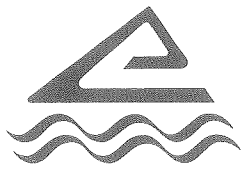


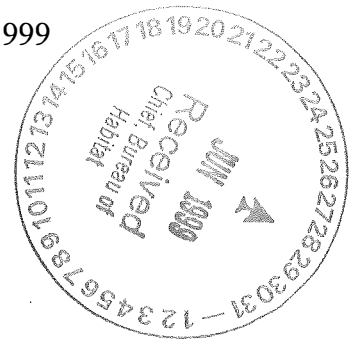
FISH REIMPINGEMENT STUDY AT RAVENSWOOD GENERATING STATION

May 1999

NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

Con Edison
Consolidated Edison Company of New York, Inc.
4 Irving Place, New York, N.Y. 10003

June 23, 1999



Mr. Michael Calaban
NYS Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233

Re: Intake Screen Consent Order
NYSDEC File No. R22-2985-90-04
Ravenswood Generating Station

Dear Mr. Calaban:

Enclosed are the following reports pertaining to additional diagnostic studies, which were agreed upon at our February 13, 1997 meeting and completed for the Ravenswood Generating Station:

Fish Reimpingement Study at
Ravenswood Generating Station
May 1999

Thermal Tolerance Assessment for
Ravenswood Generating Station
April 1999

Ravenswood Generating Station
June 25, 1999 Velocity Studies
March 1999

If you have any questions regarding these reports, please call me at 212-460-6059.

Sincerely,

Kenneth L. Marcellus

Enclosures

CC: J. Gilmore, Region 2
P. Gallay., Esq., Region 2

FISH REIMPINGEMENT STUDY AT RAVENSWOOD GENERATING STATION

Prepared for

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
4 Irving Place
New York, New York 10003

Prepared by

NORMANDEAU ASSOCIATES INC.
25 Nashua Road
Bedford, NH 03110-5500

R-13494.015

May 1999

FISH REIMPINGEMENT STUDY AT RAVENSWOOD GENERATING STATION

PROJECT OVERVIEW

Normandeau Associates Inc. (Normandeau) conducted a field evaluation during the fall of 1998 to help identify potential locations for a fish return discharge associated with the condenser cooling water intake screens at Con Edison's Ravenswood Generating Station in New York City. Impinged fish were collected and examined for the occurrence of marked fish that were released at one of three proposed fish return locations under low slack tide current conditions. The proportion of marked fish recovered from each lot of marked fish released was used as a measure of the reimpingement potential for the selected release location.

Fish Marking and Release Procedures

Live juvenile alewives (*Alosa pseudoharengus*) were used to represent the impinged fish because they are similar in size and shape to other herring species impinged at Ravenswood Station, and because equipment was not available to collect and hold sufficient numbers of live impinged fish for testing. Live, juvenile alewives were used instead of dead fish so that the probability of being reimpinged would mimic as closely as possible that of live fish being returned to the water in the screenwash discharge. The juvenile alewives were 3 in. to 5 in. long at the time of testing, and were obtained from a local bait dealer, who delivered the fish in batches to Ravenswood Station. Prior to release, the test fish were acclimated to ambient salinities (10-15 ppt) and marked (stained) with a diluted Acridine Orange® solution to ensure that they could be distinguished from other impinged fish of the same species. The proposed number of fish for each release event was 1,000. The overall study design was approved by the New York State Department of Environmental Conservation in a letter from Mr. Edward W. Radle (NYSDEC) to Dr. William L. Kirk (Con Edison) dated 16 July 1998.

Marked juvenile alewives were released into the East River at Ravenswood Station at night approximately one-hour before the time of low slack tide, so that when the tidal current began to flood, the water would flow toward the cooling water intake and carry the marked fish with it. The tests were conducted at night because this is typically the time of highest impingement rates. Therefore, selection of the tidal stage and time of day were both conservative and would tend to provide the highest estimates of reimpingement rates.

Fish releases were made near the bottom by means of an induction pipe. The release sites at Ravenswood Station were all located along the intake bulkhead as indicated by an "X" on the attached Figure 1. One release location was along the bulkhead approximately 50 ft. south of the

Unit 10 cooling water intake (X-1), the second was approximately 25 ft. north of the Unit 30 intake (X-2), and the third release location was in the middle approximately 25 ft. north of the Unit 20 intake (X-3). River currents in front of Ravenswood Station were usually slow an hour before the slack tides, preventing the marked fish from being swept away from the study area. Depending on the tidal current and release location, marked fish that were susceptible to transport by the current would be carried toward one or more of the intakes and exposed to impingement. When the tidal current began to flood following low slack tide, the water flowed northward from location X-1 (Unit 10 intake) toward the Unit 30 intake (Figure 1). When the tide ebbed after high slack tide, the river flow was southward from location X-2 (Unit 30 intake) toward the Unit 10 intake (Figure 1). Fish released in the middle of the intake structure at location X-2 would have a tendency to move south during the ebb tide past the Unit 20 and Unit 10 intakes and north during the flood tide past the Unit 30 intake. Marked fish were released at least 48 hours apart, so that the probability of impinging a released fish from the previous release event was remote.

Impingement Monitoring

Impinged fish were monitored for the presence of marked (stained) alewives at about 30 minute intervals for six hours following the time of the release. Impingement monitoring after each release consisted of continuously netting the fish from the screenwash discharge for a period of six hours and examining the catch for marked fish. The impinged fish were collected by setting one or more nets in the screenwash discharge sluiceways. The nets were exchanged about every 30 minutes (or more frequently if it was necessary to prevent blockage of the sluiceway by the accumulation of material in the net). Each time throughout the six-hour monitoring period that a collection net was emptied, the time was recorded and the corresponding count of recaptured fish for the time interval since the previous net change was recorded with it. This information may provide some insight into the rate of tidal transport (or active movement) of fish from the proposed fish return location to the intake, and the length of time that they were most vulnerable to reimpingement.

Impingement Collection Efficiency

Collection efficiency testing was also performed at one screen per unit during each release event, using a total of approximately 100 fish per unit, divided into two batches of 50 each. Dead fish were used for both types of collection efficiency tests to prevent these fish from actively avoiding being impinged. The fish in each batch were marked with fin clips to distinguish the two batches from each other and from any naturally impinged fish or from stained fish released at the fish return site being tested. The first batch was introduced in the water immediately in front of the ascending side of an operating screen, as a combined test of the efficiency of both the screenwash system and of the gear and crew (referred to as traveling screen collection efficiency). The second batch was introduced directly into the screenwash discharge sluice, as a test of the efficiency of the collection gear (referred to as collection net efficiency). Collection net efficiency tests were conducted as a supplement to the study plan when sufficient fish were available to help determine

what portion of the traveling screen collection efficiency was due to the collection nets. If sufficient fish were not available for both types of efficiency tests, only the traveling screen collection efficiency test was performed.

The "raw" or unadjusted count of the total number of marked fish reimpinged from each potential fish return location was adjusted upward based on the applicable collection efficiency results. For example, if 1,000 stained fish were released at low slack tide at location X-1, 40 of these marked fish were recovered after six hours of impingement monitoring at the intake screens for Unit 10, and the corresponding traveling screen collection efficiency test for Unit 10 recovered 45 out of 50 fin clipped fish (collection efficiency = 90%), then the adjusted reimpingement rate, expressed as a reimpingement percentage, was 40/1000/0.9 = 0.044 or 4.4%.

Site Safety

Normandeau employees adhered to all applicable safety procedures. Work was conducted under a site-specific health and safety plan, and each crew member working on site at Ravenswood attended a safety training session conducted by Con Edison and view the plant's safety film.

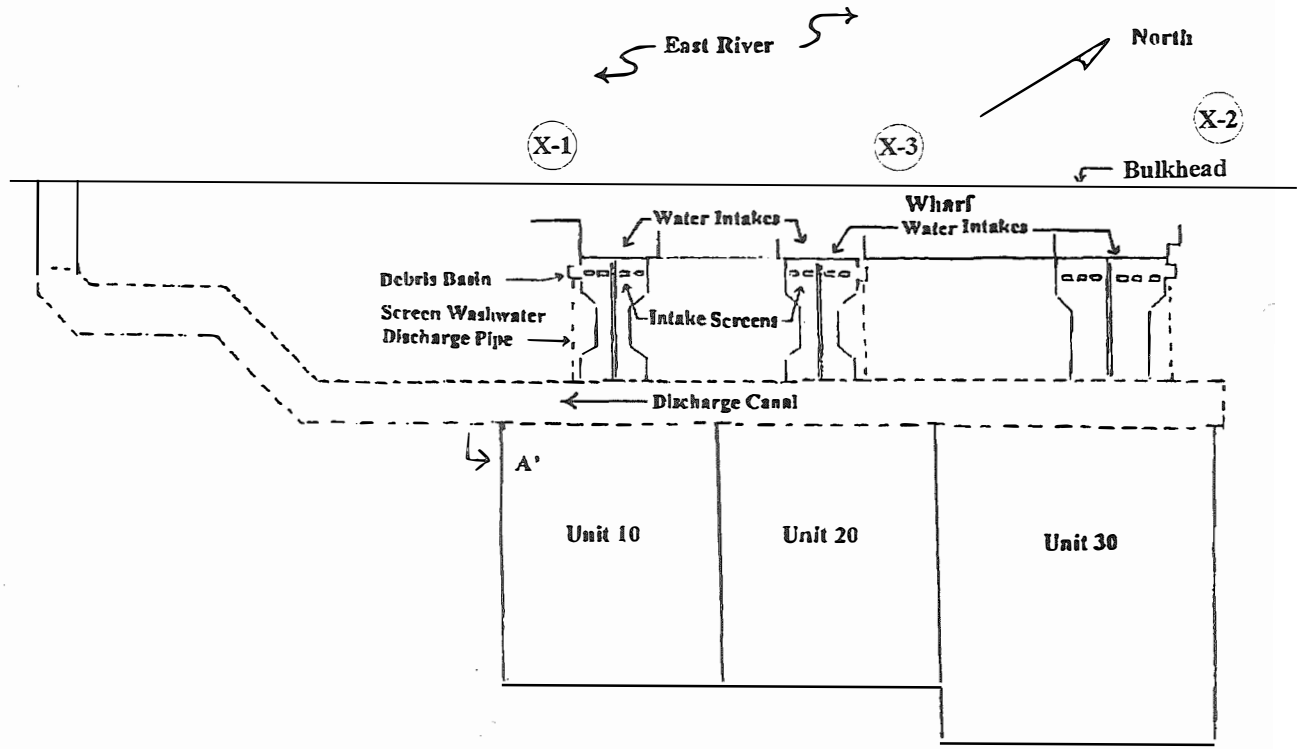
RESULTS

Two low tide and two high tide releases at stations X-1 and X-3 were completed at Ravenswood Station (Tables 1, 2, 3, 4 and 5). One high tide release was completed at station X-2 (Tables 1 and 6), however, we canceled the low tide release at station X-2 because the Unit 20 system was shut down for maintenance. The highest adjusted reimpingement percentages were observed for marked alewives released at station X-1 during both low and high slack tides. An adjusted reimpingement percentage of 2.6% was observed for the low tide release at station X-1 on 27 October 1998 (Tables 1 and 3), and the adjusted reimpingement percentage for the high tide release at station X-1 on 29 October 1998 was 1.2% (Tables 1 and 2). Marked alewife reimpingement rates were low (0.1%) for the two releases at station X-3 (Tables 1, 4, and 5), and were also low for the high tide release at station X-2 (0.4%, Tables 1 and 6). Both traveling screen and collection net efficiencies were relatively high at Ravenswood Station (Tables 1, 2, 3, 4, 5 and 6).

Station X-1 is located at the southern end of the intake structure, approximately 50 ft. south of the Unit 10 intake (Figure 1). When the tide began to flood about 75 minutes after the fish were released at station X-1, the tidal currents flowed northward carrying the marked fish that were susceptible to transport by the current past the Unit 10, Unit 20 and Unit 30 intakes. Release of fish at night during the low slack tide at southern end of the intake structure (X-1) probably represents the worst case (conservative) scenario for reimpingement at Ravenswood Station and produced the highest reimpingement percentage, because the fish were potentially exposed to reimpingement at all three operating units during the flood tide. The second highest reimpingement percentage was for the high tide release on 29 October 1998 at station X-1. These marked fish should have been carried downstream and away from the Ravenswood Station intakes when the tidal current began to ebb in a

southward direction about 75 minutes after the release. However, the fish may have moved upstream before the current began to ebb, because the first five fish were impinged at Unit 20 within 60 minutes after their release, and the next three fish were impinged at Unit 30 five minutes later (Table 3).

It was expected that the reimpingement rate would also be high for the marked alewives released on 9 November 1998 during the high slack tide at station X-2, because this station is located on the north end of the Ravenswood Station intake bulkhead (Figure 1) and the ebb tide currents could carry marked fish in a southerly direction exposing them to impingement at all three intakes. However, the Unit 20 circulating water pumps were off-line for repairs at the time of the release, and the marked fish were released only 15 minutes before the high slack tide, instead of one hour before high slack tide (Table 6). Therefore, the tidal currents probably began to ebb shortly after the release, and the fish had little time to disperse before they were carried south and exposed to impingement at the Unit 30 and Unit 10 intakes.



Plan view, not to scale

Figure 1. Ravenswood Generating Station intake bulkhead and waterfront area showing the three locations (X-1, X-2 or X-3) where marked fish were released into the East River to evaluate fish reimpingement, 20 October to 4 November 1998.

Table 1. Fish Reimpingement Percentages Observed for Marked Alewives Released and Recaptured at Ravenswood Station, 27 October - 9 November 1998.

Test date	Time released	Tide stage	Time of slack tide	Predominant flow towards intakes	Release location	No. of marked fish released	No. of marked fish recaptured	Unadjusted reimpingement percent	Adjusted no. of marked fish recaptured	Adjusted reimpingement percent
10/29/98	1630	high	1730	no	X-1	1,146	13	1.1%	13.8	1.2%
10/27/98	2040	low	2140	yes	X-1	1,189	29	2.4%	30.7	2.6%
11/9/98	1545	high	1530	yes	X-2	1,108	4	0.4%	4.0	0.4%
11/3/98	2015	high	2115	yes	X-3	1,024	1	0.1%	1.0	0.1%
11/5/98	1640	low	1719	no	X-3	1,034	1	0.1%	1.2	0.1%

Note: Adjusted reimpingement percent is the raw reimpingement percent adjusted for traveling screen collection efficiency.

Table 2. Ravenswood Station Fish Reimpingement Evaluation, 27 October 1998.
Release location and tide: X-1, low tide.

Time net fished	Number of Marked Fish Recaptured Unit 10	Unit 20	Unit 30	Units Combined
2140	9	0	0	9
2240	0	4	0	4
2323	0	0	1	1
2340	9	0	0	9
40	0	1	0	1
115	0	0	1	1
140	4	0	0	4
240	0	0	0	0
Unadjusted Recapture Total:	**22**	**5**	**2**	**29**
Screen Collection Efficiency:	**94.0%**	**94.0%**	**100.0%**	**96.0%**
Adjusted Recapture Total:	**23.4**	**5.3**	**2.0**	**30.7**
Number of Marked Fish:				**1189**
Unadjusted Reimpingement Percentage:				**2.4%**
Adjusted Reimpingement Percentage:				**2.6%**

Notes: 1,189 stained fish were released at 2040, low tide was at 2140.
fish were released at station X-1, downstream of the intakes.

Unit 10: both circ. pumps and all four screens were operating
Unit 20: both circ. pumps and three screens (21, 23, and 24) were operating
Unit 30: both circ. pumps off until 2200, all six screens were turned on at 2237

Screen efficiency tests:
Unit 10 - 50 fin clipped fish released, 47 recovered
Unit 20 - 50 fin clipped fish released, 47 recovered
Unit 30 - not tested

Net efficiency tests:
Unit 10 - 50 fin clipped fish released, 46 recovered
Unit 20 - 50 fin clipped fish released, 49 recovered
Unit 30 - 50 fin clipped fish released, 46 recovered

Table 3. Ravenswood Station Fish Reimpingement Evaluation, 29 October 1998.
Release location and tide: X-1, high tide.

Time net fished	Number of Marked Fish Recaptured Unit 10	Unit 20	Unit 30	Units Combined
1730	0	0	0	0
1830	0	5	0	5
1835	0	0	3	3
1930	2	0	0	2
2030	0	0	0	0
2130	3	0	0	3
2230	0	0	0	0
Unadjusted Recapture Total:	**5**	**5**	**3**	**13**
Screen Collection Efficiency:	**86.0%**	**100.0%**	**100.0%**	**95.3%**
Adjusted Recapture Total:	**5.8**	**5.0**	**3.0**	**13.8**
Number of Marked Fish:				**1146**
Unadjusted Reimpingement Percentage:				**1.1%**
Adjusted Reimpingement Percentage:				**1.2%**

Notes: 1,146 stained fish were released at 1630, high tide was at 1730.
fish were released at station X-1, downstream of the intakes.

Unit 10: both circ. pumps and all four screens were operating
Unit 20: both circ. pumps and two screens (23, and 24) were operating
Unit 30: both circ. pumps and all six screens were operating

Screen efficiency tests:
Unit 10 - 50 fin clipped fish released, 43 recovered
Unit 20 - 50 fin clipped fish released, 50 recovered
Unit 30 - 50 fin clipped fish released, 50 recovered

Net efficiency tests:
Unit 10 - 50 fin clipped fish released, 48 recovered
Unit 20 - 50 fin clipped fish released, 42 recovered
Unit 30 - 50 fin clipped fish released, 49 recovered

Table 5. Ravenswood Station Fish Reimpingement Evaluation, 5 November 1998.
Release location and tide: X-3, low tide.

Time net fished	Number of Marked Fish Recaptured Unit 10	Unit 20	Unit 30	Units Combined
2030	0	0	1	1
2205	0	0	0	0
2215	0	0	0	0
2240	0	0	0	0
Unadjusted Recapture Total:	**0**	**0**	**1**	**1**
Screen Collection Efficiency:	**100.0%**	**100.0%**	**84.0%**	**94.5%**
Adjusted Recapture Total:	**0.0**	**0.0**	**1.2**	**1.2**
Number of Marked Fish:				**1034**
Unadjusted Reimpingement Percentage:				**0.1%**
Adjusted Reimpingement Percentage:				**0.1%**

Notes: 1,034 stained fish were released at 1640, low tide was at 1719.
fish were released at station X-3, upstream of the intakes.

Unit 10: both circ. pumps and all four screens were operating
Unit 20: one circ. pump and one screen (24) were operating
Unit 30: one circ. pump and all six screens were operating

Screen efficiency tests:
Unit 10 - 45 fin clipped fish released, 45 recovered
Unit 20 - not tested
Unit 30 - 50 fin clipped fish released, 42 recovered

Net efficiency tests:
Unit 10 - not tested
Unit 20 - not tested
Unit 30 - not tested

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Table 6. Ravenswood Station Fish Reimpingement Evaluation, 9 November 1998.
Release location and tide: X-2, high tide.

Time net fished	Number of Marked Fish Recaptured Unit 10	Unit 20	Unit 30	Units Combined
1830	0		0	0
1835	1		0	1
2145	3		0	3
Unadjusted Recapture Total:	**4**		**0**	**4**
Screen Collection Efficiency:	**100.0%**		**84.0%**	**94.5%**
Adjusted Recapture Total:	**4.0**		**0.0**	**4.0**
Number of Marked Fish:				**1108**
Unadjusted Reimpingement Percentage:				**0.4%**
Adjusted Reimpingement Percentage:				**0.4%**

Notes: 1,108 stained fish were released at 1545, high tide was at 1530.
fish were released at station X-2, in the middle of the three intakes.

Unit 10: both circ. pumps and all four screens were operating
Unit 20: not operating
Unit 30: two circ. pump and all six screens were operating

Screen efficiency tests:
Unit 10 - not tested
Unit 20 - not tested
Unit 30 - not tested

Net efficiency tests:
Unit 10 - not tested
Unit 20 - not tested
Unit 30 - not tested

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