenarios. Raystown Dam is an earth and rockfill dam with a maximum height of 230 ft. Raystown Lake has a volume of 762,000 acre-feet at full flood control pool.

In 1986, the ACOE performed hydraulic studies to evaluate the impact of a hypothetical dam failure as part of the emergency plan for Raystown Lake (Reference 26) under several scenarios. Based on the results of the studies, the ACOE concluded that Hazardous Conditions as a result of a Raystown Dam failure would not extend downstream of Harrisburg International Airport on the Susquehanna River, which is 115 miles downstream of Raystown dam and 2 miles upstream of TMINS. Hazardous Conditions are defined as flood depths exceeding 2 ft and velocities exceeding 4 ft per second. It is therefore evident that a failure of Raystown Dam during normal Susquehanna River flow conditions or relatively frequent floods would not top the TMINS dike. If failure of the Raystown Dam (at normal high pool or during the Spillway Design Flood) were to coincide with a major flood in the Susquehanna River river flow at TMINS could be increased by approximately 300,000 cubic feet per second, or less, depending on the magnitude of the flood. For example, during the 200 year flood of 800,000 cubic feet per second, an incremental flow increase from the failure of Raystown dam (300,000 cubic feet per second) would result in the design flood of 1,100,000 cubic feet per second at TMINS. At higher Susquehanna River flows, the incremental flow contribution from failure of the Raystown Dam would be somewhat less, due to increased valley storage. In any case, the site would have 20 to 28 hours warning before the incremental flows resulting from a failure of the Raystown Dam peaked at TMINS.

Tables 2.6-3 and 2.6-4 demonstrate data on water quality and temperature for the Susquehanna River gathered by the Pennsylvania Department of Health for Harrisburg, Marietta, and Columbia from 1962 to 1966.

2.6.2.2 Other Power Projects In Vicinity

The City of Harrisburg is seeking a license to construct a hydroelectric dam and reservoir across the Susquehanna River, approximately 11 river miles upstream from TMINS. The dam would be a gated spillway structure 17 ft high and would impound 35,000 acre-feet. Should the project be approved, an evaluation of the potential for downstream flood damage due to misoperation or failure of the dam would be performed.

Immediately downstream from the site is the York Haven hydroelectric project, consisting of a main dam averaging 10 ft in height, extending about 5000 ft across the main river channel from Three Mile Island; a secondary dam, about 8 ft high, extending 950 ft across the east channel of the river; the water impounded by these dams form a lake (Lake Frederick) which extends approximately 3.5 miles upstream from the dams, containing about 10,000 acre-feet of volume. A head race wall about 20 ft in height extends approximately 3000 ft from the west end of the main dam to the powerhouse, which contains 20 units which can generate a total capacity of about 20,000 kW.

The lake formed by the York Haven Dam is a principal source of recreational use of the river in the vicinity of the site. Sport fishing is done along the river, but the primary use of the lake is for pleasure boating.

The York Haven Station is operated on a run-of-the-river basis, and its power output is dependent upon river flow. The reservoir is used for limited peaking operation during periods of low river flow. Under the peaking conditions, the drawdown of the lake is 1.1 ft maximum.

Brunner Island Station, a large generating plant owned by the Pennsylvania Power & Light Company, is located on the Susquehanna River approximately 1 mile downstream from York Haven powerhouse. This station uses water from the river on a run-through basis for cooling water. York Haven Station maintains a minimum flow in the river of 1000 cfs for Brunner Island.

Three other hydroelectric generating stations are located downstream from the project, with each project having a dam and reservoir on the Susquehanna River. The three stations are Safe Harbor, Holtwood, and Conowingo hydroelectric projects, located approximately 25, 31, and 47 miles south of Three Mile Island, respectively. The Muddy Run pumped storage project is associated with Conowingo Station. The Peach Bottom nuclear generating station is located along the Susquehanna River, just north of the Maryland-Pennsylvania border.

2.6.2.3 Downstream Users

The following summarizes the available information on water supplies downstream from Three Mile Island Nuclear Station for a distance to 50 miles. The consumers include public water supplies, industries, and utilities. There are no points downstream from Three Mile Island where significant concentration of river flow occurs. Storage capacity for each supply is indicated; however, it was not possible to determine, in most cases, the amount of water in storage reserved for fire protection.

a. Metropolitan Edison Company owns and operates a hydroelectric generating station at York Haven, total installed capacity 20,000 kW. A dam across the Susquehanna River impounds 10,000 acre-feet of water for electric generation, recreation, and fire protection. Potable water is obtained from two wells.

b. The Pennsylvania Power & Light Company owns and operates a generating station (Brunner Island) on the west shore of the Susquehanna River 5 miles downstream from the Nuclear Station. The plant has a generating capacity of 1415 MWe and utilizes 1155 cfs of river water for the circulating water system and ash removal, which is returned to the river without reconcentration. River water for cycle makeup demineralizer requirements is treated prior to use.

c. The Wrightsville Water Supply Company has a public water supply intake on the Susquehanna River 16.25 miles downstream from the Nuclear Station. The intake is utilized as a summer reserve supply with complete treatment facilities provided in the system.

d. The Borough of Columbia takes an average supply of two million gallons per day from the Susquehanna River from an intake located 16.75 miles downstream from the Nuclear Station. The potable water receives complete treatment.

e. The Susquehanna Water Treatment Plant (City of Lancaster) has its intake on the Susquehanna River 17 miles downstream from the TMINS, and is a partial water source for the city of Lancaster. The plant processes between 12,000,000 and 16,000,000 gallons per day with occasional summer highs of 20,000,000 gallons per day. The water receives complete treatment with a flow through time of two hours.

f. The Red Lion Municipal Authority has an intake on the Susquehanna River approximately 25 miles downstream from TMINS, and is a backup source of water for the city of Red Lion. Operation is limited to typically once per week. Typically, 900,000 to 1.5 million gallons per day would be withdrawn. Operating permit will allow daily withdraw up to 3 million gallons. Water is treated through a filter treatment plant prior to distribution.

g. The Safe Harbor Water and Power Corporation owns and operates a hydroelectric generating station in the Susquehanna River about 27.25 miles downstream from the Nuclear Station. The dam across the river impounds 92,000 acre-feet for power generating purposes. Water for a public water supply system for the village of Safe Harbor is withdrawn from the reservoir at a rate of 25,000 gallons per day and receives complete treatment.

h. A public water supply system serves the village of Holtwood on the east side of the Susquehanna River 34.75 miles downstream from the Nuclear Station, at Holtwood Hydroelectric Station. Approximately 22,000 gallons per day are withdrawn from the 19,300 acre-foot Holtwood Reservoir and treated prior to distribution.

i. The Muddy Run Pumped Storage generating station is located 38 miles downstream of the Nuclear Station. It is a remotely controlled plant, 800 MW capacity, operating between an upper reservoir and Conowingo Reservoir using reversible pump-turbines. River water is used for fire protection. Potable water is supplied by deep wells.

j. Peach Bottom Nuclear Generating Station is located along the west bank of the Susquehanna River about 41 miles downstream from Three Mile Island. Two nuclear units, each rated at 1065 MWe, withdraw approximately 3450 cfs from the river for cooling purposes.

k. The City of Baltimore has an intake on the river which draws water from Conowingo Reservoir. The intake is located about 49 miles downstream from Three Mile Island. Baltimore is permitted to withdraw up to 250 MGD when the river flow exceeds 5000 cfs, but is limited to 65 MGD at lower river flow. Two water treatment plants provide complete treatment.

l. Philadelphia Electric Company owns and operates a hydroelectric generating station at Conowingo Dam which impounds 321,500 acre- feet in Conowingo Reservoir. The total installed capacity of the facility is 513,000 kW, which is located 50 miles downstream from Three Mile Island. Potable water supply is obtained from the reservoir to supply the station and Conowingo Village. Complete treatment is provided for an average supply of 12,000 gallons per day.

2.6.3 LOW FLOW STUDIES

Low flow studies of the Susquehanna River were conducted using data from the Harrisburg and Marietta gauging station, as recorded by the U.S. Geological Survey (Reference 12). The Harrisburg gauge has a continuous period of record since 1890, and Marietta since 1931.

Figures 2.6-3 and 2.6-4 show annual low flow frequency and flow duration curves for the Susquehanna River at Harrisburg, based upon daily flow data. The minimum flow of 1600 cfs occurred on November 29, 1930, as a result of a freeze-up of the river. The minimum daily flow since the construction of a dam downstream from the water filtration plant on City Island was 1700 cfs on September 28, 1964. Average yearly flow at Harrisburg is 34,000 cfs. The following tabulation summarizes the percent of time the flow is equal to, or less than, that indicated as follows:

Flow (cfs)	Percent of Time
2,000	less than 1
3,000	2
4,000	4
5,000	6
6,000	8
7,000	11
8,000	13
9,000	18
10,000	22
20,000	50
34,000 average flow	69

Figure 2.6-5 shows a minimum flow summary of mean monthly flows for the Susquehanna River at Harrisburg. The data show mean monthly flows by months for recurrence intervals of 2, 5, 10, 20, and 50 years. The curves on Figure 2.6-5 were developed from mean monthly flow data for the period of record from 1890 to 1960. It will be noted on Figure 2.6-5 that characteristically the low flows occur in the late summer and fall, and that the minimum mean monthly flow of record, in general, follows the 50 year curve. Extrapolation of the individual monthly curves for August through December produces the following mean monthly flows for the recurrence interval of once in 100 years:

Month	100 Years (cfs)
August	2200
September	2000
October	1800
November	2500
December	3000

A minimum flow duration summary is presented on Figure 2.6-6, which shows not only the minimum daily flows, but also their probable frequency and duration. For example, a flow of 5000 cfs or less lasting for 90 consecutive days may be expected to occur one in 5 years. It will also be noted that a minimum daily flow of 2000 cfs will be expected to occur once in 25 years, and this flow, lasting for 20 consecutive days, will occur once in 50 years.

Hydraulic studies were conducted to determine the availability of emergency and shutdown cooling water from the intake structure during periods of extreme low flow (1700 cfs), assuming a failure of the east channel dam or main dam at York Haven.

Loss of York Haven Reservoir could result from failure of the main dam, failure of the east channel dam, or failure of both dams. Failure of a dam was considered to be complete removal of the structure as a barrier to flow. Loss of the east channel dam alone would cause only a partial loss of reservoir. The reservoir would still have ample capacity to furnish water for a safe shutdown, and would also furnish sufficient water for operation.

Loss of the main dam would return the river to normal open channel flow with the depth of the water, at any point, dependent upon the hydraulic continuum of the river channel systems. A hydraulic study was made of the river to determine such conditions, since the loss of the main dam is the critical condition.

A hydrographic survey was conducted over the entire reach of the river, involving horizontal and vertical control by normal methods of surveying procedure, determination of water surface elevations by an integrated gaging system, and the use of a fathometer survey to determine stream bed elevations. These results, shown as Figures 2.6-6A through 2.6-6G, gave the necessary information regarding actual channel geometry in order to enter an analytical process of flow distribution and water surface determinations.

The analytical process was carried out by using a general program of water surface profiles in a multidivided channel, using FORTRAN II language, for an IBM 1620 computer. With the channel characteristics, as determined by the hydrographic survey, inserted into the program, it became a specific program for the reach of the Susquehanna River in question. The program was run with the main dam removed and with a total flow of 1700 cfs in the river, which is the minimum daily flow on record. This represents the most severe restrictive effect possible under the existing conditions.

The results of the study show that, under the most conservative evaluations, approximately 430 cubic feet per second will be available at the service water screen and pump house based upon a minimum river flow of 1700 cfs. The quantity is many times the amount required for a safe and orderly plant shutdown, and corresponds to a pool surface elevation of 271.7 ft above mean sea level in the middle channel of the river (Reference 24). The intake structure was constructed at an elevation to take water from the bottom of the river and to maintain minimum submergence on the nuclear service pumps at all times. The low-flow intake canal assures that the intake structure has continuous access to river waters at water surface elevations of 270 feet or above.

Hydrographic surveys of the pool performed from 1974 to 1993 have shown no substantial changes in the bathymetry of the pool. The computer program that calculates water surface profiles for flow in a multidivided channel was rerun using hydrographic data collected in 1987, and assuming a river flow of 1700 cubic feet per second and main dam removed. The results of the follow-up analysis confirmed that sufficient water would be available at the service water screen and pump house to provide for a safe and orderly plant shutdown (Reference 25).

Using additional hydrographic data collected in 1995, the water surface profiles in the pool were again reevaluated assuming a river flow of 1700 cubic feet per second, TMINS flow requirements totaling 47 cubic feet per second, and main dam removed. Based on this analysis, approximately 740 cubic feet per second will be available at the service water screen and pump house, corresponding to a river water surface elevation of 272.2 ft above mean sea level. The results of this analysis again confirmed that sufficient river water would be available under these conditions to provide for a safe plant shutdown (Reference 30).

Two supplementary analyses were performed assuming a river flow of 1700 cubic feet per second, TMINS flow requirements totaling 77 cubic feet per second and 130 cubic feet per second, respectively, and both the main and east channel (Red Hill) dams removed. Based on these analyses, approximately 620 cubic feet per second will be available at the service water screen and pump house, corresponding to a river water surface elevation of 272.0 ft above mean sea level (Reference 30 and 31, respectively).

In 2005, the TMI area hydrographic survey and analysis were repeated (Reference 37). This work is a continuation of and is consistent with the above previous studies. The 2005 study shows that with river flow of 1700 cfs (minimum daily flow of record at Harrisburg); TMI intake flow of 130 cfs; postulated failure and complete removal of the York Haven Dam; approximately 914 cfs of water will be available at the service water screen and pump house. This corresponds to a river water surface elevation of 271.96' above mean sea level.

The 2005 study also shows that with river flow of 1700 cfs (minimum daily flow of record at Harrisburg); TMI intake flow of 130 cfs; postulated failure and complete removal of both the York Haven Dam and the East Channel Dam; approximately 882 cfs of water will be available at the service water screen and pump house. This corresponds to a river water surface elevation of 271.93' above mean sea level.

An emergency procedure directs operational responses to low water level. Operational responses are required under specified conditions of low water level inside the service water screen and pump house, extreme low river flow, and availability of bar rakes and traveling screens. Operational responses include shutting down pumps, operating bar rakes and traveling screens at increased rates, actions to remove accumulated debris, and shutting down the plant.

2.6.4 FLOOD STUDIES

Since the site is located on an island in the Susquehanna River, the flood conditions of the river are of prime importance in the planning of the project.

The Susquehanna River is the principal source of flooding in the Harrisburg area. The large tributaries such as the Conodoguinet, Paxton, Yellow Breeches, and Swatara overflow their banks at times; however, the major cause of flooding is the Susquehanna River. The generating station and its facilities will not have any effect on upstream conditions during the design flood.

Prior to June 1972, the 1936 flood was the flood of record. The 1936 flood was gauged at Harrisburg at 740,000 cfs and resulted from precipitation **and snow melt over the entire basin.**

The TMI- design flood was established based on the Probable Maximum Flood (PMF) as defined by the ACOE in 1967 (time of PSAR), which was 1,083,000 cfs at Harrisburg. The design flood established for the site is 1,100,000 cfs. The design of the dike which protects TMINS therefore was based upon a design flood of 1,100,000 cfs. The hydraulic design of plant inundation protection is based upon this design flood, with an ample margin of free board to account for wind driven waves.

In 1969, the ACOE issued a revised PMF which predicts a peak river flow of 1,625,000 cfs at TMI. The revised PMF and computations indicate that flood discharge of an unregulated river will be 1,750,000 cfs. This flood, as modified by existing upstream flood control projects, will produce a flow at Harrisburg of 1,600,000 cfs and of 1,625,000 cfs as the PMF at Three Mile Island. The probable maximum precipitation (PMI) for the Susquehanna watershed was obtained from Hydrometeorological Report No. 40. The precipitation at Lewisburg, Wilkes-Barre, and Harrisburg has been chosen as index figures. These precipitation values are shown in histogram form on Figure 2.6-14 and in Table 2.6-5. Figure 2.6-9 shows the resulting hydrographs of the PMF, as furnished by the Corps of Engineers.

The design basis flood event remains a flow of 1,100,000 cfs. The flood barrier system and protective measures described in Section 2.6.5 provide the capability to maintain safe shutdown in the event of a PMF in accordance with the 1973 licensing commitment to AEC.

In 2011, the validity of the PMF as determined in 1969 was reviewed. The ACOE HEC-HMS model was used to assess the Impact of the most significant changes on the PMF since 1969. The model was prepared based on a HEC-1 model of the Susquehanna watershed completed in 1975 by ACOE to learn from the observations made after Tropical Storm Agnes. The rainfall input (PMP) was derived from the National Oceanic and Atmospheric Administration (NOAA), Hydrometereological Report 40 (HMR-40). The most significant change since the 1969 PMF was the construction of three (3) dams in the upper portions of the watershed in 1979 (Tioga, Hammond, and Cowanesque Dams). This assessment concluded that the PMF flow determine in 1969 (i.e. 1,625,000 cfs) remains the bounding hazard. (Reference 39)

An analysis of flood discharge and frequency relationship was made using data gathered by U.S. Geological Survey on past floods, dating back to 1786 (References 8, 9, 10, and 11). The flood of record occurred in June 1972. This event, according to the U.S. Geological Survey, is the highest flood to have occurred since 1784 and probably the highest since 1740 or an earlier date. The 1972 flood resulted from the blowout of tropical storm "Agnes" which covered the 25,000 square mile drainage area with an average depth of approximately eight inches of rainfall. This rainfall produced a flood at Harrisburg estimated at 1,020,000 cfs. The June 1972 flood water level remained below the top of the protective dikes and observed water elevations showed that the 1970 stage discharge analysis was a conservative assessment of the design flood. Preceding the flood of June 1972, the flood of 1936 was the flood of record. The 1936 flood was gauged at Harrisburg at 740,000 cfs and resulted from precipitation and snow melt over the entire basin.

The following table summarizes key TMI-1 flood hazard parameters (from Reference 38):

Event Definition	River Flow Rate (cfs) at TMI	Predicted Recurrence Interval (years)	Water Surface Elevation (ft.) at ISPH
	200,000	1.4	284.2
	350,000	4.5	287.4
2011 Tropical Storm Lee	600,000	45	292.1
1936 Flood	740,000	124	294.6
Flood of Record (Agnes 1972	1,042,000	705	300.4
Design Flood	1,100,000	911	301.6
Probable Maximum Flood (PMF)	1,625,000	8670	313.3

2.6.4.1 Discharge Frequency Analysis

An analysis of flood discharge and frequency relationship was made using data gathered by U.S. Geological Survey on past floods. 119 years of peak annual stream flow records from the USGS Harrisburg Gage were used to complete the stage frequency analysis following the procedure outlined in USGS Bulletin 17B. The Log-Pearson Type III statistical analysis of stream-flow gage data was used to generate a discharge-frequency/probability curve. Figure 2.6-7 shows the predicted discharge frequency for the Susquehanna River at TMI (from Reference 38).

2.6.4.2 Stage Discharge Analysis

The original analysis of flood discharge and frequency relationship was made using data gathered by U.S. Geological Survey on past floods, dating back to 1786 (References 8, 9, 10, and 11). Considerable study was devoted to the stretch of the Susquehanna River between the Middletown Rapids and Safe Harbor Dam to determine the profile of the design flood and to establish the elevation for flood protection facilities. Hydrographic surveys conducted over the entire reach of river under study established stream bed elevations and channel geometry for backwater computations. A computer model of the river was then established using known gaged floods and high water marks. The rationale for using such a computerized program was based upon the premise that the profile of a known flood can be matched by a computed profile over a significant stretch of the river, and the parameters thus established can be applied to the computation of profiles for higher floods. The original stage discharge analysis used the 1936 flood as the benchmark event to calibrate the model. This analysis completed in 1970 provided the basis for the original design and licensing of TMI-1.

The original analysis was superseded by Reference 38. The current river stage discharge analysis used NAVD-88 as the reference for elevation. Typical TMI design and operating documents, and all elevation references in UFSAR section 2.6 are referenced to NGVD-29. Figures 2.6-8, 2.6-9b and 2.6-9c use NAVD-88 as the elevation reference. To convert values which are referenced to NAVD-88 to NGVD-29, add +0.8 ft.

The current river stage discharge analysis was completed as follows. A steady-state, one-dimensional hydraulic analysis was completed using the USACE Hydrologic Engineering Center's River Analysis System (HEC-RAS). The hydraulic model extends approximately 13.7 miles downstream of TMI and 5.4 miles upstream of TMI. The downstream study limit was established to minimize sensitivity to error in estimating the downstream boundary condition. The downstream study limit is located at the Marietta USGS Gage Station. Topographic information for the model was obtained from the PA DCNR LiDAR data for Dauphin, York, and Lancaster Counties. Bathymetric data (from measurements obtained and evaluated by Ocean Surveys Inc in April 2005) along the Susquehanna River around TMI upstream of the York Haven Dams was incorporated into the HEC-RAS model. Additional survey data for the top of dams and the river bottoms, representing the East and Main Channels below each dam (the "Conewago Rapids"), were incorporated into the HEC·RAS model from the 1999 York Haven Hydrostation Fish Passage Project. For all other cross sections, bathymetric data was obtained from FEMA's effective (1978) HEC-2 hydraulic model.

Additional parameters (such as Manning's 'n' values, ineffective flow areas, and blocked obstructions) were added based on review of PAMAP orthophotographs for Dauphin, Lancaster, and York Counties as well as local observations. Structures, including the East Channel York-Haven Dam, West Channel York-Haven Dam, Shocks Mill Railway Bridge, upstream TMI access bridge, and downstream TMI access bridge, were included in the HEC-RAS model. A USGS stage-discharge rating curve for the Marietta Gage Station was used to establish the downstream boundary conditions of the HEC-RAS model.

A range of discharge values were used in the hydraulic analysis to develop a stage-discharge rating curve at each location of interest along TMI. Flow along the Susquehanna River at TMI splits into four (4) channels formed by TMI, Hill Island, and Shelly Island. Each channel has independent hydraulic characteristics due to the varying geometry, structures, and allocation of flow. As river flow increases, some islands become inundated, which changes flow characteristics into contiguous conveyance systems. This situation results in unique split flow scenarios, depending on the river discharge.

At lower flows, the river flow was split among all four (4) channels. During intermediate flows, when some or all of the islands are inundated, the river flow was split only among the channels separated by islands not inundated. When all of the islands are inundated at high flows, the full river section (bank to bank) was included in the model, treating the entire river as a contiguous system. Because of these varying conditions, separate HEC-RAS models were developed:

- Split Flow Model for smaller flow rates (less than 500,000 cfs) - No islands are inundated (split flow around each island);
- Split Flow Model for intermediate flow rates (between 500,000 cfs and 1,500,000 cfs) - Only Shelly Island is inundated (split flow around TMI only);
- Total Flow Model for higher flow rates (greater than 1,500,000cfs) - Shelly Island and TMI Inundated (no split flow).

The HEC-RAS model was run at the measured peak flow rate from the 1972 Tropical Storm Agnes event. The results (Figure 2.6-9b and 2.6-9c) were compared to observed flood elevations at corresponding locations. The model was calibrated by adjustment of the Manning 'n' values used. An analysis was conducted to assess the sensitivity of the computed Water Surface Elevations (WSE) to a range of overbank Manning's 'n' values for various land uses.

At PMF conditions, use of minimum or maximum 'n' values obtained from Table 5-6 in Chow's Open Channel Hydraulics (1959) for various overland conditions did not change the WSE by more than 1.1 feet.

Flow pattern complexities along the Susquehanna River in the vicinity of TMI, caused by islands, dams, and bridges, raised concerns that the 1D HEC-RAS model would produce unacceptable errors in predicting flood elevations. To address these concerns, a Two-Dimensional (2D) Finite-Element River Dynamics Computer Model was used to simulate the PMF hydraulics (flow depths and velocity vectors). The 2D model reach included Three Mile Island, Shelly Island, Hill Island, the York Haven Dams, and the two (2) access bridges. The 2D model was calibrated to observed peak WSEs from Tropical Storm Agnes.

WSEs from the appropriate models were used to develop stage-discharge rating curves (Figure 2.6-8). Figure 2.6-8 presents the series of stage-discharge curves for the indicated locations between PA Turnpike Bridge and Marietta.

Table 2.6-6 presents the stage discharge relationship at the TMI-1 ISPH.

2.6.5 DESIGN OF HYDRAULIC FACILITIES

Designs were prepared for the structures associated with flood protection and cooling water facilities including earth dikes, channels, and pressure conduits. The design criteria are conservative and based on sound civil engineering practices. The strength parameters and other design characteristics of the foundations and of the materials which were used in constructing the facilities were determined from comprehensive field and laboratory testing programs. The facilities were constructed and will be maintained and inspected consistent with their design as integral parts of a nuclear station. The designs of the facilities were reviewed and approved by the appropriate state and federal agencies, including the Federal Power Commission, the Corps of Engineers, and the Water and Power Resources Board of the Commonwealth of Pennsylvania, where applicable.

The dikes are earth embankments, constructed of clay and silt. Approved borrow material has been excavated, hauled, placed, and compacted to produce a stable, impervious facility. The material is compacted in layers to a minimum of 95 percent of Standard Proctor density. The permeability of the dike is of the order of 10^{-6} cm/sec. The dike dimensions are: A top width of 20 ft, side slopes of two horizontal to one vertical, and of height, ranging up to 20 ft. Soil tests were conducted during construction to control the placement of material and ensure adequate and proper compaction. The dikes are protected by a layer of dumped riprap of sufficient size and thickness, and with an adequate zone of sand and gravel embedment material, to withstand wave height of 2.25 ft, and a velocity in excess of 12.0 ft/sec, on a 2-on-1 slope. The riprap was sized according to the standards of the Tennessee Valley Authority for riprap on earth dams and in power house and spillway tailraces. The riprap continues downward into natural ground for a minimum depth of 2 ft to provide a cutoff against undermining. This system of dikes will protect the site against inundation and wave action for the site design flood of 1,100,000 cfs. Dikes are provided for the site to protect the plant from wave action for the design flood, since plant grade at 304 ft is above the design flood water surface elevation. The top elevation of the protective dike at the northern tip of Three Mile Island is 310 ft, providing a freeboard of at least 6 ft above the design flood at this location. The dikes along both sides of the island descend uniformly from elevation 310 ft to elevation 305 ft, extending sufficient distances to protect the entire plant site for the design flood. The freeboard at the intake structure is at least 2 ft. Provision has been made for a cutoff at elevation 304 ft extending across the downstream end of the plant site.

The permanent access bridge (the north bridge) extends from the east shore a distance of 1600 ft to Three Mile Island, crossing the east channel and Sand Beach Island. The bridge is a combination rail- roadway structure with concrete slab and steel girders supported on 16 concrete piers and end abutments. The elevations of the deck slab are 306.3 ft at the east end of the bridge, 313.2 ft near the center, and 310 ft at the west end. Throughout the main spans of the bridge, the bottom of the supporting steel girders is approximately 9 ft below the deck. The bridge has been designed to withstand the forces of the design flood. The deck is high enough to ensure dry passage over the bridge during the design flood. The backwater effect of the bridge during the design flood is estimated to be in the order of 0.4 ft at the bridge.

A comparison of top of dike elevations and water surface elevations to define freeboard on the dikes, as well as the mean velocities, which can be expected during the design flood are shown on Figure 2.6-15. The plan of the access bridge is also shown on this figure. Elevations and sections of the access bridge are shown on Figure 2.6-16. A cross section of the dike showing riprap details is shown on Figure 2.6-17.

A Corps of Engineers' "Standard Project Flood," or roughly a repetition of the 1936 flood, is required before water can reach the elevation of the base of the dikes. Periodic inspection of the natural banks and the dikes after flow periods (i.e., ice flow and spring flow) will be made by the operators to determine any bank erosion or riprap weathering. Any required remedial actions will be taken.

The intake structure has been based upon competent rock and is a reinforced concrete structure with wing walls for erosion protection and concrete cutoff walls to resist undercutting. The design ensures that the pumps remain operable if the site is subjected to the maximum flood level. The structure has been designed to be stable under all conditions of loading, including maximum flood and ice jams. The banks upstream and downstream have been rip-rapped to afford protection against erosion during flood. Recirculation has been provided from the unit to the intake to provide warm water to control ice problems that might develop during cold weather. The structure has been adequately protected from trash and debris by automated bar rakes and traveling screens.

A commitment was made to the Atomic Energy Commission that the plant would be provided with component protection to the degree which will assure a safe and orderly shutdown for the level of flooding postulated by the official value of the new Probable Maximum Flood, as modified by existing upstream flood control projects (Q = 1,625,000 cfs). Various components provide protection for achieving and maintaining a safe shutdown condition, in compliance with the commitment made to the Atomic Energy Commission.

These gates, seals and other barriers will prevent water intrusion into safety-related structures at a water surface elevation below 313.5 ft. These barriers and protective measures include, but are not limited to, the following locations and type of flood protection:

a. Intake Screen and Pump House (ISPH)

    1) Flood Gates (TMI-FGE1, E2A/B/C, E4).

2) Seals where pump shafts penetrate the floor slab.

3) Manholes in slab at 308 feet floor elevation will be sealed. (U1-E-5 & 6)

4) Floor Drain Penetrations in Pump Rooms will be plugged.

5) Screen wash pump seal leak-off basin drains will be isolated.

6) River pump seal leak-off funnels (12) will be plugged.

b. Fuel Handling Building

1) Flood Gate (TMI-FG-A1).

2) Inflatable seal at railroad missile shield door (FH-208).

3) Plugs will be installed in RB Personnel Hatch Access Area floor drains and WDL-V-531 will be closed.

c. Control Building (CB)

1) Flood Gate (TMI-FG-B1 and B2).

2) Plugs will be installed in Turbine Bldg and CB elevator Machine Room Area floor drains.

3) Check valves (SD-V-144 and SV-V-151) prevent flood water flow into Control Bldg through drain lines.

4) Secondary chem. lab drain will be isolated (SS-V-257) to prevent flood water flow into Control Bldg.

d. Auxiliary Building (AB)

1) Inflatable seal at truck unloading missile shield door (A-116).

2) Isolate BWST Tunnel sump pump discharge (WDL-V-612).

e. Intermediate Building (IB)

1) Flood Gate (TMI-FG-C1).

2) Close Sump Pump Discharge Isolation Valve (SD-5A/5B/7A/7B) if a sump pump is unavailable and check valve does not prevent flood water from the Turbine Bldg into IB.

f. Diesel Generator Building

1) Flood Gates (TMI-FG-D1 &D3) will be installed.

2) Flood gates (TMI-FG-D2A, D2B, D4A &D4B) are normally installed.

g. Air Intake Tunnel

1) Air inlet is located at an elevation above PMF level.

2) Check valves (SD-V-3 & SD-V-10A/B) prevent flood water from entering AIT through the AIT sump pump discharge pit.

h. Diesel Fuel Oil Storage Tank

1) The 30k underground tank design is sufficient to withstand the hydraulic forces with flood water at 313.5' elev.

i. General

All penetrations on flood barrier system boundary below PMF elevation (ducts, pipes, conduits, cable trays, seismic gaps, and so forth) are sealed. The 3 inch seismic gap between interfacing bldgs (IB, Alligator PIT, FHB, Aux Bldg) and the Reactor Building was made watertight.

The actions to be taken preceding and during a flood will be initiated based on projected discharge rates or actual river stage at the plant. Actions required for safe shutdown are performed in accordance with the flood protection procedures. The capability to successfully mitigate a PMF is based on the PMF hydrograph on Figure 2.6-9. These procedures include the following actions:

a) A 36 hour forecast of 350,000 cfs or greater will initiate the Flood Protection Procedure.

b) If a 36 hour forecast exceeds 900,000 cfs, then EMERGENCY CLOSURE will be initiated. The flood barrier system (gates, covers, etc. discussed above) boundary will be closed.

c) If the River Water level at the TMI1 Intake Structure reaches 300 feet (corresponding to 900,000 cfs river flow), an UNUSUAL EVENT will be declared.

d) If the river water level at the TMI-1 Intake Structure reaches 300 feet, then the reactor will be shutdown.

The precipitation necessary to cause a PMF type flood is given for various locations in Hydrometeorological Report No. 40, by the U.S. Weather Bureau. The precipitation at Lewisburg, Wilkes-Barre, and Harrisburg has been chosen as index figures. These precipitation values are shown in histogram form on Figure 2.6-14 and in Table 2.6-5.

A comparison of top of dike elevations and water surface elevations to define freeboard on the dikes, as well as the mean velocities, which can be expected during the design flood are shown on Figure 2.6-15. The plan of the access bridge is also shown on this figure. Elevations and sections of the access bridge are shown on Figure 2.6-16.

A cross section of the dike showing riprap details is shown on Figure 2.6-17. A Corps of Engineers "Standard Project Flood," or roughly a repetition of the 1938 flood, is required before water can reach the elevation of the base of the dikes. Periodic inspection of the natural banks and of the dikes after flow periods (i.e., Ice flow and spring flow), will be made by the operators to determine any bank erosion or riprap weathering. Any required remedial actions will be taken.

TABLE 2.6-1
(Sheet 1 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

Data On Reservoirs and Lakes Within a 50 Mile Radius

No.	Reservoir	Stream	Owner	Total Storage (Acre-Feet)	Surface Area (Acres)
1	Lake Williams	E. Br. Codorus Creek	York Water Company	3,440	220
2	Lake Redman	E. Br. Codorus Creek	York Water Company	5,530	290
3	Pinchot Lake	Beaver Creek	Pa. Dept. Forest & Waters	2,800	342
4	Lake Pa Ha Ga Co.	Branch of Bunch Creek	P.H. Glatfelter Co.	3,350	137
5	Lake Marburg	W. Br. Codorus Creek	P.H. Glatfelter Co.	48,500	1275
6	Indian Rock Res.	W. Br. Codorus Creek	U.S. Corp. of Engineers	28,000	1430
7	Long Arm Reservoir	Long Arm Creek	Hanover Municipal Water Works	5,220	185
8	Sheppard-Myers	Long Arm Creek	Hanover Municipal Water Works	615	46.8+
9	*	Trout Run	Shippensburg Borough Authority	640	35
10	*	Carbaugh Run	Pa. Dept. Health	*	20
11	Lake Heritage	Plum Creek	Lake Heritage, Inc.	*	146
12	Lake Mead	Mud Run	Lake Mead, Inc.	3,680	291
13	#6 Dam	S. Br. Roaring Creek	Roaring Creek Water Company	4,080	185
14	#4 Dam	Trout Creek	Roaring Creek Water Company	108	12
15	#2 Dam	S. Br. Roaring Creek	Bear Gap Water Co.	592	65
16	Clark Valley	Clark Creek	City of Harrisburg	23,600	650
17	Muddy Run Pumped Storage Pond	Muddy Run	Philadelphia Electric Company	60,500	985
18	Conowingo	Susquehanna River	Philadelphia Electric Company	*	6975
19	Holtwood Dam	Susquehanna River	Pennsylvania Power & Light Co.	*	2048
20	Safe Harbor Dam	Susquehanna River	Safe Harbor Power Co.	92,200	*

TABLE 2.6-1
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HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

Data On Reservoirs and Lakes Within a 50 Mile Radius

No.	Reservoir	Stream	Owner	Total Storage (Acre-Feet)	Surface Area (Acres)
21	Dock Street Dam	Susquehanna River	City of Harrisburg	*	*
22	*	Hammer Creek	Penna. Fish Commission	*	106.4
23	*	Conodoguinet Creek	U.S. Corp of Engineers Letterkenny Ordinance Depot	1,012	54
24	No.1	W. Br. Hammer Creek	City of Lebanon	55	*
25	No.2	W. Br. Hammer Creek	City of Lebanon	150	*
26	DAM REMOVED	-	-	-	-
27	Octoraro Lake	Octoraro Lake	Chester Municipal Authority	7,700	669
28	Blue Marsh (1)	Tulpehocken Creek	U.S. Corp of Engineers	49,000	1000(2)
29	Antietam	Stony Creek	City of Reading	310	*
30	Angelica	Angelica Creek	City of Reading	147	22.5
31	Lake Ontelaunee	Maiden Creek	City of Reading	11,900	1082
32	*	Furnace Creek	Womelsdorf-Robesonia Auth.	108	*
33	*	Peters Spring Run	Maiden Creek Township	92	35
34	High Bridge Dam	Fishing Creek	City of Lebanon	1,170	55
35	Wolf Creek	Tar Run	Pottsville Water Co.	492	25.6
36	Indian Run	Indian Run	Pottsville Water Co.	52	1,470
37	Upper Dam	Tumbling Run	Borough of Schuykill Haven	725	30
38	Lower Dam	Tumbling Run	Borough of Schuykill Haven	530	28
39	Mud Run	Mud Run	Mahanoy Township Authority	620	54
40	No. 2 Dam	Little	Borough of Mahanoy Creek Ashland	330	13

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TABLE 2.6-1
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HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

Data On Reservoirs and Lakes Within a 50 Mile Radius

No.	Reservoir	Stream	Owner	Total Storage (Acre-Feet)	Surface Area (Acres)
41	Dam No.4	Dyers Run	Minersville Water Company	204	21.7
42	Sweet Arrow Lake	E.Br. Swatara Creek	Pennsylvania Power & Light Co.	1,100	100
43	Kauffman Dam	Kauffman Run	Pottsville Water Co.	320	19
44	Rock Run Dam	Rock Run	City of Coatsville	1,020	61
45	Liberty	N.Br. Patapsco River	City of Baltimore	132,000	3,100
46	Pretty Boy	Gun Powder Falls	City of Baltimore	61,400	1,500
47	Lock Raven	Gun Powder Falls	City of Baltimore	70,600	2,400
48	Long Pine Run Dam	Long Pine Run	Borough of Chambersburg	5,370	150
49	Chambers-burg Reser-voir	Conococheague Creek	Borough of Chambersburg	1,037	49
50	Little Buffalo Dam	Little Buffalo Creek	Pa. Dept. Forest & Waters	880	88

TABLE 2.6-1
(Sheet 4 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

Data On Reservoirs and Lakes Within a 50 Mile Radius

No.	Reservoir	Stream	Owner	Dead Storage (Acre-Feet)	Surface Area (Acres)
1	Lake Williams	E. Br. Codorus Creek	York Water Company	0	0
2	Lake Redman	E. Br. Codorus Creek	York Water Company	0	0
3	Pinchot Lake	Beaver Creek	Pa. Dept. Forest & Waters	0	0
4	Lake Pa Ha Co.	Branch of Bunch Creek	P.H. Glatfelter Co.	0	0
5	Lake Marburg	W. Br. Codorus Creek	P.H. Glatfelter Co.	0	0
6	Indian Rock	W. Br. Codorus Creek	U.S. Corp. of Engineers	0	0
7	Long Arm Reservoir	Long Arm Creek	Hanover Municipal Water Works	0	0
8	Sheppard-Myers	Long Arm Creek	Hanover Municipal Water Works	0	0
9	*	Trout Run	Shippensburg Borough Authority		
10	*	Carbaugh Run	Pa. Dept. Health	0	0
11	Lake Heritage	Plum Creek	Lake Heritage, Inc.	0	0
12	Lake Mead	Mud Run	Lake Mead, Inc.	0	0
13	#6 Dam	S. Br. Roaring	Roaring Creek Water Company	0	0
14	#4 Dam	Trout Creek	Roaring Creek Water Company	0	0
15	#2 Dam	S. Br. Roaring	Bear Gap Water	0	0
16	Clark Valley	Clark Creek	City of Harrisburg	0	0
17	Muddy Run Pumped Storage Pond	Muddy Run	Philadelphia Electric Company	*	640
18	Conowingo	Susquehanna River	Philadelphia Electric Company	*	*
19	Holtwood Dam	Susquehanna River	Pennsylvania Power & Light Co.	*	*
20	Safe Harbor Dam	Susquehanna River	Safe Harbor Power Co.	*	*

TABLE 2.6-1
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HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

Data On Reservoirs and Lakes Within a 50 Mile Radius

No.	Reservoir	Stream	Owner	Dead Storage (Acre-Feet)	Surface Area (Acres)
21	Dock Street Dam	Susquehanna River	City of Harrisburg	*	*
22	*	Hammer Creek	Penna. Fish Commission	0	0
23	*	Conodoguinet Creek	U.S. Corp of Engineers Letterkenny Ordinance Depot	0	0
24	No.1	W. Br. Hammer Creek	City of Lebanon	0	0
25	No.2	W. Br. Hammer Creek	City of Lebanon	0	0
26	DAM REMOVED	-	-	-	-
27	Octoraro Lake	Octoraro Lake	Chester Municipal Authority	0	0
28	Blue Marsh (1)	Tulpehocken Creek	U.S. Corp of Engineers	1500	*
29	Antietam	Stony Creek	City of Reading	0	0
30	Angelica	Angelica Creek	City of Reading	0	0
31	Lake Ontelaunee	Maiden Creek	City of Reading	0	0
32	*	Furnace Creek	Womelsdorf-Robesonia Auth.	0	0
33	*	Peters Spring Run	Maiden Creek Township	0	0
34	High Bridge Dam	Fishing Creek	City of Lebanon	0	0
35	Wolf Creek	Tar Run	Pottsville Water Co.	0	0
36	Indian Run	Indian Run	Pottsville Water Co.	0	0
37	Upper Dam	Tumbling Run	Borough of Schuykill Haven	0	0
38	Lower Dam	Tumbling Run	Borough of Schuykill Haven	0	0
39	Mud Run	Mud Run	Mahanoy Township Authority	0	0
40	No. 2 Dam	Little Mahanoy Creek	Borough of Ashland	0	0

TABLE 2.6-1
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HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

Data On Reservoirs and Lakes Within a 50 Mile Radius

No.	Reservoir	Stream	Owner	Dead Storage (Acre-Feet)	Surface Area (Acres)
41	Dam No.4	Dyers Run	Minersville Water Company	0	0
42	Sweet Arrow Lake	E.Br. Swatara River	Pennsylvania Power & Light Co.	0	0
43	Kauffman Dam	Kauffman Run	Pottsville Water Co.	0	0
44	Rock Run Dam	Rock Run	City of Coatsville	0	0
45	Liberty	N.Br. Patapsco	City of Baltimore	0	0
46	Pretty Boy	Gun Powder Falls	City of Baltimore	0	0
47	Lock Raven	Gun Powder Falls	City of Baltimore	0	0
48	Long Pine Run Dam	Long Pine Run	Borough of Chambersburg	0	0
49	Chambers-burg Reser-voir	Conococheague Creek	Borough of Chambersburg	0	0
50	Little Buffalo Dam	Little Buffalo Creek	Pa. Dept. Forest & Waters	0	0

TABLE 2.6-1
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HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

Data On Reservoirs and Lakes Within a 50 Mile Radius

No.	Reservoir	Stream	Owner	Average Flow (CFS)	Distance (Miles)
1	Lake Williams	E. Br. Codorus Creek	York Water Company	*	18
2	Lake Redman	E. Br. Codorus Creek	York Water Company	*	18
3	Pinchot Lake	Beaver Creek	Pa. Dept. Forest & Waters	50	10
4	Lake Pa Ha Co.	Branch of Bunch Creek	P.H. Glatfelter Co.	*	21
5	Lake Marburg	W. Br. Codorus Creek	P.H. Glatfelter Co.	*	25
6	Indian Rock	W. Br. Codorus Creek	U.S. Corp. of Engineers	97	16
7	Long Arm Reservoir	Long Arm Creek	Hanover Municipal Water Works	*	31
8	Sheppard-Myers	Long Arm Creek	Hanover Municipal Water Works	*	32
9	*	Trout Run	Shippensburg Borough Authority		50
10	*	Carbaugh Run	Pa. Dept. Health	*	43
11	Lake Heritage	Plum Creek	Lake Heritage, Inc.	*	34
12	Lake Mead	Mud Run	Lake Mead, Inc.	*	20
13	#6 Dam	S. Br. Roaring	Roaring Creek Water Company	*	49
14	#4 Dam	Trout Creek	Roaring Creek Water Company	*	46
15	#2 Dam	S. Br. Roaring	Bear Gap Water	*	48
16	Clark Valley	Clark Creek	City of Harrisburg	*	21
17	Muddy Run Pumped Storage Pond	Muddy Run	Philadelphia Electric Company	*	32
18	Conowingo	Susquehanna River	Philadelphia Electric Company	5985(3)	44
19	Holtwood Dam	Susquehanna River	Pennsylvania Power & Light Co.	6505(4)	30
20	Safe Harbor Dam	Susquehanna River	Safe Harbor Power Co.	*	24

TABLE 2.6-1
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HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

Data On Reservoirs and Lakes Within a 50 Mile Radius

No.	Reservoir	Stream	Owner	Average Flow (CFS)	Distance (Miles)
21	Dock Street Dam	Susquehanna River	City of Harrisburg	*	11
22	*	Hammer Creek	Pennsylvania Fish Commission	*	23
23	*	Conodoguinet Creek	U.S. Corp of Engineers Letterkenny Ordinance Depot	*	14
24	No.1	W. Br. Hammer Creek	City of Lebanon	*	21
25	No.2	W. Br. Hammer	City of Lebanon Creek	*	21
26	DAM REMOVED		-	-	-
27	Octoraro Lake	Octoraro Lake	Chester Municipal Authority	183	43
28	Blue Marsh (1)	Tulpehocken Creek	U.S. Corp of Engineers	*	40
29	Antietam	Stony Creek	City of Reading	*	47
30	Angelica	Angelica Creek	City of Reading	*	43
31	Lake Ontelaunee	Maiden Creek	City of Reading	*	47
32	*	Furnace Creek	Womelsdorf-Robesonia Auth.	*	33
33	*	Peters Spring Run	Maiden Creek Township	*	48
34	High Bridge Dam	Fishing Creek	City of Lebanon	*	29
35	Wolf Creek	Tar Run	Pottsville Water Co.	*	48
36	Indian Run	Indian Run	Pottsville Water Co.	*	42
37	Upper Dam	Tumbling Run	Borough of Schuylkill Haven	*	47
38	Lower Dam	Tumbling Run	Borough of Schuylkill Haven	*	46.5
39	Mud Run	Mud Run	Mahanoy Township Authority	*	49
40	No. 2 Dam	Little Mahanoy Creek	Borough of Ashland	*	48

TABLE 2.6-1
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HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

Data On Reservoirs and Lakes Within a 50 Mile Radius

No.	Reservoir	Stream	Owner	Average Flow (CFS)	Distance (Miles)
41	Dam No.4	Dyers Run	Minersville Water Company	*	45
42	Sweet Arrow Lake	E.Br. Swatara River	Pennsylvania Power & Light Co.	*	35
43	Kauffman Dam	Kauffman Run	Pottsville Water Co.	*	49
44	Rock Run Dam	Rock Run	City of Coatsville	*	49
45	Liberty	N.Br. Patapsco	City of Baltimore	*	49
46	Pretty Boy	Gun Powder Falls	City of Baltimore	*	36
47	Lock Raven	Gun Powder Falls	City of Baltimore	*	48
48	Long Pine Run Dam	Long Pine Run	Borough of Chambersburg	*	43
49	Chambers-burg Reser-voir	Conococheague Creek	Borough of Chambersburg	*	42
50	Little Buffalo Dam	Little Buffalo Creek	Pa. Dept. Forest & Waters	*	30

TABLE 2.6-1
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HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

Data On Reservoirs and Lakes Within a 50 Mile Radius

No.	Reservoir	Stream	Owner	Direction
1	Lake Williams	E. Br. Codorus Creek	York Water Company	S
2	Lake Redman	E. Br. Codorus Creek	York Water Company	S
3	Pinchot Lake	Beaver Creek	Pa. Dept. Forest & Waters	SW
4	Lake Pa Ha Co.	Branch of Bunch Creek	P.H. Glatfelter Co.	SSE
5	Lake Marburg	W. Br. Codorus Creek	P.H. Glatfelter Co.	SSE
6	Indian Rock	W. Br. Codorus Creek	U.S. Corp. of Engineers	S
7	Long Arm Reservoir	Long Arm Creek	Hanover Municipal Water Works	SW
8	Sheppard-Myers	Long Arm Creek	Hanover Municipal Water Works	SW
9	*	Trout Run	Shippensburg Borough Authority	W
10	*	Carbaugh Run	Pa. Dept. Health	WSW
11	Lake Heritage	Plum Creek	Lake Heritage, Inc.	SW
12	Lake Mead	Mud Run	Lake Mead, Inc.	WSW
13	#6 Dam	S. Br. Roaring	Roaring Creek Water Company	NNE
14	#4 Dam	Trout Creek	Roaring Creek Water Company	NNE
15	#2 Dam	S. Br. Roaring	Bear Gap Water	NNE
16	Clark Valley	Clark Creek	City of Harrisburg	N
17	Muddy Run Pumped Storage Pond	Muddy Run	Philadelphia Electric Company	SE
18	Conowingo	Susquehanna River	Philadelphia Electric Company	SE
19	Holtwood Dam	Susquehanna River	Pennsylvania Power & Light Co.	SE
20	Safe Harbor Dam	Susquehanna River	Safe Harbor Power Co.	SE
21	Dock Street Dam	Susquehanna River	City of Harrisburg	NW
22	*	Hammer Creek	Pennsylvania Fish Commission	E

TABLE 2.6-1
(Sheet 11 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

Data On Reservoirs and Lakes Within a 50 Mile Radius

No.	Reservoir	Stream	Owner	Direction
23	*	Conodoguinet Creek	U.S. Corp of Engineers Letterkenny Ordinance Depot	NW
24	No.1	W. Br. Hammer Creek	City of Lebanon	ENE
25	No.2	W. Br. Hammer Creek	City of Lebanon	ENE
26	DAM REMOVED	-	-	-
27	Octoraro Lake	Octoraro Lake	Chester Municipal Authority	SE
28	Blue Marsh (1)	Tulpehocken Creek	U.S. Corp of Engineers	ENE
29	Antietam	Stony Creek	City of Reading	ENE
30	Angelica	Angelica Creek	City of Reading	ENE
31	Lake Ontelaunee	Maiden Creek	City of Reading	NE
32	*	Furnace Creek	Womelsdorf-Robesonia Auth.	ENE
33	*	Peters Spring Run	Maiden Creek Township	ENE
34	High Bridge Dam	Fishing Creek	City of Lebanon	NNE
35	Wolf Creek	Tar Run	Pottsville Water Co.	NNE
36	Indian Run	Indian Run	Pottsville Water Co.	NE
37	Upper Dam	Tumbling Run	Borough of Schuylkill Haven	NE
38	Lower Dam	Tumbling Run	Borough of Schuylkill Haven	NE
39	Mud Run	Mud Run	Mahanoy Township Authority	NNE
40	No. 2 Dam	Little Mahanoy Creek	Borough of Ashland	NNE

TABLE 2.6-1
(Sheet 12 of 12)

HISTORICAL INFORMATION
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Data On Reservoirs and Lakes Within a 50 Mile Radius

No.	Reservoir	Stream	Owner	Distance
41	Dam No.4	Dyers Run	Minersville Water Company	NNE
42	Sweet Arrow Lake	E.Br. Swatara River	Pennsylvania Power & Light Co.	NNE
43	Kauffman Dam	Kauffman Run	Pottsville Water Co.	NNE
44	Rock Run Dam	Rock Run	City of Coastville	ESE
45	Liberty	N.Br. Patapsco	City of Baltimore	S
46	Pretty Boy	Gun Powder Falls	City of Baltimore	S
47	Lock Raven	Gun Powder Falls	City of Baltimore	S
48	Long Pine Run Dam	Long Pine Run	Borough of Chambersburg	WSW
49	Chambers-burg Reser-voir	Conococheague Creek	Borough of Chambersburg	WSW
50	Little Buffalo Dam	Little Buffalo Creek	Pa. Dept. Forest & Waters	NW

* Information not available

(1) Proposed construction to be completed in 1971, begin about 1968.
Multi-purpose, flood control, water supply, recreation
(2) Area of recreation pool at storage capacity of 14,500 acre-feet
(3) 90% of time as recorded for 33 year period
(4) 90% of time as recorded for 31 year period

TABLE 2.6-2
(Sheet 1 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

DATA ON OTHER WATER SUPPLIES WITHIN A 20 MILE RADIUS

No.	Water Authority	Consumption Gallons per Day	Source	Well Depth (Ft.)	Well Diam. (In.)
1	Marysville Water Company	140,000	Stony Creek in Dauphin Lambs Gap Run (100,000 gal. pond) Trout Run (50,000 gal. pond) Sitterly Spring Run	-	-
2.	Summerdale Water Company	*	# 1 Well # 2 Well	* 200	* 6
3.	William Grove Park Company	9,000	Spring in center of lake (Covered and protected from lake water)	-	-
4.	Pennsylvania Industrial School	50,000	Riverton Consolidated Water Company Well	66	8
5.	Mechanicsburg Water Company	*	Trindle Spring # 1 Well	 115	 8
6.	Gulf Oil Company (Turnpike Service Area)	*	# 1 Well # 2 Well	348 150	6 6
7.	Mechanicsburg Water Company	1,240,000	Yellow Breeches Creek	-	-
8.	Riverton Consolidated Water Company	8,100,000	Yellow Breeches Creek	-	-
9.	Center Square Water Company	11,400	# 1 Well	*	*
10.	Grantham Water Company	35,000	# 1 Spring # 2 Spring Well	- 500	- 6
11.	Dillsburg Borough Council	85,000	12 Springs # 1 Well # 3 Well # 4 Well	 179 300 130	 6 6 8

TABLE 2.6-2
(Sheet 2 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

DATA ON OTHER WATER SUPPLIES WITHIN A 20 MILE RADIUS

No.	Water Authority	Consumption Gallons per Day	Source	Well Depth (Ft.)	Well Diam. (In.)
12.	Gifford Pinchot State Park	100,000	Pinchot Lake	-	-
13.	Dover Borough	*	# 1 Well	310	8
			# 2 Well	408	8
			# 3 Well	311	8
			# 4 Well	800	8
			# 5 Well	311	8
14.	Gleneagles Water Company	50,000	Well	258	8
15.	Mt. View Water Company	26,386	Well	210	6
16.	Dover Township Authority	143,000	# 1 Well	300	8
			# 2 Well	300	8
			# 3 Well	383	8
			# 4 Well	230	8
17.	West Manchester Township Authority	275,000	4 Wells	*	*
18.	Ivan R. Lehr Water Company	*	Well	312	8
19.	Penvale Water Company	15,000	Well	785	12
20.	Hallam Borough Authority	60,000	8 Spring		
			1 Well	177	8
21.	Jackson Township Water District #1	*	2 Springs		
22.	Pine Springs Water Company	25 houses	1 Well	830	8
23.	New Salem Borough Authority		# 1 Well	140	6
			# 2 Dug Well	7	*
		100,000	# 1 Spring	-	-

TABLE 2.6-2
(Sheet 3 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

DATA ON OTHER WATER SUPPLIES WITHIN A 20 MILE RADIUS

No.	Consumption Water Authority	Gallons per Day	Source	Well Depth (Ft.)	Diam. (In.)
24.	Sylvan Hills Development Water Works	50 Homes	Well	200	8
25.	Windsor Water Authority	65,000	8 Springs 2 Wells	- *	- *
26.	Red Lion Municipal Authority	*	Cabin Creek Reservoir (50 MG)	-	-
27.	Red Lion Municipal Authority	*	Beaver Creek Reservoir (5.6 MG)	-	-
28.	Wrightsville Water Supply Company	144,000	6 Springs # 1 Well Abandoned quarry (5.5 acres, 140 MG) filled by Susque-hanna River intake	- 425	- 6
29.	Dauphin Consolidated Water Company	3,500,000	Stony Creek (2 acre lake)	-	-
30.	Linglestown Water Company	25 homes	Well	150	6
31.	Sky Line View Extension	170 homes	Well	400	6
32.	Annville Water Company	450,000	Springs	-	-
33.	Cleona Water Company	25,000	2 Springs from City of Lebanon	-	-

TABLE 2.6-2
(Sheet 4 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

DATA ON OTHER WATER SUPPLIES WITHIN A 20 MILE RADIUS

No.	Consumption Water Authority	Gallons per Day	Source	Well Depth (Ft.)	Well Diam. (In.)
34.	Dauphin Consolidated Water Company	1,200,000	Open Quarry (1 acre, 10 MG)	-	-
35.	Gulf Oil Company (Turnpike Service Area)	10,000	# 1 Well	242	*
			# 2 Well	239	*
			# 3 Well	214	*
36.	Steelton Water Company	2,000,000	Susquehanna River	-	-
37.	Dauphin Consolidated Water Company	1,700,000	Beaver Creek (1.2 acre lake) Well	-	-
38.	Dauphin Consolidated Water Company	2,000,000	Swatara Creek (5 acre lake)	178	13
39.	Cambelltown Water Company	700 people	9 Springs	-	-
			1 Well	350	8
40.	Mt. Gretna Heights Water Company	12,000	Well	165	*
41.	Mt. Gretna Camp Meeting Association	25,000	Well	200	8
42.	Quentin Water Company	10,000	#1 Well	223	6
			#2 Well	314	*
43.	Cornwall Borough Municipal Authority	270,000	#1 Well	*	*
			#4 Well	360	6
			White Quarry	-	-
			Tract Spring	-	-
			Freeman's Springs	-	-
			Saddler Run	-	-

TABLE 2.6-2
(Sheet 5 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

DATA ON OTHER WATER SUPPLIES WITHIN A 20 MILE RADIUS

No.	Consumption Water Authority	Gallons per Day	Source	Well Depth (Ft.)	Well Diam. (In.)
44.	Highspire Water Company	314,000	# 1 Well	255	*
			# 2 Well	806	*
			# 3 Well	878	10
			2 Springs		
45.	Carroll Acres Development	*	# 1 Well	253	8
			Quarry (4.5 acres, 68 MG)	-	-
46.	Olmstead Air Force Base	1,000,000	Wells	*	*
47.	-	-	-	-	-
48.	Middletown Water Company	880,000	# 1 Well	400	8
			# 2 Well	800	10
49.	Gulf Oil Company (Turnpike Service Area)	15,000	# 1 Well	475	*
			# 2 Well	806	*
			# 3 Well	350	*
			# 4 Well	250	*
50.	Elizabethtown Water Company	500,000	7 Springs	-	-
			# 1 Well	*	*
			# 2 Well	219	18
			# 3 Well	476	10
			# 4 Well	700	*
			# 5 Well	500	10
			W. Br. Conoy Creek (1500 gal. pond)	-	-
			Conewago Creek (emergency)		
51.	Masonic Homes	250,000	7 Springs	-	-
		#3 Well (emergency)	*	*	
		# 4 Well			
		# 5 Well		200	8
		# 6 Well		500	*

TABLE 2.6-2
(Sheet 6 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

DATA ON OTHER WATER SUPPLIES WITHIN A 20 MILE RADIUS

No.	Water Authority	Consumption Gallons per Day	Source	Well Depth (Ft.)	Well Diam. (In.)
52.	Rheems Water Company	40,000	Well	380	6
53.	Mt. Joy Water Authority	*	Spring	-	-
54.	Mt. Joy Water Authority	700,000	Little Chickies Creek	-	-
55.	Manheim Water Company	460,000	Reiffs Run	-	-
			Quarry (0.23 acres)	-	-
56.	Bainbridge	12,000	# 1 well	182	6
			# 2 Well	242	6
57.	Shocks Mill	7,000	1 Well	101	4
58.	East Donogal Municipal Authority	100,000	Glatfelter Springs	-	-
59.	Marietta Water Company	380,000	Dugans Run (0.2 acre, 660,000 gal. lake)	-	-
			Wildcat Reservoir (0.36 acres, 1,000,000 gal. lake)	-	-
60.	Marietta Water Company	*	# 1 Well	116	8
			# 2 Well	133	8
			Spring		
61.	Columbia	2,000,000	Susquehanna River	230	12
62.	Lancaster, City of	8,000,000	Susquehanna River	230	12
63.	Safe Harbor	25,000	Susquehanna River	-	-
64.	Holtwood	290,000	Susquehanna River	-	-
65.	Riverton Consolidated Water Company	2,000,000	Conodoguinet Creek	-	-
66.	Pa. Dept. Agriculture at Summerdale	*	# 1 Well	-	-
			# 2 Well	-	-

TABLE 2.6-2
(Sheet 7 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

DATA ON OTHER WATER SUPPLIES WITHIN A 20 MILE RADIUS

No.	Water Authority	Consumption Gallons per Day	Source	Yield (Ft.)	Pump (In.)
1	Marysville Water Company	140,000	Stony Creek in Dauphin Lambs Gap Run (100,000 gal. pond)	*	*
			Trout Run (50,000 gal. pond)	*	*
			Sitterly Spring Run		
2.	Summerdale Water Company	*	# 1 Well	*	40
			# 2 Well	60	*
3.	William Grove Park Company	9,000	Spring in center of lake (Covered and protected from lake water)	*	*
4.	Pennsylvania Industrial School	50,000	Riverton Consolidated Water Company Well	200	275
5.	Mechanicsburg Water Company	*	Trindle Spring	500	*
			# 1 Well	500	500
6.	Gulf Oil Company (Turnpike Service Area)	*	# 1 Well	*	100
			# 2 Well	*	100
7.	Mechanicsburg Water Company	1,240,000	Yellow Breeches Creek	*	*
8.	Riverton Consolidated Water Company	8,100,000	Yellow Breeches Creek	*	*
9.	Center Square Water Company	11,400	# 1 Well	120	120
10.	Grantham Water Company	35,000	# 1 Spring	*	*
			# 2 Spring	*	30
			Well	*	30
11.	Dillsburg Borough Council	85,000	12 Springs	*	*
			# 1 Well	*	50
			# 3 Well	*	40
			# 4 Well	200	200

TABLE 2.6-2
(Sheet 8 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

DATA ON OTHER WATER SUPPLIES WITHIN A 20 MILE RADIUS

No.	Water Authority	Consumption Gallons per Day	Source	Yield (Ft.)	Pump (In.)
12.	Gifford Pinchot State Park	100,000	Pinchot Lake	*	*
13.	Dover Borough	*	# 1 Well	*	30
		# 2 Well	*	15	
		# 3 Well	*	30	
		# 4 Well	*	35	
		# 5 Well	*	21	
14.	Gleneagles Water Company	50,000	Well	57	55
15.	Mt. View Water Company	26,386	Well	23	23
16.	Dover Township Authority	143,000	# 1 Well	112	100
			# 2 Well	201	100
			# 3 Well	70	70
			# 4 Well	50	50
17.	West Manchester Township Authority	275,000	4 Wells	*	*
18.	Ivan R. Lehr Water Company	*	Well	89	45
19.	Penvale Water Company	15,000	Well	75	75
20.	Hallam Borough Authority	60,000	8 Spring	*	*
			1 Well	*	100
21.	Jackson Township Water District #1	*	2 Springs		20
22.	Pine Springs Water Company	25 houses	1 Well	300	125
23.	New Salem Borough Authority		# 1 Well	*	19
			# 2 Dug Well	10	*
		100,000	# 1 Spring	*	*

TABLE 2.6-2
(Sheet 9 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

DATA ON OTHER WATER SUPPLIES WITHIN A 20 MILE RADIUS

No.	Water Authority	Consumption Gallons per Day	Source	Yield (Ft.)	Pump (In.)
24.	Sylvan Hills Development Water Works	50 Homes	Well	22	*
25.	Windsor Water Authority	65,000	8 Springs 2 Wells	* *	* *
26.	Red Lion Municipal Authority	* *	Cabin Creek Reservoir (50 MG)	* *	* *
27.	Red Lion Municipal Authority		Beaver Creek Reservoir (5.6 MG)	* *	* *
28.	Wrightsville Water Supply Company	144,000	6 Springs # 1 Well Abandoned quarry (5.5 acres, 140 MG) filled by Susque-hanna River intake	* * *	* * 25 150 200
29.	Dauphin Consolidated Water Company	3,500,000	Stony Creek (2 acre lake)	*	*
30.	Linglestown Water Company	25 homes	Well	60	50
31.	Sky Line View Extension	170 homes	Well	*	75
32.	Annville Water Company	450,000	Springs	*	*
33.	Cleona Water Company	25,000	2 Springs from City of Lebanon	*	*

TABLE 2.6-2
(Sheet 10 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

DATA ON OTHER WATER SUPPLIES WITHIN A 20 MILE RADIUS

No.	Water Authority	Consumption Gallons per Day	Source	Yield (Ft.)	Pump (In.)
34.	Dauphin Consolidated Water Company	1,200,000	Open Quarry (1 acre, 10 MG)	*	*
35.	Gulf Oil Company (Turnpike Service Area)	10,000	# 1 Well	*	*
			# 2 Well	*	*
			# 3 Well	*	*
36.	Steelton Water Company	2,000,000	Susquehanna River	*	*
37.	Dauphin Consolidated Water Company	1,700,000	Beaver Creek (1.2 acre lake)	*	*
			Well	753	700
38.	Dauphin Consolidated Water Company	2,000,000	Swatara Creek (5 acre lake)	*	*
39.	Cambelltown Water Company	700 people	9 Springs	*	*
			1 Well	38	25
40.	Mt. Gretna Heights Water Company	12,000	Well	*	*
41.	Mt. Gretna Camp Meeting Association	25,000	Well	*	65
42.	Quentin Water Company	10,000	#1 Well	*	60
			#2 Well	*	80
43.	Cornwall Borough Municipal Authority	270,000	#1 Well	*	*
			#4 Well	150	150
			White Quarry	*	*
			Tract Spring	*	*
			Freeman's Spring	*	*
			Saddler Run	*	*

TABLE 2.6-2
(Sheet 11 of 12)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

DATA ON OTHER WATER SUPPLIES WITHIN A 20 MILE RADIUS

No.	Water Authority	Consumption Gallons per Day	Source	Yield (Ft.)	Pump (In.)
44.	Highspire Water Company	314,000	# 1 Well	*	100
			# 2 Well	*	150
			# 3 Well	*	250
			2 Springs	*	*
45.	Carroll Acres Development	*	# 1 Well	*	20
			Quarry (4.5 acres, 68 MG)	*	*
46.	Olmstead Air Force Base	1,000,000	Wells	*	*
47.	-	-	-	-	-
48.	Middletown Water Company	880,000	# 1 Well	*	600
			# 2 Well	575	435
49.	Gulf Oil Company (Turnpike Service Area)	15,000	# 1 Well	*	*
			# 2 Well	*	*
			# 3 Well	*	*
			# 4 Well	*	*
50.	Elizabethtown Water Company	500,000	7 Springs	*	*
			# 1 Well	*	*
			# 2 Well	*	50
			# 3 Well	120	150
			# 4 Well	*	400
			# 5 Well	440	300
			W. Br. Conoy Creek (1500 gal. pond)	*	*
			Conewago Creek (emergency)	*	*
51.	Masonic Homes	250,000	7 Springs	*	*
			#3 Well (emergency)	*	*
			# 4 Well	*	*
			# 5 Well	405	250
			# 6 Well	*	400

TABLE 2.6-2
(Sheet 12 of 12)

HISTORICAL INFORMATION
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DATA ON OTHER WATER SUPPLIES WITHIN A 20 MILE RADIUS

No.	Water Authority	Consumption Gallons per Day	Source	Yield (Ft.)	Pump (In.)
52.	Rheems Water Company	40,000	Well	50	60
53.	Mt. Joy Water Authority	*	Spring	600	*
54.	Mt Joy Water Authority	700,000	Little Chickies Creek	*	*
55.	Manheim Water Company	460,000	Reiffs Run	*	*
			Quarry (0.23 acres)	*	225
56.	Bainbridge	12,000	# 1 well	*	60
			# 2 Well	*	60
57.	Shocks Mill	7,000	1 Well	20	18
58.	East Donogal Municipal Authority	100,000	Glatfelter Springs	*	*
59.	Marietta Water Company	380,000	Dugans Run (0.2 acre, 660,000 gal. lake)	*	*
			Wildcat Reservoir (0.36 acres, 1,000,000 gal. lake)	*	*
60.	Marietta Water Company	*	# 1 Well	550	300
			# 2 Well	700	300
			Spring	*	50
61.	Columbia	2,000,000	Susquehanna River	*	10
62.	Lancaster, City of	8,000,000	Susquehanna River	*	100
63.	Safe Harbor	25,000	Susquehanna River	*	*
64.	Holtwood	290,000	Susquehanna River	*	*
65.	Riverton Consolidated Water Company	2,000,000	Conodoguinet Creek	*	*
66.	Pa. Dept. Agriculture at Summerdale	*	# 1 Well	*	*
			# 2 Well	*	*

*Data not available

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant

Table 2.6-3

STREAM: Susquehanna River
STATION LOCATION: Walnut St. Bridge, Harrisburg, Dauphin Co. (1/3 Pts.)
HSE 6526

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF HEALTH
SANITARY ENGINEERING

PENNSYLVANIA WATER QUALITY NETWORK

REGION: VI
BASIN CODE: 2.03.0
STATION NUMBER: 2-2

NOTE: ALL RESULTS ARE IN MG/L POUNDS EXCEPT WHERE NOTED OTHERWISE = UNITS ARE THOSE USED IN STANDARD METHODS.

Date: Month	Date: Day	Date: Year	Stream Flow (CFS)	Field Analysis: Temperature (Degrees F)	Field Analysis: Conductivity / Dissolved Oxygen	Field Analysis: pH (Units)	Laboratory Analysis: Appearance (No Units)	Color (Pt-Co Std)	Odor (Units)	Turbidity (Units)	pH (Units)	Alkalinity	Acidity (pH 4)	Acidity (pH 8)	Hardness	B.O.D.	Chloride	Sulfate	Nitrate (Nitrogen)	Total Solids	Suspended Solids (Total)	Copper	Iron (Total)	Manganese	Phenol	ABS	Phosphate (PO4)	Gage Reading	Coliform Organisms MPN/100 CC	Alpha PC/L	Beta PC/L
7	12 10:05 AM	62	2,920	76	7.5	7.3	Pale Gray	25	Ft. Grassy	10	7.5	51	0	0	170	2.7	16	115	-	300	10	-	0.1	0	-	0.07	-	-	230		
10	17 12:50 PM	62	19,900	64	7.2	6.6	Brown Yellow	40	Dist. Musty	210	7.0	24	0	0	70	2.4	5	66	-	400	270	-	.6	0.6	-	.07	-	-	150,000 150,000		
1	23 10:50 AM	63	-	33	13.3	6.6	Clear	5	V. Ft. Musty	5	6.4	15	-	0	64	.4	5	48	-	80	5	-	.2	.5	-	0	-	-	230		
4	22 12:25 PM	63	27,150	64	8.0	6.8	Pale Yellow	15	V. Ft. earthy	15	6.9	28	-	0	84	1.9	4.0	54	-	180	15	-	0.6	0.4	-	0.1	-	4.41WW 4.35 P	2400		
7	16 8:25 AM	63	3,550	76	8.8	7.7	Yellow Ink	10	0	5	7.1	35	-	0	140	2.4	8	120	-	275	5	-	.2	0	-	0	-	3.1P	1500		
10	22 8:30 AM	63		59	9.0	7.6	Yellowish	10	V. Ft. Musty	5	7.5	54	-	-	190	1.8	28	175	-	335	0	-	0	0	-	.12	-	2.20ET 2.18 R	230 36		
1	21 2:00 PM	64	26,660	36	12.4	6.4	Clear	10	Faint Musty	10	7.0	13	-	0	58	1.9	5	53	-	125	10	-	0.4	0.5	-	.06	-	4.39-ETG 4.39-P	930		
4	8 9:00 AM	64	57,770	42	5.6	7.0	V. Sl. Brown	5	0	10	7.0	18	-	0	56	2.3	4	42	-	110	5	-	.8	.25	-	0.1	-	ETG 5.53 R 5.35	2,400		
6	24 9:45	64	5,750	74	9.0	-	Sl. Green	15	Faint Musty	10	8.7	51	-	0	124	2.8	10	79	-	224	10	-	0	0	-	0	-	PEN - 3.3	430		
9	29	64		56	8.8	7.4	Clear	10	V. Ft. Earthy	5	7.1	64	-	0	260	2.0	27	190	-	340	5	-	0	0	-	0.1	-	ETG 2.7 PEN 2.7	1,100,000		
12	22 9:00 AM	64	7,150	30	13.4	6.8	Clear	5	V. Ft. Musty	5	6.5	24	-	0	146	2.4	18	100	-	200	5	-	0	1.4	-	.15	-	ET 3.40 PEN 3.40	230		
3	31 8:55 AM	65	48,680	40	12.0	6.9	V. Sl. Brown	10	0	10	6.7	24	-	0	76	2.5	0.9	48	-	136	5	-	0.6	0.4	0	0	-	PEN 5.20 ET 5.21	2,400		
6	29 9:00 AM	65	3,380	77	7.2	7.4	Sl. Yellow	10	0	10	7.4	47	-	0	138	3.4	13	124	-	274	5	-	0	0.18	0	0	-	32.15 WW 3.09 ETG 3.08 R	230		
9	15 1:30 PM	65	2,490	L-70 R-70	L-6.8 R-8.0	L-7.2 R-7.2	V. Sl. Green	10	0	10	7.2	41	-	0	205	2.3	20	195	-	365	10	-	0	0	0	0	-	3.1 WW 2.99 ETG	11,000 2,400 2.17 R(P)	< 1	3± 3
12	15 8:40 AM	65	12,200	39	160 12.0	7.0	V. Sl. Brown	10	0	10	7.1	29	-	0	110	4.4	7	81	-	155	10	-	0.6	0.6	0	0	-	ETG 3.70 R(P) 3.65 WW 3.80	L. 92,000 R. 2,400	< 1	4± 3
3	21 10:45 AM	66	48,400	44	150 11.0	6.8	Clear	15	0	20	6.9	28	-	0	50	1.2	6	41	-	80	15	-	0.8	0.25	L-0 R-0	0.05	-	WW 6.1 ETG 5.2 PM 5.26	R. 1,100 L. 94,000	< 1	3
5	31 11:00 AM	66	32,000	62	150 8.4	6.8	Sl. Brown	10	0	20	7.0	29	-	0	66	5.2	5	48	-	160	25	-	1.4	0.4	L-0 R-0	-	-	WW 5.4 ETG 4.40 R(A) 7.63	R. 78 L. 330	< 1	5± 3
9	8 11:15 AM	66	2,210	66	540 8.8	7.4	Clear	10	0	5	6.4	4.1	-	0	238	2.2	24	145	-	428	5	-	0.1	0	L-0 R-0.1	0	-	WW 30.85 ETG 21.3 R(A) 2.73	R. 45 L. 20		5± 3
12	1	66	58,930	42	180 11.6	6.4	Brown	30	Dist. Musty	35	5.9	22	-	0	54	4.5	3	28	-	190	35	-	3.2	0.4	RT-0 LT-0	0	-	5.57	R. 35,000 L. 240,000	< 1	4± 3

REMARKS:

GPU Nuclear
TMI Unit-1
Update - 8
7/89
Susquehanna River Water Quality at Harrisburg
Table 2.6-3

HISTORICAL INFORMATION

This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant

Table 2.6-4

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF HEALTH
SANITARY ENGINEERING

PENNSYLVANIA WATER QUALITY NETWORK

STREAM: Susquehanna River *

STATION LOCATION: USGS Gage - Above Chickies Cr, E. Donegal Twp., Lancaster Co. (Marietta) (Lt. Bk.)

HSE 6526

REGION: VI

BASIN CODE: 2.02.0

STATION NUMBER: 2-1

NOTE: ALL RESULTS ARE IN MG/L EXCEPT WHERE NOTED OTHERWISE: UNITS ARE THOSE USED IN STANDARD METHODS.

Month	Day	Year	Stream Flow (CFS)	Field: Temperature (Degrees F)	Field: Conductivity / Dissolved Oxygen	Field: pH (Units)	Appearance (No Units)	Color (Pt-Co Std)	Odor (Units)	Turbidity (Units)	pH (Units)	Alkalinity	Acidity (pH 4)	Acidity (pH 8)	Hardness	B.O.D.	Chloride	Sulfate	Nitrate (Nitrogen)	Total Solids	Suspended Solids (Total)	Copper	Iron (Total)	Manganese	Phenol	ABS	Phosphate (PO4)	Gage Reading	Coliform Organisms MPN/100 CC	Alpha PC/L	Beta PC/L
7 4:10 PM	12	62	3,350	80	12.9	7.6	Pale Green	35	V. Ft. Earthy	25	8.7	64	0	0	220	6.5	16	145	-	335	10	-	0.1	0	-	0.16	-		91 430		
10 5:40 PM	17	62	22,300	64	7.1	6.8	Pale Yellow	35	Decided Musty	20	7.2	36	-	0	120	1.2	7	80	-	300	15	-	0.8	0.1	-	0.13	-		430,000 930,000		
1 3:15 PM	23	63		32	12.3	6.8	Pale Gray	20	0	40	7.0	30	-	0	96	3.6	10	78	-	185	15	-	1.4	.6	-	0	-		Froze in Transit		
4 5:40 PM	22	63	28,030	64	7.6	7.2	Pale Yellow	15	Ft. Chem.	25	7.0	35	-	0	130	2.9	2.0	89	-	260	10	-	.4	0.6	-	0.1	-	(1) 36.4 06	7,300		
7 2:05 PM	15	63	6,610	89	12.2	8.5	Yellow	10	Ft. Earthy	30	8.3	52	-	0	180	7.2	13	140	-	370	40	-	.3	.1	-	.75		33.0	2,400		
10 2:15 PM	22	63	2,144	50	9.4	7.5	Pale Straw	10	0	5	7.7	68	-	0	250	2.6	23	220	-	405	0	-	0	0	-	.17		31.67 ET 31.57 R	2,400 2,400		
1 12:30 PM	22	64		RIVER FROZEN OVER							NO SAMPLES	→																			
4 2:30 PM	8	64	65,214	43	5.7	7.0	Brown	15	0	15	8.1	53	-	0	86	2.3	.7	46	-	120	5	-	.4	.25	-	.15	06 FTG P	39.6 39.32 39.30	2,400		
7 2:50 PM	6	64		79	9.9	8.7	V. Sl. Brown	10	V. Ft. Musty	10	9.2	47.0	-	0	190	3.8	16	150	-	350	10	-	0	0	-	.08	—	—	< 2.2		
9	29	64		60	9.0	7.4	V. Sl. Brown	15	Dist. Earthy	10	7.5	61	-	0	315	1.6	33	248	-	460	10	-	0	0	-	.15	OG ETG DR	Dry 1.66 1.66	430		
12 12:20 PM	22	64		34	13.8	7.0	Clear	20	Dist. Musty	15	7.2	31	..	0	164	2.8	19	90	-	284	5	-	0	1.0	-	.15	(2) OG ETG DR	33.45	2,400		
3 12:15 PM	31	65		45	11.8	6.7	V. Sl. Brown	10	0	10	7.7	27	-	0	76	3.5	7	50	-	142	5	-	0.8	0.25	0	.05	—	05 55.5 [illegible]	46,000		
6 1:00 PM	29	65		82	9.0	8.0	Sl. Yellow	15	0	15	8.3	58	-	0	144	5.2	15	126	-	282	10	-	0.2	0.25	0	0.1	-	2.17 ETG 2.17 D	2,400 430 2,400		
9 11:00 AM	15	65	3,008	L-68 R-68	L-8.0 R-8.0	L7.6 R7.6	Sl. Yellow	10	Decided Grassy	20	7.8	57	-	0	185	6.1	21	180	-	375	20	-	0.4	0.1	0	.08	-	31.41 ET 2.99 R(D)	L. 460,000 R-1,100,000	< 1	7 ± 3
12 12:30 AM	15	65	11,435	42	160 12.2	7.1	V. Sl. Yellow	15	Faint Musty	10	7.8	37	-	0	90	3	9	64	-	140	10	-	0.4	0.33	0	0	-	ETG 34.05 R(D) 4.05	R. 9,200 L. 2,400	< 1	3
3 2:45 PM	21	66	55,115	48	140 11.2	7.0	Clear	10	Faint Musty	15	7.4	25	-	0	50	1.2	5	36	-	100	15	-	0.6	0.25	L-0 R-0	0	-	ETG 35.64 OG 35.7	R. 9,200 L. 16,000	< 1	3
5 3:15 PM	31	66	36,230	68	180 9.6	7.6	V. Sl. Yellow	5	0	10	7.7	30	-	0	76	4.0	6	50	-	140	10	-	0.6	0.2	L-0 R-0	0	-	OG 37.2 ETG 37.2	R. 170 L. 20	< 1	3
9 3:00 PM	8	66	1,860	72	525 9.2	7.6	Clear	10	Decided Musty	10	7.3	45	-	0	224	3.0	22	245	-	426	5	-	0.1	0	LO.02 RO.0	0	-	ETG 34.48 R(D) 1.48	R. 2.2 L. 2.0	<1	3 ± 3
12	1	66	63,465	40	200 11.6	6.8	Brown	30	Dist. Musty	35	6.9	29	-	0	62	8.0	6	34	-	208	40	-	4.0	0.6	RT-0 LT-0	0	-	9.28	R: [illegible] L. 24,000	< 1	4 ± 3

REMARKS: (1) Rating table starts at 35.5', so reading of 3.64 should be 36.4 or stream flow of 28,030 cfs per Rhodes Memo of 6-27-63
(2) See letter of 1-27-65 from Italy in WQW File. There is a 10' correction

* June 12, 1964 2-1 sampling point charged to US30 Bridge @ Columbia

GPU Nuclear — Update -8
TMI Unit-1 — 7/89
Susquehanna River Water Quality at Marietta and Columbia
Table 2.6-4

TABLE 2.6-5
(Sheet 1 of 3)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

TABULAR PRECIPITATION FOR PMF – HYDROMET NO. 40

TOTAL DURATION (HOURS)			6	12	18	24
PERIODS (HOURS)			6	6	6	6
WILKES-BARRE WARNING: 18 HOURS 8.4" RAIN 24 HOURS 9.6" RAIN	CUMULATIVE RAINFALL IN INCHES	6 HOUR	4.9	1.9	1.6	1.2
		12 HOUR		6.8		2.8
		24 HOUR				9.6
		48 HOUR				
		72 HOUR				
LEWISBURG WARNING: 18 HOURS 10.1" RAIN 24 HOURS 11.5" RAIN	CUMULATIVE RAINFALL IN INCHES	6 HOUR	6.2	2.3	1.6	1.4
		12 HOUR		8.5		3.0
		24 HOUR				11.5
		48 HOUR				
		72 HOUR				
HARRISBURG WARNING: 18 HOURS 6.6" RAIN 24 HOURS 7.8" RAIN	CUMULATIVE RAINFALL IN INCHES	6 HOUR	3.4	1.8	1.4	1.2
		12 HOUR		5.2		2.6
		24 HOUR				7.8
		48 HOUR				
		72 HOUR				

TABLE 2.6-5
(Sheet 2 of 3)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

TABULAR PRECIPITATION FOR PMF – HYDROMET NO. 40

TOTAL DURATION (HOURS)			30	36	42	48
PERIODS (HOURS)			6	6	6	6
WILKES-BARRE WARNING: 18 HOURS 8.4" RAIN 24 HOURS 9.6" RAIN	CUMULATIVE RAINFALL IN INCHES	6 HOUR	1.0	0.8	0.8	0.6
		12 HOUR		1.8		1.4
		24 HOUR				3.2
		48 HOUR				12.8
		72 HOUR				
LEWISBURG WARNING: 18 HOURS 10.1" RAIN 24 HOURS 11.5" RAIN	CUMULATIVE RAINFALL IN INCHES	6 HOUR	1.1	0.9	0.8	0.6
		12 HOUR		2.0		1.4
		24 HOUR				3.4
		48 HOUR				14.9
		72 HOUR				
HARRISBURG WARNING: 18 HOURS 6.6" RAIN 24 HOURS 7.8" RAIN	CUMULATIVE RAINFALL IN INCHES	6 HOUR	1.1	0.9	0.7	0.7
		12 HOUR		2.0		1.4
		24 HOUR				34
		48 HOUR				11.2
		72 HOUR				

TABLE 2.6-5
(Sheet 3 of 3)

HISTORICAL INFORMATION
This information was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

TABULAR PRECIPITATION FOR PMF – HYDROMET NO. 40

TOTAL DURATION (HOURS)			54	60	66	72
PERIODS (HOURS)			6	6	6	6
WILKES-BARRE	CUMULATIVE RAINFALL IN INCHES	6 HOUR	0.5	0.4	0.3	0.2
		12 HOUR		0.9		0.5
WARNING:		24 HOUR				1.4
18 HOURS 8.4" RAIN		48 HOUR				14.2
24 HOURS 9.6" RAIN		72 HOUR				
LEWISBURG	CUMULATIVE RAINFALL IN INCHES	6 HOUR	0.6	0.4	0.3	0.2
		12 HOUR		1.0		0.5
WARNING:		24 HOUR				1.5
18 HOURS 10.1" RAIN		48 HOUR				
24 HOURS 11.5" RAIN		72 HOUR				16.4
HARRISBURG	CUMULATIVE RAINFALL IN INCHES	6 HOUR	0.6	0.4	0.3	0.2
		12 HOUR		1.0		0.5
WARNING:		24 HOUR				1.5
18 HOURS 6.6" RAIN		48 HOUR				
24 HOURS 7.8" RAIN		72 HOUR				12.7

TABLE 2.6-6
(Sheet 1 of 1)

SUSQUEHANNA RIVER LEVEL VERSUS FLOW AT TMI ISPH

Flow (cfs)	Level (feet)
125000	282.4
200000	284.2
250000	285.4
300000	286.4
350000	287.4
400000	288.3
450000	289.2
500000	290.0
550000	291.0
600000	292.1
650000	293.0
700000	293.9
750000	294.8
800000	295.8
850000	296.8
900000	297.8
950000	298.8
1000000	299.8
1050000	300.5
1100000	301.6
1150000	302.6
1200000	303.5
1250000	304.4
1300000	305.3
1350000	306.2
1400000	307.6
1450000	309.3
1500000	311.0
1550000	311.9
1600000	312.8
1625000	313.3
1650000	313.6
1700000	314.2
1750000	314.8

2.7 ENGINEERING GEOLOGY AND FOUNDATION CONSIDERATIONS

2.7.1 GENERAL

Three Mile Island is located approximately 2.5 miles south of Middletown, Pennsylvania, at longitude 76°43'30" west and at latitude 40°8' north. The reactor vessel coordinates are N300.827; E2,286,878, based on the Pennsylvania State coordinate system (UTM coordinates, Zone 18, 4,446,102 meters north, 353,062 meters east). It is one of the largest of a group of several islands in the Susquehanna River and is situated about 900 ft from the east bank. It is elongated parallel to the flow of the river, with its longer axis oriented approximately due north and south. The island is about 11,000 ft long and 1700 ft wide. This unit is located in the northern one third of the island.

The southeasterly flowing Susquehanna River makes a sharp change in direction, to nearly due south, in the vicinity of Middletown. After this directional change just north of Three Mile Island, the channel widens to approximately 1.5 miles.

The island on which the site is located is basically composed of fluvially deposited sand and gravel of adequate density to support moderately heavy loads. The underlying rock is a sedimentary sequence of interbedded sandstone, shaley siltstone, and shaley claystone which belongs to the Gettysburg Formation of Triassic Age. Below the weathered surface, bedrock is capable of safely bearing loads imposed by the heaviest structures (Reference 16).

A program of test borings and a seismic refraction survey, supplemented by field geology, photogeology, and a tectonic evaluation, have been employed to determine and evaluate the suitability of the geology at the site to support a nuclear powered generating station.

Groundwater occurs above the bedrock-soil interface and varies in response to fluctuating river levels. Foundation design includes the effect of such hydrostatic variations.

The site is not considered to be deleteriously affected by faulting, and it is concluded that regional tectonic elements are inactive and present no threat to the structural integrity of local geology.

Historically, earthquakes in Pennsylvania have been infrequent and of low intensity. The resultant intensity at the site of past quakes greater than 50 miles distance was between III and IV. The highest recorded intensity within a 50 mile radius of the site was modified Mercalli VI which was rapidly attenuated with distance from the epicenter. Assuming that the closest future earthquake activity would occur 5 to 6 miles north of the site at the Triassic Border Fault, which to this time has produced a maximum epicentral intensity of VI, the intensity would be attenuated to V at the site. If the focal depth is greater than the previous earthquakes, the intensity at the station site might approach the epicentral intensity and not be rapidly attenuated. Therefore, based on intensity at the site to be a low intensity VI, a ground acceleration of 0.04g should be expected, according to Figure 4 as referenced in Reference 21. The design is conservatively based on a basic ground motion of 0.06g maximum.

Acceleration response spectra for the design earthquake were partially developed using records from the March 1957 San Francisco earthquake normalized to a basic ground motion of 0.06g. Data from this earthquake were recorded by an instrument located on rock in Golden Gate Park. The instrumented records provide valuable data on the attenuation of a moderate earthquake occurring a short distance from the recording station. These field conditions are considered to best approximate those at the Three Mile Island site. The acceleration response spectra were further developed on the basis of the spectra for the 1940 El Centro earthquake, again normalized to a basic ground motion of 0.06g. The resultant spectra (Figure 2.7-1) therefore are controlled in the low frequency region by the El Centro Spectra.

Without qualification, the site is considered to be geologically competent to safely support a nuclear-powered generating station.

2.7.2 FIELD INVESTIGATION

Supplemented by a ground surface survey team, aerial photographs, and a geologic surface investigation, a subsurface exploration program consisting of 21 borings in conjunction with a seismic refraction survey was initiated in August and September of 1966 to establish the general range of soil depths, types, and engineering properties, and to examine and evaluate the condition of the bedrock and depth of weathering (Figure 2.7-2). This work was done to ascertain the capabilities of the site to safely and economically support a nuclear-powered generating station.

The borings and seismic profiles covered the entire length of the island. From the initial interpretation of the longitudinal seismic line and accompanying borings, the general area of the island appearing to offer the best subsurface conditions was selected, and the seismic cross lines and additional borings were concentrated in that area.

In January 1967, 20 borings were added in the plant site area for further soil investigation and to obtain reliable water table information.

The Phase I drilling program consisted of continuous sampling of overburden using the Standard Penetration Method and coring (NX core) a minimum of 10 feet into sound rock. Phase II drilling, in all but a few holes, consisted of continuous split-barrel soil sampling of overburden to bedrock and the installation of 3 inch slotted standpipes in drilled holes, comprising a system of groundwater observation points.

Forty eight additional borings were then taken in Phase III: 15 at the cooling towers, 12 at the Reactor Building, and 21 at other structure locations. These borings substantiated the conclusions drawn from the Phase I drilling program. Phase III drilling consisted of continuous split-barrel soil sampling of overburden to bedrock and core drilling into bedrock to various depths; the deepest hole penetrating 128 feet into rock.

A seismic survey was conducted (Reference 17). A twelve trace seismic refraction system with a recording oscillograph was used. Seismic energy was generated with explosives. Data were collected using two 100 foot long geophone spreads, with 20 foot geophone intervals and with three 10 foot intervals on both ends of the geophone spreads. The standard continuous profiling technique was used. In addition to end shots, two intermediate shot point determinations were made on each spread.

Seismic results were interpreted (Reference 17) and incorporated in the text of this report and on the soils profile, Figure 2.7-3. The location of the seismic lines and borings are shown on the boring location plan, Figure 2.7-4.

2.7.3 GEOLOGY

2.7.3.1 Geographic Setting

The site lies within the Gettysburg Basin section of the physiographic division known as the Piedmont Province. The topography of the area immediately surrounding Three Mile Island is of a slightly undulating nature with maximum relief of about 200 feet and highest elevation seldom above 500 feet. From the east, drainage is largely represented by the southwesterly flowing Swatara Creek which has its mouth near Middletown, and by the more westerly flowing Conewago Creek which empties into the Susquehanna River at the south end of Three Mile Island. Fishing Creek flows into the Susquehanna west of the site, and the northeasterly flowing Conewago Creek terminates at York Haven. Three Mile Island has very little relief, with elevations ranging from about 280 feet at the water's edge to slightly more than 300 ft in the north central portion.

2.7.3.2 Regional Geologic History

A geologic history of the Three Mile Island area was prepared (Reference 18), which summarized the regional structural, geologic, and tectonic aspects of this locale. The site is located in the Triassic lowland of Pennsylvania, one of a series of long narrow basins of Triassic deposits which extend in broken patches from Connecticut to North Carolina. The Triassic lowland in the vicinity of the site is referred to as the Gettysburg Basin. North and west of the Triassic lowland are the folded and thrust faulted Paleozoic rocks which comprise the Appalachian Mountains. Southeast of the Triassic lowland is the Piedmont, of Pre-Cambrian and Early Paleozoic Age, composed of granites, gneisses, and schists.

Reference 14 states after the late Paleozoic mountain making during which compression had been relieved by folding and overthrusting, large blocks of the region settled along nearly vertical joint planes, resulting in normal faulting and tilting of blocks, which formed a vast sunken basin or trough with a northeast trend and a highland to the southeast. In the following Triassic period torrential rains washed the waste from the disintegrated crystalline rocks of this highland into the trough, and arkosic sand, argillaceous sand and fine sandy mud accumulated. Much of this sediment was of a pronounced red color, owing to the fact that the iron content of the rocks was highly oxidized when they disintegrated, apparently under acid conditions. After the accumulation of a thickness of many thousands of feet of these red rocks, which now form the Newark group, further adjustment of earth blocks by tilting and normal faulting, took place on a still larger scale than before, and in places mountains were formed on the northwest side of the basin by differential uplift of several thousand feet. Catoctin Mountain in Southern Pennsylvania is an example.

The Newark group is believed to have a thickness of approximately 16,000 feet and tilts toward the northwest. This is due to subsidence and faulting along the northwest border.

Later, intrusion of Triassic diabase dikes and sills cut through the Newark group and metamorphism took place along the edges of these intrusions. Since Triassic times an erosional period has been prevalent except for glacio-fluvial deposition from Pleistocene glacial advances. The farthest advance occurred during the Illinoian stage when a lobe of the glacier extended down the Susquehanna Valley to near Fisher's Ferry, approximately 45 miles north of Three Mile Island. Glacial meltwater was responsible for the deposition of some alluvial terrace deposits now present in the region.

The tectonic history of the area (Reference 18) indicates that the region has been extremely stable for at least the last 10,000 to one million years, and that studies did not establish the existence of minor faults or fractures at the site. Reference 18 concludes, "In the event that such inconspicuous features do exist, the probability of future movement along such zones is so small as to be negligible."

2.7.3.3 Depositional History Of Three Mile Island

Three Mile Island, along with Shelley Island and other small islands in the vicinity, were formed as a result of fluvial deposition by the Susquehanna River. The carrying capacity of the river sharply decreases as the channel width increases after the stream crosses an east-west trending, very resistant diabase dike just downstream from Middletown. At this point the channel has been incised into the more easily erodable Gettysburg shale, resulting in a conspicuously wider channel. In addition, a change of flow direction occurs after the stream cuts through the diabase dike which crosses the river at that point (represented by Hill Island), and is directed along N 10°E striking vertical joints until it is again restricted and deflected by a second diabase dike just south of Three Mile Island.

Boulders carried by the glacial meltwater or transported downstream by ice rafts were first deposited in this wide-channel, low-velocity section of the river and became the nuclei for subsequent deposition of smaller materials. This gradual accretion of river sediment resulted in the growth of most of the islands in this area. Three Mile Island is made up of two such nuclei which eventually merged. This area between the two nuclei is presently represented by fine-grained deposits which were deposited in a low energy fluvial environment between the two growing depositional islands.

2.7.3.4 Bedrock Geology

The site is underlaid by the sedimentary rocks of the Gettysburg shale, a part of the Newark group of Triassic Age. Two easterly trending diabase intrusions cut through the Gettysburg shale, one approximately 1 mile upstream from Three Mile Island and a second one about 0.2 miles downstream from the island. These more erosion resistant diabase dikes and the metamorphosed shales along their edge have caused restrictions in the river at Hill Island, north of the site and at Conewago Falls, downstream of the site.

The bedrock surface at the site is essentially flat and lies at approximately elevation 277 ft. Lithologic types vary from red to brown, interbedded, fine to medium-grained sandstone, shaley siltstone, and shaley claystone which range from medium-hard to hard, possessing seismic velocities in a range from 8500 to 11,500 ft/sec. There is 1 to 3 ft of weathered rock at the overburden-bedrock interface.

The regional dip of the Gettysburg shale is to the northwest at 10° to 50°. Near the site, the attitude of these beds as measured in surface outcrop, varies from N 65° to 80° E with 35° to 70° northerly dips. This variation in inclination of strata was not apparent from drill cores, as a fairly consistent dip of 37.5° to 45° was observed in the subsurface of Three Mile Island.

Well developed, near vertical jointing is conspicuous along a N10°E trend. Drill hole data substantiated surface observations regarding jointing, and revealed that healing of some joints has occurred, while others were altered by oxidation.

2.7.3.5 Faulting

No evidence of faulting which transects the island was seen in the field from available rock exposures along the east bank of the river, or along the western periphery of the island. Aerial photographs give no suggestion of faulting through the island.

Reference 14 has mapped a hypothetical NE trending fault which they projected through Three Mile Island approximately 0.5 miles south of the site area. The substance for their structural geology was obtained by large scale surface mapping which was completed in 1929. Based on the data collected to date, this hypothetical fault does not exist. Likewise, these studies show no evidence to substantiate the projections of other hypothetical faults across the river immediately north and south of the island. The Triassic depositional basins were subjected to an appreciable degree of diastrophism during the Palisades disturbance. Most significant, however, is the fact that structural features resulting from such diastrophism are as much as 185 million years old, and that area has been extremely stable for the last 10,000 to 1 million years. In addition, rock velocities obtained from the seismic survey are normal to Triassic Gettysburg Formation rock types and indicate that the bedrock is not in a state of stress, thereby eliminating any latent threat of future strain.

A comprehensive evaluation of major tectonic elements in south central Pennsylvania was prepared as in Reference 18. It is concluded that the site is not deleteriously affected by faulting, and further, that regional tectonic elements are inactive and present no threat to the structural integrity of the local geology.

2.7.3.6 Soils

The island, as a whole, is composed of fluvially stratified subrounded to rounded sand and gravel containing varying amounts of silt, clay, and occasional lenses of clean sand. Density values range from loose to very dense, as established by Standard Penetration Tests. Boulders are presented at depth and are mainly confined to the lower portions of the soil zone on the north end of the island. Soil depths vary from approximately 6 ft at the south end of the island to a maximum of 30.0 ft near the axial intersection of the island. Depth of soil is relatively constant at about 20 ft in the vicinity of the plant site.

The overburden is made up primarily of two units. Directly overlying the sedimentary rocks is a layer of coarse sand and gravel which, at the north end of the island, contains numerous boulders and cobbles and ranges from medium dense to very dense.

Above the coarse sand and gravel is a layer of loose to medium dense, fine-grained granular material which varies from a fine silty sand and gravel, north of Station 13 + 00 (north) to a very stiff, clayey silt on the south end of the island.

Local variations do occur, and in some drill holes at the plant site, the amount of fines appeared slightly greater below a depth of about 10.5 ft. This variation is believed to be a function of a mechanical breakdown of individual shale and siltstone pebbles contained in the soil. From one half to one foot of topsoil, composed of sandy silt with much organic material, covers the island. The island had been cultivated and planted into corn fields in past years.

2.7.4 GROUNDWATER HYDROLOGY

2.7.4.1 General

Three Mile Island Nuclear Station is located on a large island in the Susquehanna River. Purely from the standpoint of geography, its groundwater conditions are unique, but relatively constant, and predictably controlled by the Susquehanna River itself. The drainage area of the Susquehanna River extends from its source at Otsego Lake, Cooperstown, New York, for a distance of 444 miles, across the states of Pennsylvania and Maryland, and terminates in the Chesapeake Bay. This major water course collects surface runoff and groundwater seeps as well as their respective contaminants from a watershed area of approximately 27,000 square miles. Three Mile Island is located in the lower third course of the river and therefore is influenced by the quantity and quality of that portion of the water from the Susquehanna River watershed upstream from the island. Average annual rainfall at the site is 40 inches.

2.7.4.2 Mode Of Occurrence

The bedrock underlying the general area is composed of shales, sandstones, and siltstones belonging to the Gettysburg shale of Triassic Age. A wide range in yields occurs within the formation, with the sandstone facies normally being the best aquifers. However, in closely jointed or fractured shales, relatively high yields can occur. The alluvial deposits are not believed to be a major source of groundwater in this area.

2.7.4.3 Site Studies

Groundwater was studied at the site by means of:

a. Standpipes to record elevation and fluctuation of water levels,

b. A pumping-out test to determine permeability of the saturated soil,

c. A falling head permeability test to determine permeability of soil above the water table.

Groundwater at the site occurs under water table conditions. The water table reaches its maximum elevation at the highest topographic point in the center of the island and falls off toward both the east and west shores. A variation of only about 5 ft occurs from either side to the center producing a gradient of approximately 0.6 percent toward the river.

At twenty observation points in and surrounding the plant area, water levels occurred generally at a depth in excess of 15 ft and ranged from 14 to 19 ft. The groundwater level occurred at a maximum of 6.2 ft above the top of rock with less than 1 ft of head existing above the soil-rock interface at one point of observation.

The water level of the Susquehanna River, which normally flows at elevation 277 ft, controls Three Mile Island groundwater levels. A rapid rise in the river in response to a heavy rain and thawing of ice jams during January 1967 was seen to produce significant rises in the water levels of observation wells 200 ft from the water's edge. Since a positive head exists on the island, any movement of groundwater from the plant site would be toward either channel of the river, and would eventually enter the stream. The river would act as a natural boundary, limiting the dispersal of groundwater from the island to the river. Two factors are important in considering the possibility of infiltration of groundwater into the underlying Gettysburg shale and transmission to onshore water supplies:

a. A maximum positive head of 6 ft exists above the impervious (relative to the soils) Gettysburg formation.

b. Groundwater levels are higher on either shore of the river, with hydraulic gradients sloping toward the river.

In order for groundwater to move from Three Mile Island to the mainland, it would be necessary to reverse the hydraulic gradient on the mainland, which would necessitate partial dewatering of the Susquehanna River.

Further, it is unlikely that river water would ever significantly infiltrate rocks on either shore, except under sustained high capacity pumping, creating induced infiltration. A natural condition of river water flowing into the ground would not be normal to this climate and geography.

The length of time required for the groundwater to move to the river is problematical. Two types of tests were run, in an attempt to establish permeability of the soils overlying the bedrock. A pumping-out test was run on the eastern side of the island and the results determined indicated the permeability of the saturated soil zone to be on the order of 10^{-2} cm/sec. A falling head test was run in the center of the island which showed a coefficient of approximately 10^{-3} cm/sec. These results confirmed those permeabilities estimated from examining the continuous samples from the test borings. Some change in slope of the water table will occur due to the variations of the river level, and temporary minor reversal of groundwater movement will probably result during periods of high water or during periods of extended drought. Any additional impoundment of water in either channel would necessarily have an effect on the direction of groundwater movement and on the slope of the water table, but in any event the final discharge point would still be into the river.

2.7.4.4 <u>Area Water Well Data</u>

Most of the data on groundwater wells in the Gettysburg shale came directly from the U.S. Geologic Survey water supply paper on the groundwater resources of Harrisburg International Airport at Middletown (Reference 13). The airport is located approximately two and one half miles north of Three Mile Island.

The average strike of the formation in this area is N 43° E with dips at angles varying from 19 to 38°. The rock consists of alternating layers of fine to coarse-grained sandstone, siltstone, and shale.

Groundwater occurs under artesian conditions at the base. In 20 wells ranging from 300 to 800 ft in depth, specific capacities of the aquifers tapped ranged from 0.33 to 15.0 gpm/foot drawdown and transmissibilities varied from 1200 gpd per ft to somewhat less than 50,000 gpd per foot. The pH of wells tested ranged from 6.6 to 8.1, hardness from 137 to 826 ppm and dissolved solids from 200 to 1340 ppm. The Brunswick shale (the name applied to the eastern counterpart of the Gettysburg shale) and the Gettysburg shale were combined and included together in groundwater tabulations (Reference 15). Of 112 wells surveyed, the depths ranged from 18 to 500 feet, with an average depth of 157 feet. Yields ranged from zero to 300 gallons per minute with an average yield of 41. Six analyses were included showing the range of total dissolved solids to be between 201 and 786 ppm, hardness from 152 to 499 ppm, and iron from 0.5 to 4.9 ppm. Since these are fairly deep rock aquifer wells where water chemistry is a function of mineralogy of the reservoir rocks, one should not expect the alluvial groundwater to be of similar chemical makeup.

2.7.5 FOUNDATION CONSIDERATIONS

As set forth in Section 2.7.3.3, the subsurface of Three Mile Island indicates that it formed first as two islands which were later joined as a result of the fluvial cycle of the Susquehanna River. Both nuclei have subsurface conditions which are favorable for safe, economic foundation design; however, the larger thickness of the uniformly dense to very dense sand and gravel layer at the north end of the island provides a better opportunity to utilize these dense soils as bearing materials and a greater opportunity to remain above the groundwater table. A plant built on the south end of the island would involve expensive rock excavations and definite dewatering costs. Also, a greater variation in the bedrock surface was detected by the seismic survey on the south end of the island, and inferences of greater variations in intensity of weathering were also noted in this area. The type of foundation, base elevation, and foundation medium for all Class I structures are listed in Table 2.7-1.

2.7.5.1 Soils

There is a high degree of uniformity of density and of soil types at the plant location, within the upper silty sand layer and the lower sand and gravel layer.

Both layers are capable of supporting foundation loads which will greatly increase with increasing depth. The actual bearing capacity of each soil layer is dependent upon the depth, size, and spacing of footings, and is greatly influenced by the elevation of the ground water table. The bearing capacity of footings placed in the lower sand and gravel layer can conservatively be permitted within a range of 5 to 8 kips per square foot (ksf), but can be considerably increased depending upon the above variables. For instance, a square footing 10 ft wide at a depth of 10 ft can be considered to safely support 14 ksf if it remains a sufficient distance above the water table, and half of that value at the water table.

Field explorations have established that the top of dense to very dense granular overburden material (in excess of 30 blows per foot (bpf) - Standard Penetration Test (SPT) at the plant site ranges from elevation 284.5 to 289.5 ft, while at the cooling towers the elevation of this horizon varies from 283.0 to 294.0 ft.

The top of the granular material with blow counts in excess of 20 bpf - spt varies from 288.6 to 295.4 ft at the cooling towers and at the plant site from 295.0 to 298.7 ft.

2.7.5.2 Rock

The fact that the bedrock surface is differentially weathered necessitates a variation in the surface bearing capacity, and points out the need for assuring that any structure supported by rock be firmly established on sound rock. For preliminary planning and estimating purposes, the sound rock surface was assumed to be represented by the seismic top of rock line, defined by a compressional wave velocity of 10,000 ft/sec, shown on Figure 2.7-3, and the bearing capacity of rock to support any given foundation at a constant elevation was assumed to be equal to a maximum of 30 ksf.

Since bedding dips at approximately 45 degrees to the horizontal, the heavily loaded foundations (those in excess of 10 ksf) were not placed up dip from sides of excavations. The shearing strength of rock parallel to unconfined bedding planes is significantly smaller than the compressive strength of the rock perpendicular to bedding planes. Also, due to the combination of vertical jointing and moderately dipping bedding planes which afford potential shear surfaces, the high differentially loaded foundations were not placed at shallow depths.

Under conditions of even loading at constant elevation, the unweathered rock at Three Mile Island is capable of safely sustaining maximum loading of 30 ksf.

At the cooling tower locations, the top of rock elevation varies from 270.5 ft to a maximum elevation of 276.2 ft. At the Reactor Building and other main structures, the top of rock varies from elevation 275.0 to 279.5 ft.

All Class I structures founded on bedrock were excavated to sound rock. Wherever necessary concrete fill was placed on top of the rock to the base elevation listed in Table 2.7-1.

The following test data were obtained on BX core samples which were sealed in cheesecloth and wax to preserve natural water until laboratory tests could be performed.

Five representative samples were tested in unconfined compression and one sample in consolidated, undrained triaxial compression. The triaxial compression test was performed with a cell pressure of 50 psi. All compression test samples, having a diameter of approximately 1.65 ± 0.02 in were trimmed into lengths of 3.03 ± 0.02 in by means of a diamond saw prior to testing.

Three unconfined compression tests were carried to failure using a rate of strain of 0.025 in/min. The remaining unconfined compression tests and the triaxial compression test were terminated at a compressive load usually in the order of 100 tons per square foot (tsf). Unload-reload cycles were carried out in four of the tests with stress excursions below the elastic limit.

The pertinent physical, strength, and elastic property test data are tabulated on the summary of laboratory test results in Table 2.7-2. It is noted that the First Load, Secant Modulus (Ec) of the test specimens averaged 0.6 x 10^3 ksi and that the Second Load (reload), Secant Modulus (E) averaged 1.35 x 10^3 ksi, based on five and four tests, respectively. The average unconfined compressive strength of the three test specimens which were loaded to failure was 87.4 tsf.

No significant difference was noted between an unconfined and triaxial test performed on specimens trimmed from the same core sample. This finding is noted to be consistent with the relatively small confining pressure utilized during triaxial testing.

The allowable bearing capacity used for the design of the foundations on rock has been determined based upon the average unconfined compressive strength of the rock.

The factors of safety used to determine the allowable bearing stress were as follows:

30 ksf, for normal load: F.S. = 6
60 ksf, for factored load: F.S. = 3
90 ksf, for extreme load: F.S. = 2 (airplane impact)

The soils and rock are capable of safely supporting the anticipated design loads at the proposed elevations.

2.7.5.3 Groundwater

Groundwater levels were recorded in detail around the plant site and vary from 279.0 to 282.0 feet with elevation and distance from the river. Assuming that the river is maintained at elevation 277 feet, the groundwater levels should vary little from those presently observed. However, flood studies indicate a mean annual flood at the 286 feet elevation with 5, 10, 25, and 30 year flood predicted at 288.0, 290.0, 291.5, and 292.5 feet, respectively.

Deep excavations were dewatered by pumping from shallow sumps. Hydrostatic pressures were considered in the foundation design.

TABLE 2.7-1
(Sheet 1 of 2)

FOUNDATIONS FOR CLASS I STRUCTURES

Structure	Type of Foundation	Base Elevation	Foundation Medium
Reactor Building	Mat	270 ft	Bedrock
Auxiliary Building	Mat	278 ft	Bedrock
Fuel Handling Building	Mat	276 ft 6 in	Bedrock
Control Building	Continuous foot-ings under walls. Square footings under columns.	278 ft	Bedrock
Diesel Generator Building	Mat	303 ft	Compacted Backfill
Intermediate Building	Continuous footings under walls.	277 ft	Bedrock
Intake Building	Mat	259 ft 6 in 262 ft 6 in	Bedrock
Heat Exchanger Vault	Mat	267 ft 6 in	Bedrock
Access Tunnel Vault to Auxiliary Building	Mat	279 ft	Bedrock
Air Intake Structure	Mat	266 ft 278 ft	Bedrock

TABLE 2.7-1
(Sheet 2 of 2)

FOUNDATIONS FOR CLASS I STRUCTURES

Structure	Type of Foundation	Base Elevation	Foundation Medium
Foundations for Storage Tanks:			
Borated Water Sodium thiosulfate (1) Sodium hydroxide (1)	Mat	300 ft	Compacted Backfill
Emergency Feedwater System Condensate	Mat	300 ft 11 in	Compacted Backfill
Underground Diesel Fuel	Mat	283 ft 6 in	Compacted Backfill

(1) – The Sodium Thiosulfate and Sodium Hydroxide Tanks are isolated from the DH and BS Systems.

TABLE 2.7-2
(Sheet 1 of 1)

SUMMARY OF LABORATORY TEST RESULTS

Comprehensive Boring Sample	RB-1BX/1	RB-1BX/2	RB-1BX/3	RB-1BX/2A	RB-1BX/3A
Sample Depth (ft)	30.0-30.7	33.4-34.1	44.6-45.0	33.4-34.1	44.6-45.0
Water Content (%)	0.85	0.82	0.92	0.90	0.94
Dry Density (psf)	168.3	167.9	167.0	166.0	166.1
Elastic Modulus					
$E_{(psi)}$	$0.67x10^6$	$0.50x10^6$	$0.62x10^6$	$0.90x10^6$	$0.30x10^6$
$E_{(psi)}$	$1.6x10^6$	$1.2x10^6$	$1.3x10^6$	$1.3x10^6$	-
Strength (tsf)	90.7	91.6	82.9	-	-
Type Failure	Chisel-Shattered	Chisel-Shattered	Chisel-Shattered	-	-

2.8 SEISMOLOGY

A seismicity and response spectra was conducted and is represented in Reference 19.

2.8.1 SEISMICITY

The seismicity analysis indicated that Pennsylvania is relatively inactive seismically, based upon 200 years of historical data and 40 years of instrumental data. Earthquakes in the greater Pennsylvania area, which have or might have affected the site, were studied and their intensity at the site was determined by attenuation of the earthquake with distance.

Earthquakes which have affected the site were studied in two categories, those within a 50 mile radius of the site, and those beyond this radius. Nearly all the earthquakes considered were felt over very limited areas, which are generally elliptical in shape, and aligned with the general structural trend of the area. The high attenuation of these earthquakes indicates that their foci must have been close to the earth's surface.

An estimate of the maximum expected intensity of an earthquake was predicated on the assumption that the activity which would affect the site would originate along the border fault of the Triassic Lowland, five to six miles north of the site. The highest intensity earthquake to occur on this fault has been modified Mercalli VI. The intensity of such an earthquake at the site would be V, based upon the rapid attenuation of similar earthquakes in the area and along the fault. Consideration was given, however, to the future occurrence of an earthquake at a greater depth in the fault, with a conservative assumption that the resulting intensity at the site could approach the epicentral intensity, and not be rapidly attenuated.

The conservative estimate of the maximum earthquake intensity to be expected at the site is a low intensity VI. Using relationships published in Reference 21, this intensity corresponds to a ground acceleration of 0.04g. The design is conservatively based on a basic ground motion of 0.06g maximum.

2.8.2 ACCELERATION RESPONSE SPECTRA

The objective of this study was to establish an acceleration response spectra corresponding to a possible earthquake of low intensity VI (Modified Mercalli), as established by the seismicity analysis.

Figure 2.7-1 indicates the average smooth response spectra derived from the ground motions of the 1957 Golden Gate Park, San Francisco earthquake together with the revised acceleration spectra reflecting the greater response at lower frequencies based upon the 1940 El Centro spectra. The resulting acceleration response spectra (Figure 2.7-1) were developed as described in Subsection 2.7.1.

2.9 GEOLOGIC GLOSSARY

2.9.1 GENERAL

Alluvial	Stream transported
Aquifer	A water producing geologic unit
Artesian water	Groundwater that rises above the level at which it is encountered
Bedrock	Rock underlying soil, sand, clay, boulders, etc.
Diastrophism	The process of deformation of the earth's crust
Dike	A tabular body of igneous rock that cuts across the structure of adjacent rocks or cuts massive rocks
Decomposition	Breakdown and decay of rock to soils condition
Dip	The angle at which a stratum or any planar feature is inclined from the horizontal
Fault	A break in rock along which there has been displacement of the two sides relative to one another parallel to the break
Fluvial	Produced by river action
Folds	Bends in the strata
Footwall	Rock below a fault plane
Fractures	Breaks in rock due to folding or faulting
Groundwater	Subsurface water in the zone of saturation
Hanging wall	Rock above a fault plane
Ice raft	Floating ice which transports rock particles and other materials
Intrusion	An invasion of older rock by igneous rock
Joint	A fracture or parting along which little or no movement has occurred parallel to the fracture
Lithology	Composition and texture of rock
NX	Core size - 2.155 inches
Overburden	Soil, sand, gravel, boulders, etc., that overlie bedrock

Overthrust	In faulting, the process of thrusting the hanging wall (relatively) over the footwall
Sandstone	Sandstones are composed of cemented grains of sand-size material
Shale	A laminated sediment, composed predominantly of particles of clay size
Siltstone	A very fine grained clastic rock composed predominantly of particles of silt size
Tectonics	The study of the structure of the earth in response to earth movements
Water table	The upper surface of a zone of saturation
Weathering	Mechanical and chemical action on rocks which eventually reduces them to a soil state

2.9.2 HARDNESS CRITERIA

Rock hardness as indicated on the boring logs is a qualitative property determined by field classification, and is used as an aid in analyzing general subsurface conditions. Actual rock hardness is difficult to define; therefore, an arbitrary method of hardness determination was defined by the following criteria:

Very soft	Rock disintegrates to touch; exhibits destructive alteration; can be considered as hard to very hard soil.
Soft	Rock is coherent but is broken very easily by thumb pressure at sharp edges and crumbles with firm hand pressure. Exhibits partial alteration.
Medium hard	Rock appears to be relatively hard, but small pieces can be broken by considerable hand pressure. Usually exhibits high degree of oxidation.
Hard	Rock cannot be broken by thumb pressure. May exhibit minor oxidation (i.e., some oxide staining or discoloration, etc.).
Very hard	Rock broken with difficulty by hammer. Exhibits no effects from weathering.

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