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PLANT NAMES: Three Mile Island, Units 1 & 2	(43 cys encl rec'd)

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October 19, 1972

Mr. Daniel R. Muller
Assistant Director for Environmental Projects
Directorate of Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

SUBJECT: THREE MILE ISLAND UNITS 1 AND 2
DOCKETS NO. 50-289 AND 50-320

Enclosed please find forty (40) copies of responses to comments made by Federal and State Agencies in connection with the Commission's Draft Impact Statement for Three Mile Island Nuclear Station Units 1 and 2.

This submittal includes the remainder of the responses to these comments, as indicated in our letter of September 22, 1972.

Very truly yours,

F. J. Smith
Vice President

mw
Enclosure

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METROPOLITAN EDISON COMPANY
JERSEY CENTRAL POWER & LIGHT COMPANY
AND
PENNSYLVANIA ELECTRIC COMPANY

THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2

Application For
Class 104b Utilization Facility Operating License

DOCKET NOS. 50-289 AND 50-320

Applicant herewith submits 40 copies of the balance of the responses to comments made by Federal and State Agencies in connection with the Commission's Draft Impact Statement for Three Mile Island Nuclear Station Units 1 and 2.

METROPOLITAN EDISON COMPANY

ATTEST:

R. D. Hollinger
Secretary

By F. J. [signature]
Vice President

Sworn to and subscribed before me this 18th day of October 1972.

[signature]
Notary Public

50-289
50-320

Regulatory File Cy.

Received w/Ltr Dated 10-19-72

APPLICANT'S RESPONSE

TO

QUESTIONS RAISED BY GOVERNMENTAL AGENCIES

ON THE

COMMISSION'S DRAFT ENVIRONMENTAL IMPACT STATEMENT

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RESPONSE TO THE DEPARTMENT OF INTERIOR'S REQUEST
FOR DIMENSIONS OF THE DIKE AT THREE MILE ISLAND

The approximate dimensions of the periphery of the dike are as shown on the attached Figure 1-1. The following additional dimensions will be of interest:

1. Normal river water level in Yorkhaven pool - 278' above sea level.
2. Elevation to top of dike North end - 310' above sea level.
3. Elevation to top of dike on both the east and west sides of the island - Slopes from 309' to 305' above sea level.
4. Elevation to top of dike South end - 304' above sea level.
5. The dike is 20' wide with a 2:1 side slope.

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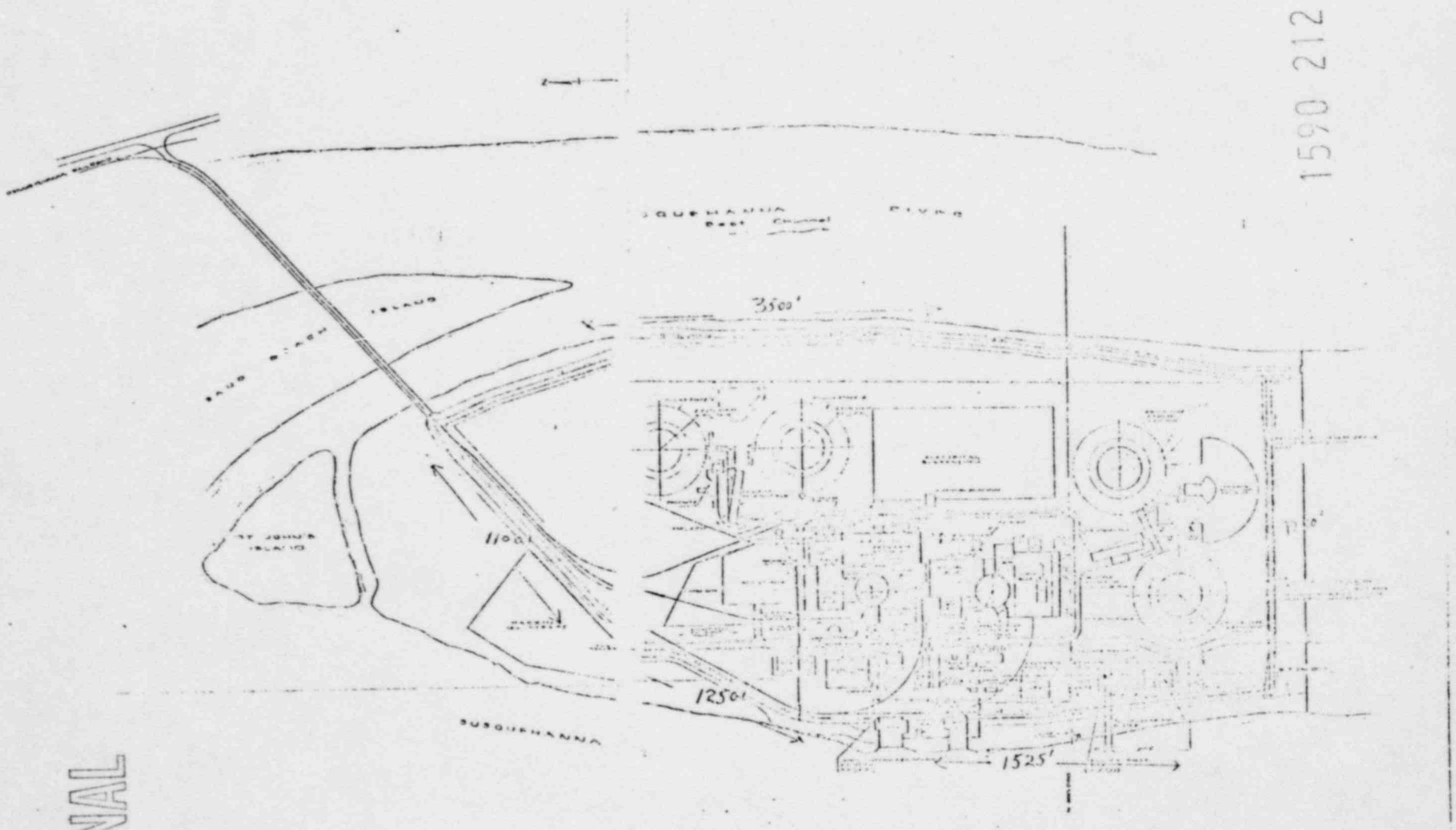

PLOT PLAN
THREE MILE ISLAND NUCLEAR STATION UNIT 1
FIGURE 1-1

RESPONSE TO EPA QUESTION ON CHLORINATION

CHLORINATION AT THE THREE MILE ISLAND PLANT

I. INTRODUCTION

Chlorine, as a gas or in some compound form, has been used in the United States for the disinfection of water since 1908. In addition to its use as a disinfectant, chlorine is also used as a biocide to prevent the development of fouling growths in condenser tubes and cooling towers. In addition to acting as a biocide, chlorine reduces and removes objectionable tastes and odors and oxidizes iron, manganese and hydrogen sulfide aiding in the removal of these materials.

Chlorine hydrolizes in water to produce hypochlorous acid, which provides the disinfecting and oxidizing properties of the solution.

Residual chlorine occurs in both free and combined forms. Free available residual chlorine exists in water as hypochlorous acid. Combined available residual chlorine is represented by compounds such as the chloramines. The bactericidal properties of free and combined chlorine residual differ. Approximately 25 times as much combined chlorine residual is required for complete bactericidal effect as is required for free residual chlorine. Further, for combined residual chlorine to be an effective bactericide contact time must be about 100 times greater than what is required for free residual chlorine to be effective.

Chlorine demand is the difference between the amount of chlorine supplied and the amount of total residual chlorine. Chlorine demand varies with water quality, contact time, pH, and temperature. Bacterial kill is usually accomplished when chlorine is added to produce a residual of 0.2 to 0.5 ppm after a minimum ten minute contact period at temperatures at and above 68°F (20°C). Higher residual values may be necessary if the residual chlorine exists as combined chlorine residual.

Free available chlorine is toxic to aquatic organisms. Chlorine compounds involving ammonia, phenols, cyanide, or other substances may have equal or greater toxicity levels. This circumstance has led to concern about the use of chlorine as a disinfectant. Alternative methods of biological control are being studied. Other biocides exist, but little is known of their effect on aquatic life. Ozonization is being used experimentally at a few sewage treatment plants as is radiation by cobalt 60. The application of these latter two techniques to generating stations apparently has not been investigated.

II. RESIDUAL CHLORINE EFFECT ON AQUATIC LIFE

A. Literature Annotation

McKee and Wolf[1] presented annotations of earlier literature on the effects of chlorine on aquatic life. Results reported by various workers include:

1. Aquatic plants are harmed by concentrations of chlorine of 3.0 mg/l or more.

2. Most algae can be controlled by chlorine concentrations of 0.25 to 3.0 mg/l. Synura, a flagellate alga, was killed by 5 to 10 mg/l.

3. Midge larvae (Chironomus), important fish food organisms, were killed by doses of chlorine of 15 to 50 mg/l.

4. Small invertebrate organisms (crustaceans, rotifers) were killed by chlorine at 1.0 mg/l, but larger organisms (worms, mollusks) were not killed by this concentration.

5. Freshwater clams, snails and sponges in cooling systems were killed by 2.5 mg/l.

From the material presented by McKee and Wolf it would appear that the primary producers and fish food organisms of aquatic communities would not be affected by free available residual chlorine of less than 1 ppm.

Fish, however, in some cases appear to be more sensitive to chlorine than do lower forms of life. The fish data presented by McKee and Wolf appear somewhat contradictory. Concentrations of chlorine as mg/l that caused kills or permitted survival as reported by McKee and Wolf are tabulated below:

	DEATH CONCENTRATIONS	SURVIVAL CONCENTRATIONS
Trout	0.03, 0.08, 0.3, 0.8, 1.0	0.1, 0.5
Carp	0.15 to 0.2	1.0
Goldfish	1.0, 2.0	0.25, 1.0, 5.0
Minnows	0.8	0.3, 1.0

As McKee and Wolf point out, the apparent contradictions stem from differences in water quality among the various studies reviewed as well as the time of duration of exposure.

In an early (1950) literature review Doudoroff and Katz[2] summarized the effects of chlorine on fish. Methods of analysis for measuring chlorine or chlorine residuals were not presented. The authors did observe that there was no very great difference between the toxicity of free chlorine and that of chloramines. Among the concentrations they found reported as having adverse effects were:

1. Free chlorine at 0.3 ppm killed rainbow trout in two hours.

2. Eels and tench* were resistant to residual chlorine of about 1 ppm for long periods.

3. Trout and pike died at concentrations of residual chlorine at 1 ppm in 40 hours.

4. Chloramine concentrations of 0.76 to 1.2 ppm were fatal to hardy minnows, carp and bullheads while 0.4 ppm killed trout, sunfish and some bullheads.

Jones[3] said that chlorine was found toxic to rainbow trout at less than 0.2 ppm while eels and tench* were more resistant. Roach* had a threshhold toxicity of about 0.4 ppm. Jones did not identify the methods of analysis. The work he cited was experimental laboratory work by the Water Pollution Research Laboratory (England). Apparently these were investigations on the effect of chlorine as an inorganic gas in aqueous solution rather than residual chlorine following its use as a disinfectant. Jones also referred to an earlier (1958) work by Merkens[4] who felt that for pollution control purposes it should be assumed that all residual chlorine was present as free chlorine. Merkens found 0.08 ppm chlorine fatal to trout in seven days and assumed, based on extrapolation of a survival curve, that the safe threshhold (for trout) was as low as 0.004 ppm chlorine. A trout population, of course, is not resident in the Susquehanna River at the Three Mile Island site. In spite of this experimental work in England, the Mersey River Board (England) has proposed that the free chlorine residual of discharges should be limited only to the extent that it should not exceed 1.0 mg/l.

Zillich[5] studied the toxicity of combined residual chlorine to fathead minnows. He found the lowest concentration to produce an adverse effect was 0.04 mg/l residual chlorine. (The iodometric method was used to measure the residual chlorine.) The chlorinated effluents used in his investigation were toxic after diluting to two to four percent. Zillich observed that avoidance reaction by fish prevented fish kills below

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* British fish species not found in North America.

chlorinated discharges. He went on to say: "It seems probable that the greatest effect of discharging chlorinated wastewater to a stream is not that it is lethal to fish but that its presence renders the water unavailable to many fish."

Tsai[6] studied the effect of sewage pollution in the upper Patuxent River. He found that chlorinated effluents are toxic and reduce fish populations below the effluent outfalls. Tasi did not measure the amounts of residual chlorine present, but his text suggests that toxicity was due to combined residual chlorine and particularly the chloramines. Tsai did find 29 fish species occurring below sewage outfalls. Of these, 15 are included among the 37 Susquehanna River fish species presented in Section 2.7.1 of the Environmental Report. (The ecological differences between the Susquehanna River and the upper Patuxent River waters are pronounced and would account for differences between the respective fish communities.)

Basch et al[7] studied the effect of chlorinated municipal waste on caged rainbow trout and fathead minnows below four sewage treatment plant outfalls in Michigan. Total residual chlorine was measured by amperometric titration. They found the trout to be more sensitive to the effluent than the minnow. The latter species, however, was adversely affected by the discharge in one instance for a distance of 0.6 mile below the outfall. In two of the four cases fathead minnows were not affected by the chlorinated discharges. In the two where these fish were affected, toxicity concentrations of residual chlorine were given as less than 0.1 mg/l in the Conclusions (p.1) and as less than 0.2 mg/l in the General Discussion (p. 34). Tabular data in the publication show calculated lethal levels of total residual chlorine for fathead minnows as 0.007 (with 120 hours of exposure) and 0.072 (with 96 hours of exposure) mg/l. Apparently the 20 experimental fish (10 trout; 10 minnows), caged in a one cubic foot box, were not fed during exposure. Differences, of course, would be expected if the nature of the combined residual chlorine differed between the two outfalls, which appears probable.

The four plants studied by Basch et al apprently practiced continuous chlorination. Operator practice at the plants was to chlorinate to a chlorine residual of 0.5 (Plants 1 and 2), 1.5 (Plant 4) and 2.0 - 2.5 (Plant 3) mg/l as measured by the orthotolidine arsenite color comparator. This technique has been established as one of the poorest analytical methods for the determination of residual chlorine (Lishka and McFarren[8]).

Most of the literature on the effect of residual chlorine fails to identify the analytical method used. The orthotolidine arsenite method is one of the commonest in use. Where this method has been used, the results expressed are probably much lower than actual concentrations. This should be borne in mind when considering older literature.

The total residual chlorines found in the effluents studied by Basch et al as measured by amperometric titration were: 0.96 to 2.94 mg/l (Plant 1), 0.95 to 1.89 mg/l (Plant 2), 5.01 to 32.5 mg/l (Plant 3), and 1.82 to 3.89 mg/l (Plant 4).

The volume of discharge for the four plants in relation to the receiving streams was 3.84 percent (Plant 1), 1.50 percent (Plant 2), 0.06 percent (Plant 3), and 5.00 percent (Plant 4). Toxic effects for fathead minnows were associated with Plants 1 and 4.

B. Three Mile Island Discharge

The average annual flow of the Susquehanna River at the Three Mile Island site is 34,000 cfs and the average discharge from the Three Mile Island Plant is 80 cfs, which represents 0.24 percent of the total river flow.

At the Three Mile Island site the Susquehanna River is about 7,000 feet wide and divided by islands into three channels. These islands represent about 4,000 of the 7,000 foot width of the river. The plant draws from and discharges to the center channel. The eastern channel, smallest of the three, is blocked at its lower end by the York Haven Dam. At times of normal flow all river water would flow downstream through the center and western channels.

Anderson[9] published on variations in the chemical characteristics of the Susquehanna River at Harrisburg where City Island forms an eastern and western channel. Anderson found strong chemical differences through the cross section of the river. Water samples from the western side of the river were alkaline and characteristic of water drained from limestone regions. Samples from the center of the river resembled water quality of the West Branch Susquehanna River. The eastern part of the river had water quality characteristics associated with mine drainage from eastern tributaries. The great width of the river in conjunction with its relatively shallow nature prevents lateral mixing and these various waters forming the river retain their identity for long distances. Anderson found that the various waters were still separate masses at least as far downstream as Columbia. This continuity to the thread of flow from tributaries entering the river would also exist for any entering discharge. Thus, when a plume develops it will, in effect, squeeze into the river flow at its point of origin but have minimal lateral spreading until its identity is lost.

The extent of a theoretical plume has been calculated for the discharge from the Three Mile Island Plant. This theoretical plume was developed for winter conditions. The choice of winter is appropriate since it has been suggested (though inconclusively) that chlorine is most harmful at low temperatures (Ebeling and Schrader[10] and Ebeling[11] in Doudoroff and Katz).

The plume was calculated with a discharge of 80 cfs into a low river flow of 10,000 cfs, with a temperature increment of 3°F above an ambient river temperature of 38°F. The plume is virtually lost after a flow distance of 220 feet, and at that distance the discharge would have been subject to a tenfold dilution.

Other plumes calculated for beginning of cooldown and 12 hours later, with a discharge of 113 cfs into 10,000 cfs, varied slightly. At the beginning of cooldown the discharge would be 12°F above river ambient, but 12 hours later this would have decayed to 3°F. These two plumes would extend for about 300 feet and 280 feet respectively. Again, at these distances dilution would be tenfold. The maximum width of the calculated plumes would be about 75 feet. The center channel into which the discharge enters is more than 1,000 feet wide.

Residual chlorine in the discharge will, of course, be intermittent, correlating with the chlorination schedule of the Three Mile Island Plant. Chlorination is expected to occur about three or four times per 24 hour day for 15 minute periods. No aquatic life would be subject to persistent, long-term exposure to chlorine residuals. The maximum area of possible influence would be a plume two or three feet deep extending for a distance of 300 feet with a width of 75 feet (<7.5 percent of channel width) for one hour a day under flow conditions of less than one-third normal river flow.

The total chlorine residual at the plant cooling water discharge will nominally be less than 0.3 ppm as measured by the orthotolidine method. Chlorine injection will occur intermittently not more than two hours per unit over a 24 hour period. Monitoring of chlorine residual will be performed by analysis of grab samples in the discharge. Analysis will be logged during a chlorination period at regular intervals.

Accumulated field experience clearly demonstrates that a discharge containing a total of 0.3 ppm total residual chlorine, as measured by the orthotolidine method, creates no biologically adverse conditions.

Lishka and McFarren state that 0.05 mg/l free chlorine is about the minimum amount that can be measured by analysis suing the following methods: leuco crystal violet, stabilized neutral orthotolidine, DPD-titrimetric, amperometric titration, DPD-coloimetric, methyl orange, and orthotolidine-arsenite. In the literature where chlorine residual values are expressed as lower than 0.5 ppm they have been based on controlled feeding in laboratory experiments or extrapolations from data observed at higher concentrations. Those values given as direct readings must be considered highly suspect.

C. Susquehanna River Biota

Since the discharge plume from the Three Mile Island plant will have a slight temperature increment over ambient temperatures the plume, with any entrained residual chlorine, will float over cooler, deeper waters. As a result, aquatic life associated with the river bottom will not be subjected to exposure to residual chlorine. With the exception of fish, the vast majority of Susquehanna River species of aquatic life, representing all trophic levels, is associated with the substrate material. No true plankton is found in the Susquehanna River. Plankters are associated with non-flowing waters. Those found in flowing waters are tychoplankton, which are drift organisms flushed into the river from ponds, lakes, etc., in the watershed area. Such forms are not major biological components of the river's biological community except sporadically as transient conditions associated with periods of heavy runoff.

The macroinvertebrate species (bottom organisms) found by Wurtz[12] at four sampling stations in the area of Three Mile Island during the course of annual surveys numbered as follows:

1967	43 species
1968	37 species
1969	23 species
1970	39 species
1971	29 species

The coefficient of variation ($V = 100\ s/\bar{x}$) for the successive years was found to be:

1967	13.3%
1968	36.1%
1969	43.9%
1970	34.2%
1971	36.8%

Coefficient of variation values of less than about 25 percent reflect biological stability. Thus, from 1968 through 1971 environmental conditions during the time of sampling (first week of August each year) were in flux and the macroinvertebrate population was lagging in adjustment to biological equilibrium with the environment. This phenomenon was independent of activity at the Three Mile Island site.

When collections across the center channel at the head of Three Mile Island and between Three Mile Island and the foot of Shelley Island are compared strong environmental differences are found. For example, in 1971 a total of 36 species was found at the upper station but only 17 species were found at the lower station. Eleven species were common to both stations, giving a similarity coefficient of 0.261. The difference rests in the greater diversity of habitats at the upper station. This would support a more diverse invertebrate fauna.

The species of macroinvertebrates found in the York Haven Pool are characteristic of upland waters in the temperate zone of eastern North America. Included in the 1971 collections (and earlier years) were worms, leeches, bryozoans, clams, snails, scuds, crayfish; nymphs of mayflies, dragonflies and samselflies; water striders and water bugs; caddisflies numphs; beetles and their larvae; various fly larvae, and midge larvae.

Personnel from Millersville State College[13] have been making biological studies of the Three Mile Island site. Two center channel stations have been collected; one above and one below the proposed discharge. Fish

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were collected at these stations in June and October, 1971, (the most recent available data). No long-range migratory species of fish were found. The species found, and the number of individual of each species taken, are presented below:

Catfish (Ictaluridae)			
1. Channel catfish	*Ictalurus punctatus*	1059	
2. Brown bullhead	*Ictalurus nebulosus*	165	
3. Yellow bullhead	*Ictalurus natalis*	31	
4. White catfish	*Ictalurus catus*	29	
		1284	Subtotal
Sunfish and bass (Centrarchidae)			
5. Pumpkinseed	*Lepomis gibbosus*	157	
6. Rock bass	*Ambloplites rupestris*	68	
7. White crappie	*Pomoxis annularis*	29	
8. Black crappie	*Pomoxis nigromaculatus*	15	
9. Bluegill	*Lepomis macrochirus*	9	
10. Redgreast sunfish	*Leopmis auritus*	5	
11. Smallmouth bass	*Micropterus dolomieui*	1	
12. Largemouth bass	*Micropterus salmoides*	1	
		285	Subtotal
Minnows (Cyprinidae)			
13. Golden shiner	*Notemigonus crysoleucas*	20	
14. Carp	*Cyprinus carpio*	2	
		22	Subtotal
Suckers (Catostomidae)			
15. White sucker	*Catostomus commersoni*	10	
16. Quillback	*Carpiodes cyprinus*	9	
17. Northern redhorse	*Moxostoma macrolepidotum*	1	
		20	Subtotal
Perches (Percidae)			
18. Walleye	*Stizostedion vitreum*	8	
		8	Subtotal
Pikes (Esocidae)			
19. Muskellunge	*Esox masquinongy*	1	
		1	Subtotal
		1620	TOTAL

It is evident from the 1971 Milersville data that 80 percent of the resident fish taken were bottom dwelling forms (catfish and suckers). These fish would not be subjected to plume influence. Piscivorous, predator fish (walleyes, the introduced muskellunge, smallmouth and largemouth bass) represented less than one percent of the fish community. These species are highly mobile and would very readily evade stress conditions if any were present in the plume. The sunfish and bass along with the minnows represented 19 percent of the catch. These fish are also evasive and would avoid stress conditions.

None of the fish found deposit bouyant eggs that could drift into the discharge plume.

The catfish, sunfish and bass prepare nests in coarse sand, gravel or stone substrate material or deposit eggs in substrate crevices. In the case of the catfish, the eggs are adhesive and cemented to substrate surfaces. The bottom under the area of inundation by the plume is soft, and eggs would not be deposited in such materials.

Suckers spawn in riffles over gravel. The nearest sucker spawning ground to the discharge would be about a mile above the discharge.

The minnows present scatter adhesive eggs over vegetation and hard substrate materials. Such an area is found at the head of Shelley Island but not in the area of the discharge plume.

The walleye spawns in shoal water on the edges of bars, or on hard or gravel bottoms. Such bottom conditions are not found under the plume area.

The muskellunge is not known to reproduce in the Susquehanna River (though it may do so) where it has been stocked. In its native haunts the muskellunge scatter their eggs along a shoreline for several hundred yards in water six to thirty inches deep. The shoreline nearest the discharge plume is the western shore of Three Mile Island. This shoreline has a steep angle of repose and is not suited to muskellunge spawning.

In their larval stage the young of the fish species collected seek shelter in shoal waters or in aquatic vegetation. The discharge plume will not inundate any such nursery grounds.

The fish sampling stations in the center channel were above and below the proposed discharge and roughly approximate the sampling sites for bottom organisms. All 19 species were found at the upper station while 15 species were found at the lower station. For the fish the coefficient of similarity between the two stations was 0.789; much higher than that found for the bottom organisms. This reflects the ranging capacity of fish as compared to invertebrate animals. Obviously such life forms could avoid a discrete slug of water such as the discharge plume if they found the water of the plume irritating.

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RESPONSE TO EPA COMMENTS ON THERMAL EFFECTS

The draft statement indicates that blowdown temperature (we prefer to designate this M.D. cooling tower effluent or discharge) will, in general, be approximately equal to the ambient river temperature during most of the year and no greater than 3°F above ambient during the winter months. This is not a correct statement and was corrected by Metropolitan Edison Company's letter of August 28, 1972, to reflect the wording "maximum" to "average" in Item 3b of the Summary and Conclusions.

Table 3.7-1 of the Environmental Report tabulates a winter intake temperature of 39.3°F and an average winter discharge temperature of 41.5°F[1]. The footnote [1] states "Based upon average winter wet bulb temperature of 2C.1°F and average winter river temperature of 39.3°F". It can only be concluded from these two (2) average temperatures that the difference or rise is an average value.

On page 5.1-3 of the Environmental Report is stated - "A sudden warm day in winter (with a very cold river) or extremely cold weather will preclude effective tower operation". On such a sudden warm day in winter, tower operation could add additional heat and operation would be terminated for a few hours until air ambient temperatures would again provide some cooling. This statement was specifically included in the Environmental Report to denote the extreme of weather variation over which one has no control.

Average river and discharge temperatures have been provided in the Environmental Report to best understand the effectiveness of the mechanical draft towers. It should be understood that several variables exist in the tower operation in a given day and often in varying directions. Ambient air temperature may cycle 30°F in a 28 hour period while the river ambient lags and cycles through a lesser total temperature variation. Cloud cover or the absence thereof, also affects river temperature. Since the tower discharge is a function of both inlet temperature to the tower (which is a function of river temperature) and air ambient (wet bulb), the tower may discharge both above and below river ambient in that 24 hour period. Secondly, the weather may tend to become progressively warmer (or colder) over several days duration with the river naturally tracking but lagging the air temperature. (During very cold winter weather, the river temperature tends to be more stabilized in a 33° - 41° range.) Hence, cycling variation in both air and river temperature occur daily and further vary in several day trends. It is thus impractical to define a "normal" variation of discharge vs. river temperature.

A description of the planned operation of the tower would be helpful to further understand tower capability in summer and winter together with temperature variation and durations.

During summertime, the towers will be operated manually. Under normal operation, the towers have the capability to reduce the discharge to river ambient and can produce 5 - 8°F colder discharge on an average weather/river basis. The operator will, however, try to match the discharge to river ambient by varying fan speed or by shutting off any combination of three (3) fans per tower. Under cooldown conditions, the tower capability is adequate to prevent the discharge from exceeding 87°F. On an average river/air basis, the discharge could be 2° higher than river ambient in a 75 - 80° discharge range during cooldown. Since the Susquehanna River is not a trout stream, the species of fish present are warm water fish. The low temperature differential obtainable through the use of the cooling towers will have no adverse effect on the fish.

During wintertime, the towers will be operated manually down to 34°F D.B. air temperature. Below 34°F, the towers will be operated automatically to achieve cooling without experiencing freezing in the tower fill. The automation basically senses dry bulb temperature and actuates fan operations of three fans full speed, 3 fans half speed, two fans half speed, one fan half speed, all fans off with water free falling over the fill. A few degrees may be sacrificed in the automatic mode to preclude freezing. Wintertime normal operation will provide discharge water 3°F (average) higher than river ambient on an average river/air basis above 4°F D.B.; this can hardly be considered an appreciable rise. At 4°F, a discharge 7° above river ambient is experienced when all fans are tripped which reduces to 4°F rise with continuing colder weather. In the manual mode, it is also possible for the discharge to be several degrees colder than river ambient. The maximum rise that can be achieved during normal operation in winter is approximately 10°F with both plants operating with the M.D. towers ineffective due to a postulated river/weather extreme mismatch and it is considered reasonable to expect these to come back into a more natural balance in 6 - 12 hours. At the beginning of cooldown in winter, the towers will discharge water, an average of 12°F higher than river ambient, and this will reduce to 2°F differential in 12 hours. (If only one unit is cooling down with the other at normal operation, the mixture from both towers is 8°F instead of 12°F - this will be the usual probability.) At the beginning of cooldown, the heat rise through the delay heat coolers can reach 36°F; selecting a freak winter warm day (March 23, 1966 - 50°F river and 67°F D.B.), the tower serving the cooldown would discharge 69°F water or a 19° rise over river ambient. It should be mentioned that the air temperature dropped as follows in 3 hour intervals following the 67°F D.B. maximum on March 23, 1966 - 56, 50, 47, 44°F. When both the decaying heat load and the dropping air temperature is considered simultaneously, it can be seen that the duration of this condition is a relatively short one. It is also to be noted that cooldown results in a temperature rise as compared with a fossil plant or any power plant with the condensers "operated run-off river". This value is further reduced to 15.2°F difference when the discharge of the cooldown is mixed with the second, normally operating unit.

Winter operation provides an average discharge +3°F above river ambient and with the cooling effect of evaporation on the river surface, this 3°F would be further reduced downstream of the discharge point. It is not an established fact that this is conducive to fish congregation at the point of discharge at the surface on the shoreline. Further, the temperature change encountered at the beginning of cooldown is a temperature rise; fish are far more tolerant of a sudden temperature increase than decrease. The cooldown over a 12 hour period provides a gradual decrease (from the 36° rise across the decay heat coolers to a 4°F rise or a tower discharge of 15.2°F to 2 - 3°F or less than 1°/hour at the discharge. State and Federal restrictions limit changes to 2°/hour mixed river discharge temperature. It should also be borne in mind that the discharge volume is small as compared to a run of river plant (less than 5 percent).

Throughout the above, no credit is taken for dilution by running spare river water pumps (or systems nor normally running during cooldown). The State of Pennsylvania takes a dim view of dilution and does not consider "dilution the answer to pollution". The State does permit mixing of wastes and considers a heated discharge a waste. Therefore, no attempt will be made to run additional, spare pumps during normal operation to achieve temperature dilution. However, it is permissible to continue to run the secondary services cooling water system during cooldown and this may be done in winter, particularly on the freak warm days.

In all of the above, discharge temperatures measured at the plant discharge are discussed. Both State and Federal restrictions apply to the mixed river discharge temperatures, i.e.: +5°F rise, 87°F max. and 2°F/hr rate of change.

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COOLING TOWER EFFLUENT & COOLING WATER PLUME ANALYSIS

IN RESPONSE TO EPA QUESTION ON PLUMES

The objective of this analysis is to determine chlorine and temperature concentrations resulting from the discharge of cooling tower effluent and cooling water from Three Mile Island Nuclear Plant to the Susquehanna River.

The discharge of tower effluent and cooling water fro a normal cooldown condition is to center channel of the Susquehanna River. The plumes resulting under the following conditions were determined:

1. Cooling tower effluent: $\Delta T = 3.0°F$ $Q = 80.0$ cfs

2. Normal cooldown @ t = 0.0 hrs. $\Delta T = 12.0°F$ $Q = 113$ cfs

e. Normal cooldown @ t = 12.0 hrs. $\Delta T = 3.0°F$ $Q = 113$ cfs.

All were computed for the following winter river conditions:

1. Low river flow of 10,000 cfs - 10 yr. avg. flow for December, January, and February center channel flow is 2700 cfs.

2. Natural river water temperature of 38°F.

Initial chlorine concentration at point of discharge was taken to be 0.05 ppm.

The technique utilized to determine the extent of the plumes is based on a widely accepted method of analysis* of turbulent mixing of a horizontal jet discharged at the surface of the receiving water body. Concentrations of substances throughout the plume are determined assuming they are conserved. Therefore, the results of the analysis are conservative. Reductions in concentration are accomplished solely by dilution which results from the entrainment of ambient water into the turbulent jet. Jet trajectory is determined by vectorially summing jet and river water velocities.

Cooling tower effluent is discharged continuously and, therefore, the plume shown in Figure 1 represents steady state conditions. The magnitude of the plume may be described in terms of the dimensions of the river and island. At the point of discharge the river is 1200 ft. wide, while the

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* Jen, Y., Wiegel, R. L., and Mobarek, I., "Surface Discharge of Horizontal Warm Water Jet," Journal of the power Division, A.S.C.E., Vol. 92, No. PO2, Proc. Paper 4801, April 1966, pp. 1-28.

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plume, as defined by the 10 dilution contour, projects only 200 ft. into the river. The plume extends downstream about 120 ft. as compared to the length of Three Mile Island which is about 12,000 ft. The conditions of cooldown are, however, time dependent. The plumes resulting from these transient conditions are presented in Figures 2 and 3. Initially the cooldown flow is at a ΔT of 12.0°F (Figure 2). This temperature reduces to 3°F within 12 hrs. (Figure 3). The plumes under these conditions are not significantly larger than the tower effluent plume. The plume extends about 225 ft. into the river and about 220 ft. downstream.

It can be seen in reviewing Figure 1 that substances will undergo 10 dilutions in about 220 ft. of plume travel. The cooling water discharge at a ΔT = 12°F (Figure 2) reaches 10 dilutions after about 300 ft. of travel. The cooling water discharge at a ΔT of 3°F (Figure 3) reaches 10 dilutions after about 250 ft. of travel.

METROPOLITAN EDISON COMPANY		GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS READING, PENNA.
THREE MILE ISLAND		
PLUME COMPUTATIONS		4197-51
COOLING TOWER EFFLUENT		
		OCT 9 72

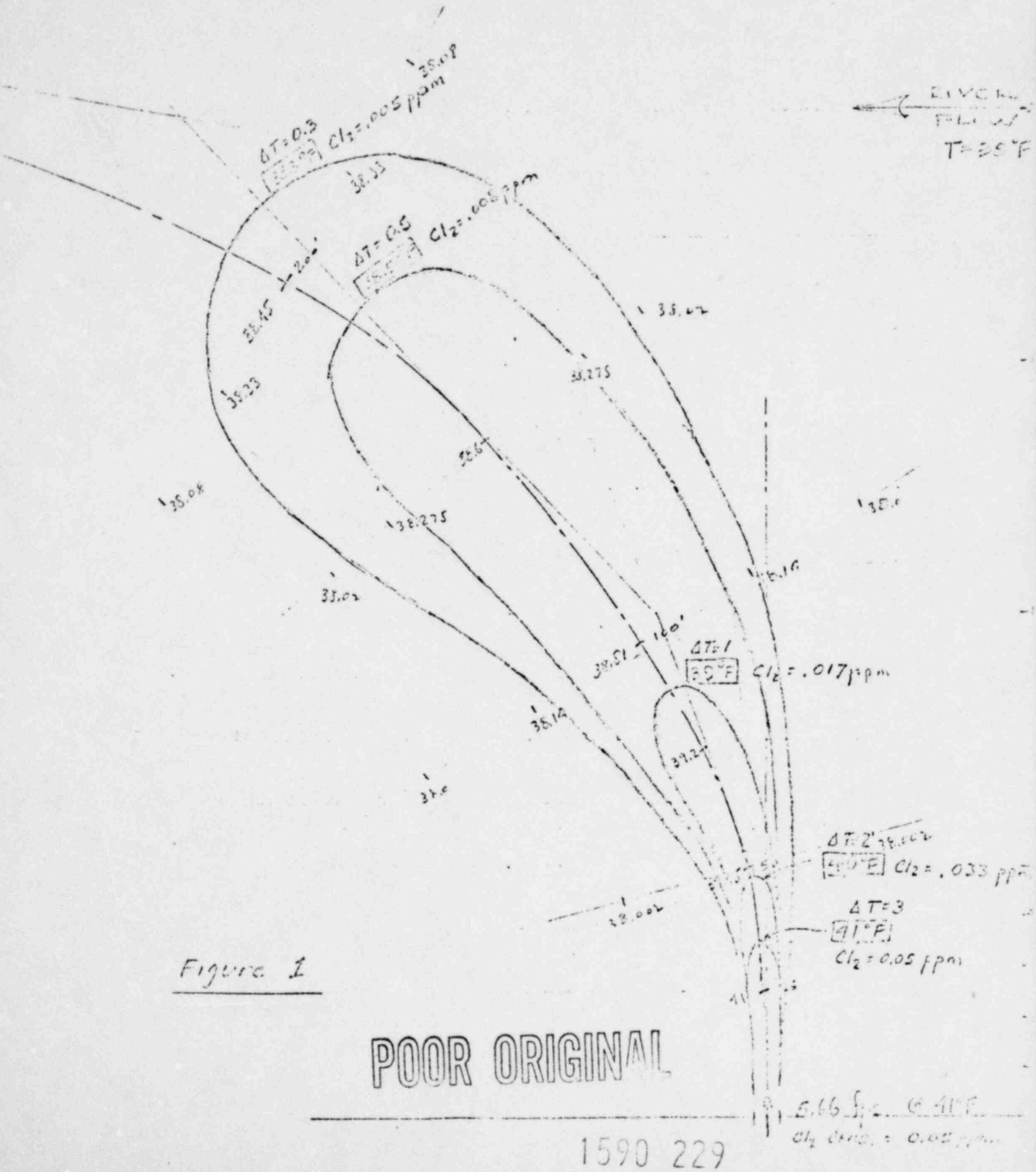

Figure 1

POOR ORIGINAL

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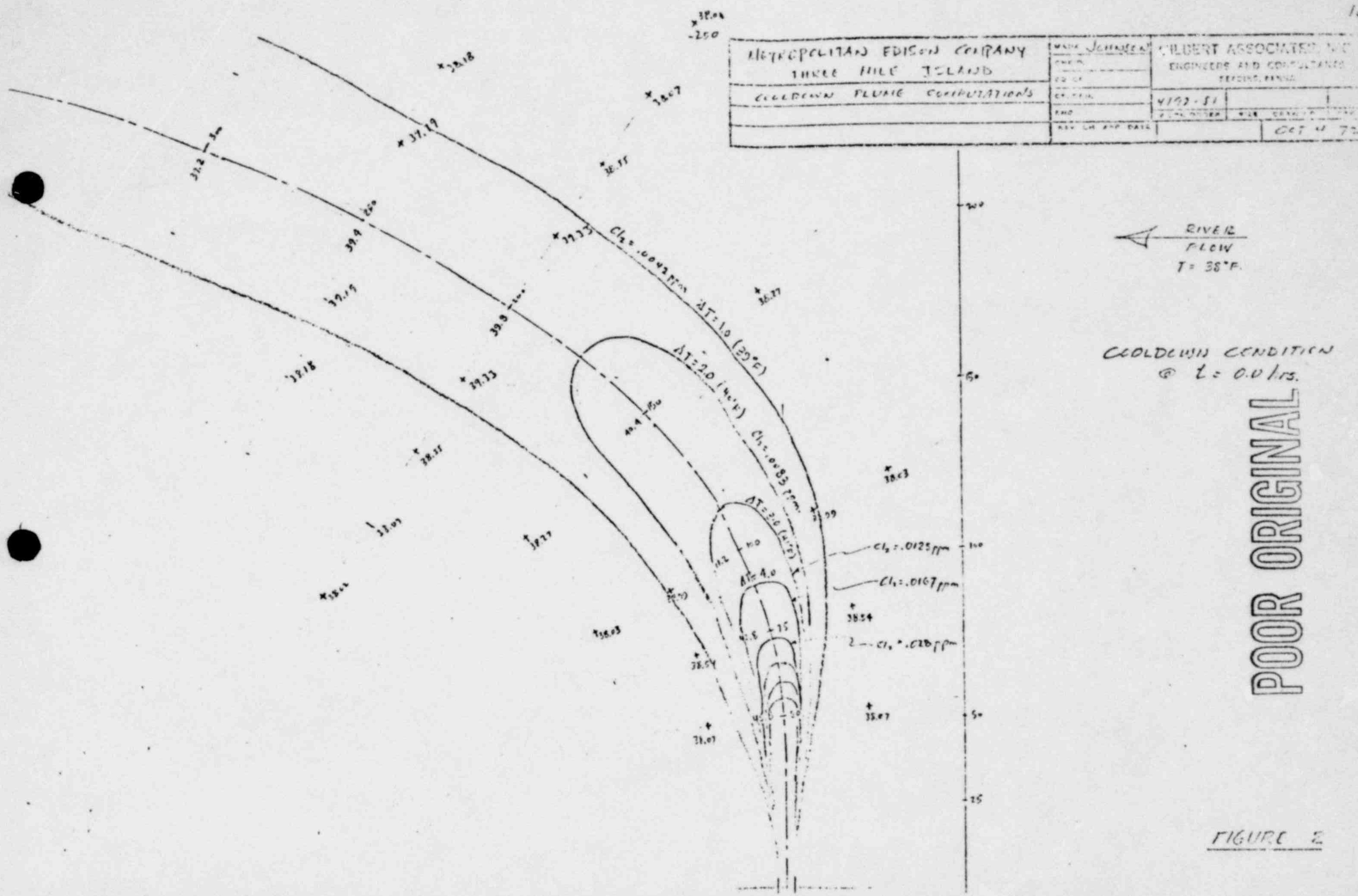
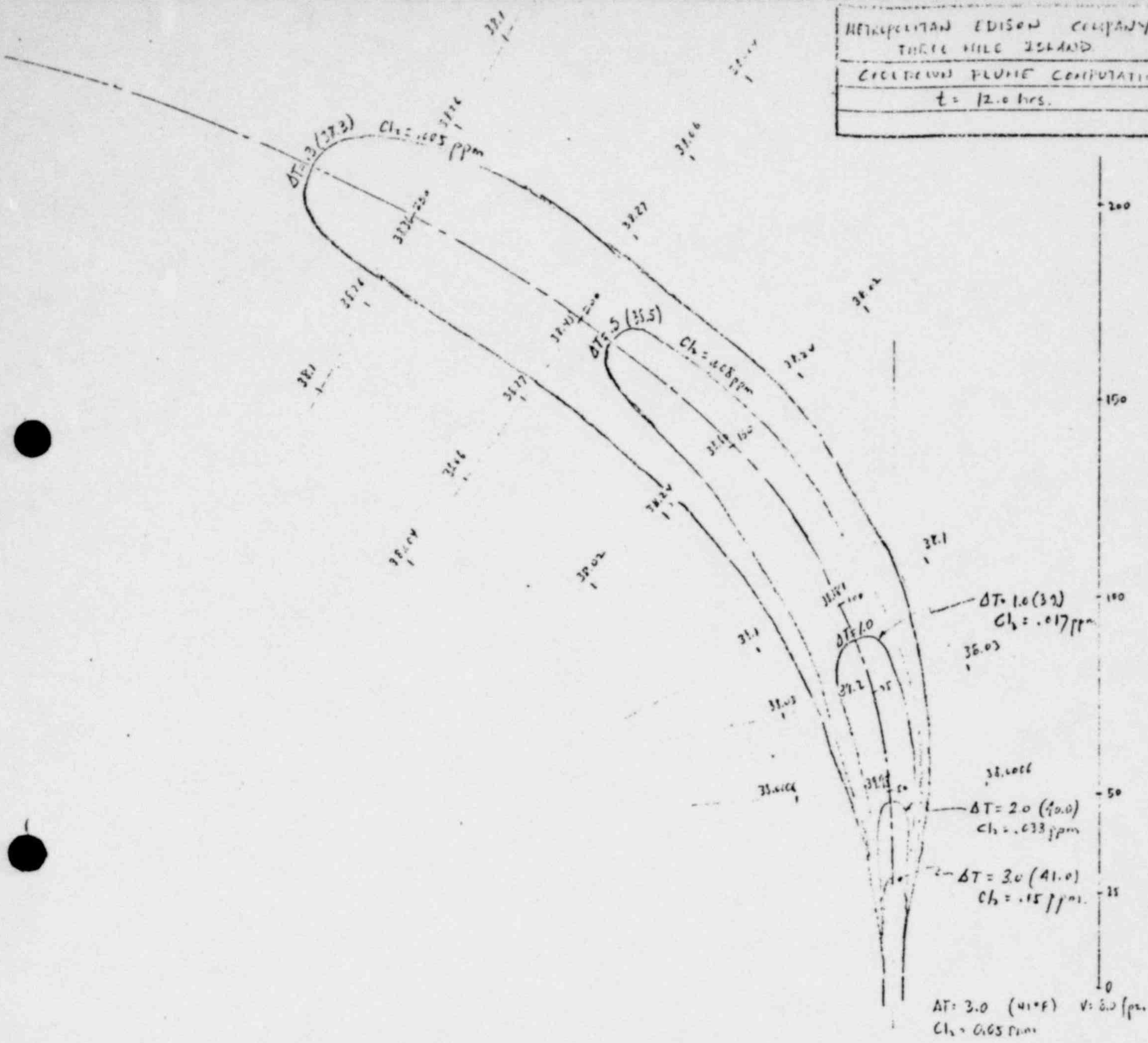


POOR ORIGINAL

FIGURE 2

METROPOLITAN EDISON COMPANY THREE MILE ISLAND	Jennison	GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS READING, PENNA.
COOLDOWN PLUME COMPUTATIONS		4172-51
t = 12.0 hrs.		OCT 4 72



RIVER FLOW
T = 38.0°F.

COOLDOWN CONDITION
@ t = 12.0 hrs.

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POOR ORIGINAL

FIGURE 3

ENTRAINMENT AND IMPINGEMENT EFFECTS - EPA QUESTION

The applicant has performed a study to determine intake velocities under various adverse conditions. The results of the study are as follows:

1. Low river water level - normal plant operation = .2 fps.
2. Loss of Yorkhaven Dam - normal plant operation = .3 fps.
3. Cooldown flow - normal plant cooldown = .25 fps.
4. Cooldown flow - Loss of Yorkhaven Dam = .4 fps.

It can be seen that even during extreme conditions the intake velocities experienced are still very low. The biological studies performed on the river have shown that the intake structure is not located in the spawning grounds for any species of fish in the Yorkhaven pool. In addition, the fish study has shown that the species of fish found in the pool do not lay buoyant eggs. When the eggs hatch the larvae will remain in the vicinity of the nests in shoal water.

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RESPONSE TO EPA COMMENT ON BIRD KILLS

After three years experience with Unit 1, natural draft towers, and two years with Unit 2, no evidence of bird kills have been reported by the plant operating staff. If such had occurred, one would expect to find the remains on the canopy joining shell and fill neck; no dead birds were found.

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