NextEra Energy
Diadromous Fish Passage Report
for the
Lower Kennebec River Watershed
during the 2009 Migration Season

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1.0 EXECUTIVE SUMMARY

The 1998 Agreement ("KHDG Agreement") among the members of the Kennebec Hydro Developers Group (KHDG), the Kennebec Coalition, the National Marine Fisheries Service (NMFS), the State of Maine, and the U.S. Fish and Wildlife Service (USFWS) requires that the members of KHDG contribute $4.75 million to the State of Maine to be used for diadromous fisheries restoration efforts in the Kennebec River basin. Approximately $4.5 million dollars has been contributed as of December 31, 2009. KHDG members will contribute the balance in equal installments prior to January 15 of each year through the year 2010 which completes the funding obligation.

In accordance with the Kennebec River Restoration Fund Agreement, the National Fish and Wildlife Foundation ("NFWF") is responsible for disbursements from the fund to the State of Maine to use for the restoration of river herring, American shad and Atlantic salmon, and for conducting American eel passage evaluations on the Kennebec River.

In addition, KHDG members have provided anadromous and catadromous fish passage and have conducted studies at the projects in accordance with the KHDG Agreement. Specific anadromous and catadromous fish passage operations, studies and restoration activities at NextEra Energy Maine Hydro (NextEra Energy) projects in 2009 are described in this report.

As described in the June 19, 2009, final rule published in the Federal Register (74 FR 29344), the NMFS and USFWS, collectively referred to as the Services, have determined that naturally spawned and conservation hatchery populations of anadromous Atlantic salmon (*Salmo salar*) whose freshwater range historically occurred in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, including those that were already listed in November 2000, constitute a distinct population segment (DPS) and hence a ''species'' for listing. The Services have determined that the Gulf of Maine DPS warrants listing as endangered under the Endangered Species Act (ESA).

In a letter to NMFS dated July 30, 2009, NextEra Energy informed the Services that it plans to continue to perform ongoing Atlantic salmon protection efforts with the Services as contemplated by the prior KHDG Agreement, and to also work with the Services via either Section 10, Section 7 or other applicable provisions of the ESA to secure the required permits.

2.0 UPSTREAM ANADROMOUS FISH PASSAGE

2.1 METHODS

2.1.1 Lockwood

The Lockwood Project (see Figure 1) is located at river mile 63 and is the first dam on the main stem of the Kennebec River. The Lockwood Project includes an 81.5-acre reservoir, an 875-foot-long and 17-foot-high dam with two spillway sections and a 160-foot-long forebay headworks section, a 450-foot-long forebay canal and two powerhouses. The dam and forebay headworks span the Kennebec River immediately upstream of the U.S. Route 201 Bridge along a

site known as Ticonic Falls. The east spillway section begins at the east abutment of the dam and extends about 225 feet in a westerly direction to the small island. The west spillway extends about 650 feet from the small island in a southwesterly direction to the forebay canal headworks, which extend to the west bank of the river. Each spillway has 15-inch-high flashboards. From the headworks, the forebay canal directs water to two powerhouses located on the west bank of the Kennebec River. The original powerhouse contains six generating units and the second powerhouse contains one generating unit.

In accordance with the FERC license and the KHDG Agreement, Merimil Limited Partnership (Merimil), licensee for the Lockwood Project, completed construction of a fish lift, trap, sort and transport system in the spring of 2006. The system was completed and became operational on May 5, 2006. In consultation with resource agencies, NextEra Energy developed operational and effectiveness plans for the new fish lift. These plans were filed with FERC on January 30, 2006, and approved on April 26, 2006.

2.1.1.1 Fish Lift

The entire fish lift facility is located on the westerly side of the powerhouse adjacent to Unit 7 (see Figure 2). The sorting and trucking portion of the facility includes: one 2,500 gallon, 12-foot-diameter, round discharge tank which collects fish discharged from the 1,800 gallon fish lift hopper; two 1,250 gallon, 10-foot-diameter, round holding tanks that sluice fish into stocking trucks; and one 250 gallon, rectangular holding tank for Atlantic salmon. The 2,500 gallon discharge tank is also equipped with piping that can discharge fish back into the tailrace.

The lift operates with an attraction flow of 150 cubic feet per second (cfs). Fish lift entrance water velocities are 4 to 6 feet per second (fps). The lift has an approximate 10 minute cycle time and is operated as described below.

An attraction flow (150 cfs) attracts the fish through the fish lift entrance gate into the lower flume of the fish lift. The fish then swim through a vee-gate crowder and remain in the lower flume of the lift. During the cycling process, the vee-gate crowder closes to hold the fish in the hopper area. The 1,800 gallon water-filled hopper lifts the fish to the holding tank elevation and the fish are sluiced into the 2,500 gallon round discharge tank. Liquid oxygen is introduced into all tanks via carbon micro porous stones to reduce stress and mortality. Auxiliary water pumps provide a constant flow of ambient river water to all the tanks. These pumps also provide ambient river water to the stocking trucks. The fish lift operates to accommodate all target species, and attraction flows are passed continuously during lift operation. The fish lift design criteria are to be able to pass 164,640 alewives, 228,470 American shad and 4,750 Atlantic salmon per year.

The Lockwood fish passage facility was operated by one-NextEra Energy employee and three-seasonal employees. NextEra Energy staffed the facility as necessary to ensure that there was an adequate number of personnel on site to effectively operate the facility. NextEra Energy was responsible for capturing shad, river herring and Atlantic salmon, and the Maine Department of Marine Resources (MDMR) was responsible for collecting biological data and trucking these fish to upstream spawning locations.

During the river herring and shad migration season (approximately May through mid July), the fish lift was generally manned seven days a week, as necessary, to meet resource agency trap and truck requirements. During the run, the lift was generally operated from early morning to late afternoon.

During other times of the season, the fish lift was generally operated three to five times a day, seven days a week for Atlantic salmon capture. The precise timing of which was determined by NextEra Energy, in consultation with the MDMR, based on factors such as the number of migrating fish, water temperature, time of year and river flow.

2.1.1.2 Visual Observations

NextEra Energy personnel conducted some general visual observations of the Lockwood tailrace and spillway section for presence of fish during the upstream migration season. Observations were generally conducted one or two times a day from the fish lift holding tank platform and from the Route 201 Bridge and lasted approximately 15 – 30 minutes. These observations were noted in the daily fish lift operations data sheet. The holding tank area is approximately 25 feet above the surface of the tailrace. The platform was the optimal area to observe fish as it allowed a clear view of the shoreline and of the tailrace area. At certain flows, the Route 201 Bridge provided a good view of the spillway section and the majority of the ledges below the spillway. Each observer was generally equipped with polarized sunglasses that reduced glare and increased overall visibility.

NextEra Energy personnel routinely monitored four underwater cameras that were hooked up to a monitor and DVD recorder. The monitor and DVD recorder were located in the control room of the fish lift and recorded generally from dawn until dusk. The cameras were also used in real time in order to aid in determining the presence of fish in the lift and maximizing fishing efforts.

Camera 1 was located just downstream of the vee-gates and provided a good view of fish moving through the vee-gates into the hopper area. Camera 2 was located just upstream of the entrance gate and provided a good view of fish swimming towards and into the fish lift. Camera 3 was located in the river just downstream of the fish lift entrance gate. This location provided a view of the tailrace area below the entrance gate. NextEra Energy also added an additional fourth camera in 2008. Camera 4 was positioned between the entrance gate and sorting tank sluice pipe on the edge of the river. This camera offered another good view of the fish lift entrance gate vicinity. Since all four cameras showed good detail, personnel could identify species, obtain an approximate number of fish, and initiate the lift cycle manually, if appropriate.

2.1.1.3 Upstream Radio Telemetry Effectiveness Study

In October 2008, NextEra Energy attended a fall fish passage planning meeting with the resource agencies. During that meeting, the agencies requested that NextEra Energy undertake an upstream radio telemetry study for American shad in 2009. The main reason for the study was to try to explain why limited numbers of shad have been captured at the Lockwood fish lift from 2006-2008. NextEra Energy contracted with Aquatic Science Associates (ASA) to conduct the shad study using radio telemetry techniques. This study is specifically described in a report in Appendix A.

2.1.1.4 Hydraulic Study of Flows

Also in the October 2008 NextEra Energy meeting with resource agencies, the agencies requested that NextEra Energy undertake a hydraulic evaluation of the flows in and around the fish lift to determine if there are any hydraulic issues that may be negatively impacting shad attraction to the fish lift. NextEra Energy contracted with Lakeside Engineering to conduct the study. During the study, fish lift attraction water current velocity, continuity, and direction was determined with a combination of dyed water releases and Acoustic Doppler Current Profiler (ADCP) techniques. This study is specifically described in a report in Appendix C.

2.1.2 Shawmut

The Shawmut Project used the Lockwood fish lift and transport system as its means of interim upstream fish passage. Fish were trucked by the MDMR from the Lockwood fish lift to areas of suitable habitat upstream of the project.

2.1.3 Weston

The Weston Project used the Lockwood fish lift and transport system as its means of interim upstream fish passage. Fish were trucked by the MDMR from the Lockwood fish lift to areas of suitable habitat upstream of the project.

2.2 RESULTS

2.2.1 Lockwood

The Lockwood fish lift was dewatered on April 28 through April 30, 2009, to vacuum debris out of the bottom of the fish lift and install the 1 by 2 isolation screens. The fish lift was operational on May 1, 2009. The lift operated properly throughout the majority of the migration season with only a couple of unscheduled shut downs. The 2007 modifications to the attraction system proved effective in 2009. Woody debris loading on the fish isolation screens was minimal, and the attraction water design flow of 150 cfs was maintained throughout the majority of the migration seasons with some minor exceptions. Beginning around June 24, the attraction flow would periodically back off due to vegetation becoming stuck on the attraction water intake grating in the Lockwood canal. This situation may have been caused by unusually high river flows dislodging vegetation. To address this, the attraction water was periodically turned off once or twice daily for a short period of time and compressed air was discharged over the attraction intake grating through a previously installed piping system, thus removing the debris. During the annual shutdown in August, the attraction intake grating was cleaned by hand and was also cleaned every couple of days after that with the compressed air.

Unusually high river flows in the Kennebec River resulted in a shutdown of fish lift operations from June 20 until June 21, 2009, June 27 to July 10, 2009, and again from July 31 to August 4, 2009. During these periods, the river flow was 24,000 to 50,000 cfs, well above safe operational levels. On July 11 and 12, 2009, the fish lift was down due to an issue with the vee-gates not opening. The problem was resolved and fishing continued as normal.

Generally once a week, NextEra Energy personnel shut down the attraction flow to clean the fish isolation screens using a pressure washer and hand rake to remove the debris. During such times, the screens were completely lifted out of the water with chain falls and cleaned allowing the debris to be flushed out of the fish lift area. Fish lift operations suspended on August 17 until August 30, 2009, due to an annual, scheduled, Lockwood facility shutdown which included dewatering and debris removal from the intake canal and performing scheduled maintenance on the hydro units.

After the shutdown was completed, the MDMR requested that NextEra Energy adjust the vee-gate gap from eighteen inches to approximately six inches. The original eighteen inch vee-gate gap was to allow river herring and American shad into the fish lift. However, since the herring and shad runs had ended, the vee-gate opening was narrowed for Atlantic salmon trapping purposes. If an Atlantic salmon did swim into the narrowed hopper area, the salmon would be less likely to swim out given the smaller six-inch vee-gate opening.

In total, there were 740 lifts from May 1 through October 30, 2009. October 30 marked the final day of fish lift operations for the 2009 season.

The daily river temperatures, river flows and status of the Lockwood fish lift are included in Appendix B.

2.2.1.1 River Herring

In 2009, 45,969 adult river herring were captured at the fish lift during approximately 390 fish lift cycles. The first river herring was captured on May 1, the first day of operations and the last river herring were captured on June 26. The peak of the river herring run occurred from May 9 to May 26, and another small peak occurred from June 2 to June 6.

The MDMR personnel transported 10,207 of these river herring to Wesserunsett Lake in Skowhegan, 12,947 were transported to the Shawmut Project headpond and 7,870 were transported to the upper Sebasticook drainage. In addition, there were 14,404 river herring transported out of basin by the MDMR. The biological information for these river herring can be found in the MDMR's 2009 Diadromous Fish Restoration Report.

All the river herring were caught between May 1 and June 26. Adult river herring were observed and recorded on the underwater cameras. The underwater cameras proved to be very valuable in catching the majority of the river herring. Personnel watched the river herring swim into the fish lift and therefore knew exactly when to begin a fish lift cycle. In addition, on a couple of occasions, NextEra Energy personnel observed small schools of river herring in the river just below the fish lift entrance.

The vast majority of the captured river herring appeared to be in very good condition with no apparent descaling and/or abrasions. NextEra Energy personnel recorded 37 mortalities out of the 45,969 adult river herring captured. The 37 mortalities represent a mortality rate of 0.08%. The vast majority of the mortality occurred when river herring slipped through a gap between the hopper and the discharge chute falling to the platform below. Some other mortality came from

holding fish over night for transport the following day. The fish were found dead in the morning.

In total, there were 45,436 river herring trucked by the MDMR personnel. The MDMR only had 8 mortalities in 2009, with a mortality rate of 0.01% after trucking.

Table 2-1 shows daily total catch rates for river herring, corresponding river temperatures and average river flows. Table 2-1 does not show dates when no herring were caught, fish lift shutdown dates, or when the flow exceeded 24,000 cfs. As per design specifications, the Lockwood fish lift shuts down when flows exceed 24,000 cfs.

Table 2-1. River Herring Totals at the Lockwood Project – 2009

Date	River Herring Captured	River Temperature Degrees Celsius	Average River Flow Cubic Feet/Second
1-May	1	10.4	11,800
2-May	21	11.3	11,600
3-May	118	11.1	11,400
4-May	97	10.4	10,800
5-May	280	10.8	10,800
6-May	143	10.6	10,900
7-May	600	10.7	11,500
8-May	326	10.8	13,100
9-May	1,115	11	17,500
10-May	1,194	11.9	17,100
11-May	420	12	18,600
12-May	1,099	11.9	19,300
13-May	1,275	12	17,100
14-May	2,180	11.8	13,600
15-May	2,117	12.2	12,900
16-May	898	12.8	10,400
17-May	2,029	12.7	8,270
18-May	1,585	12.6	9,520
19-May	887	12.7	8,090
20-May	1,211	13.1	7,910
21-May	926	13.8	8,600
22-May	9,532	14.1	7,800
23-May	396	15.5	3,330
24-May	63	14.8	6,830
25-May	3,055	15.4	5,600
26-May	3,316	15.1	7,980
27-May	134	14.8	7,370
28-May	32	13.8	6,100
29-May	15	13.5	7,100
30-May	49	14	7,000
31-May	37	13.7	9,000
1-Jun	221	13.1	8,000
2-Jun	400	13.9	7,440
3-Jun	3,193	14.6	6,040
4-Jun	4,626	15.5	6,330
5-Jun	917	16	6,070

Date	River Herring Captured	River Temperature Degrees Celsius	Average River Flow Cubic Feet/Second
6-Jun	405	16.8	4,360
7-Jun	16	17.3	4,530
8-Jun	12	17.6	6,690
9-Jun	4	17.8	5,750
10-Jun	47	16.6	6,290
11-Jun	1	16.4	5,380
12-Jun	1	15.7	5,410
13-Jun	1	15.7	10,900
15-Jun	635	15.7	8,010
16-Jun	12	15.9	9,830
17-Jun	78	16.5	8,490
18-Jun	152	17	7,390
19-Jun	12	17.1	7,060
22-Jun	44	15.5	21,200
23-Jun	4	16.3	18,300
25-Jun	1	16.8	17,100
26-Jun	1	17.8	15,700
TOTAL:	45,934		

* Of this total, approximately 488 were returned to the river.

2.2.1.2 American Shad

There were no shad captured at the fish lift during the 2009 migration season.

NextEra Energy personnel routinely monitored the four underwater cameras located in and around the fish lift for the presence of shad. NextEra Energy also conducted visual observations for the presence of shad throughout the migration season. Observations were made from the fish lift holding tank platform looking into the tailrace and from the U.S. Route 201 bridge looking into Ticonic ledges as described above.

Shad observations at the fish lift via the underwater cameras helped catch most of the shad in 2007 as NextEra Energy personnel were able to watch the shad swim into the fish lift area. Unlike 2007, no shad were observed in 2009 on any the four underwater cameras in the fish lift vicinity.

The tailrace fish lift platform and Route 201 bridge visual observations documented no shad during 2009. These observations also documented the presence of numerous large stripped bass just downstream of the fish lift entrance. These fish were observed chasing and feeding on other fish in that location. NextEra Energy personnel did observe shad being angled downstream of the fish lift entrance and in various locations in the river directly below the Lockwood Project. Local shad fisherman documented some shad spawning activity in the vicinity of the Fort Halifax Park area, and the MDMR collected juvenile shad in a number of locations in the Kennebec River below the Project.

The specific results of the radio telemetry study are included in Appendix A of this report. In summary, only two of 30 shad (6.7%, excludes the seven post-spawn shad) approached the fish lift one to two days after release and only one of these 30 shad (3.3%) entered the fish lift. This

shad entered the fish lift at approximately 8 p.m. on June 10 but was not captured because it came in after normal operating hours. It was not captured by the underwater camera and video recorder as the recorder was inadvertently programmed to stop recording prior to 8 p.m. (As a side note, after this data became available, the fish lift was manned and operated generally until dark throughout the rest of the shad migration period, and the video recorder was re-programmed. No other shad were physically captured or observed by the underwater cameras). This scarcity of fish lift approaches occurred despite the fact that tagged shad spent long periods of time in the capture/holding area located several hundred meters downstream of the powerhouse. In addition, only four of the 30 shad (13%) approached the bypass reach and only two of those shad (6.6%) moved further up the bypass reach for short periods of time. These data generally indicate that shad are not approaching the fish lift as they were most often located at the holding area (where they were caught) and the (presumed) spawning location near Fort Halifax Park just downstream of the project. These data generally indicate that most shad are holding and/or spawning downstream of the project but do not appear to migrate further upstream.

The specific results of the hydraulic flow study are included in Appendix C of this report. In summary, the dye test indicated a good surface flow with no large back eddies or breaks in the continuity of the attraction flow jet. This flow should provide adequate attraction for upstream migrating shad for 150 feet downstream of the fish lift entrance. The ADCP test demonstrated that the areas within the measured transects near the fish lift entrance are within the acceptable range of the swimming capabilities for shad. At the MDMR monitoring buoy transect, along the Waterville side of the river, there appears to be a good leading flow that should be conducive to upstream shad migration. In addition, at the MDMR buoy transect, there is a shoal in the river and an eddie that directs the flow to move upstream along the Winslow side of the river. This eddie could redirect shad downstream; however, the extent or duration is unknown.

2.2.1.3 Atlantic Salmon

In 2009, 32 Atlantic salmon were captured in the fish lift but only 26 of these were trucked to the Sandy River. By comparison, in 2006, 2007 and 2008, 15, 16 and 22 salmon were captured. The 6 fish that were not trucked were domestic salmon that the MDMR had stocked in the Sandy River last fall. These fish had radio tags and pit tags, which made them identifiable. All of these fish were returned to the river below the fish lift, except for one that was caught three times. This fish was captured and brought to the Sandy River on May 1 and on June 2 was captured in the fish lift for the second time and trucked down to Kennebec River in Gardiner, Maine. It later made its way back up river into the Lockwood fish lift for the third time on June 15 and was subsequently released back into the river just downstream of the fish lift.

The first Atlantic salmon was captured on May 1 with a water temperature of 11.4ºC and the last Atlantic salmon was captured on October 22, with a water temperature of 9.7ºC. These salmon were captured during a total of 740 fish lift cycles. On August 13, one Atlantic salmon was captured at a river temperature of 22ºC which was the warmest capture temperature in 2009. The MDMR trucked the 26 Atlantic salmon to the Sandy River. The biological information and fish lift operational information regarding these 26 Atlantic salmon is included in Table 2-2. Biological data was not collected from the 6 non-trucked domestic salmon.

The underwater cameras proved to be very valuable in capturing some of the Atlantic salmon. NextEra Energy personnel watched a few of the salmon swim into the fish lift and therefore knew exactly when to begin a fish lift cycle. Atlantic salmon were caught in the early morning hours and in the afternoon. There were a couple of occasions in which an Atlantic salmon was monitored on the underwater cameras and not immediately captured. However, the fish was subsequently captured within a short time of the initial observation.

Table 2-2: Adult Atlantic Salmon Captured at the Lockwood Fish Lift - 2009

Date	Age[1]	Sex	Origin[2]	River Temp (°C)[3]	River Flow (cfs)[3]
14-May	2SW	F	H	11.8	13,600
4-Jun	2SW	F	W	15.5	6,330
11-Jun	2SW	M	W	16.4	5,380
12-Jun	2SW	F	W	15.7	5,410
12-Jun	2SW	M	W	15.7	5,410
12-Jul	2SW	F	H	19.3	19,400
13-Jul	2SW	M	H	19	16,500
13-Jul	2SW	F	W	19	16,500
14-Jul	2SW	F	W	19	14,500
14-Jul	2SW	F	H	19	14,500
15-Jul	2SW	F	W	19.3	10,800
16-Jul	2SW	M	H	19.3	11,300
18-Jul	2SW	F	H	19.5	9,130
18-Jul	2SW	F	H	19.5	9,130
19-Jul	2SW	M	H	19.7	8,710
27-Jul	2SW	F	H	19.2	12,200
27-Jul	2SW	M	H	19.2	12,200
29-Jul	2SW	M	W	20.7	10,200
29-Jul	2SW	F	H	20.7	10,200
30-Jul	2SW	M	H	21.6	12,000
13-Aug	2SW	F	H	22	11,500
21-Sep	2SW	M	H	18.4	3,240
1-Oct	2SW	M	W	17	3,300
8-Oct	2SW	F	W	14	5,780
17-Oct	2SW	M	H	11.6	2,300
22-Oct	2SW	F	W	9.7	2,700

[1] 1SW = 1 sea-winter; 2SW = 2 sea-winters; 3SW = 3 sea-winters
[2] W = Wild origin; H = Hatchery origin; G = Grisle; U = Unknown
[3] River temperature and flow readings recorded before noon on all dates

Most of the captured Atlantic salmon appeared to be in overall good condition. There were no Atlantic salmon mortalities at the fish lift during the 2009 season or during the MDMR trucking efforts.

2.2.1.4 Non-Target Fish Species

There were 22 different non-target species captured at the fish lift for a total of 949 fish. All of the non-target species were sluiced back into the river below the fish lift. There were no non-target species mortalities at the Lockwood fish lift in 2009.

NextEra Energy captured 405 landlocked salmon between May 1 and October 30, 2009, which was the largest non-target catch. The second highest non-target catch was smallmouth bass at 126, followed by 113 red-breasted sunfish.

There were six invasive fish caught this year at the fish lift, five white catfish and one northern pike. These fish were culled and not returned back to the river.

Table 2-3 shows the total number of non-target species caught in the fish lift for the 2009 season.

Table 2-3. Non-Target Species Totals at Lockwood Project

Species	Number Caught
Landlocked Salmon	405
Brown Trout	21
Brook Trout	10
Rainbow Trout	3
Splake	1
Lake Trout	1
Small Mouth Bass	126
Large Mouth Bass	8
Striped Bass	10
White Sucker	64
Yellow Perch	90
White Perch	5
Red-breast Sunfish	113
Pumpkin Seed Sunfish	9
Black Crappie	7
Fall fish	6
Creek Chub	1
Golden Shiner	3
American Eel	51
Sea Lampray	9
Northern Pike	1
White Catfish	5
TOTAL:	949

2.3 DISCUSSION AND FUTURE PLANS

2.3.1 Lockwood

2.3.1.1 Monitoring Plans

In consultation with resource agencies, NextEra Energy will continue to follow the operation and effectiveness plans for the Lockwood fish lift during the 2010 migration season. This includes operation of the underwater cameras and daily coordination with the MDMR during sorting, counting and trucking operations.

2.3.1.2 Fish Lift Operation

NextEra Energy will continue to operate the fish lift, trap, sort, and truck facility during the 2010 migration season with experience gained from the first four seasons. NextEra Energy will continue to coordinate with the MDMR on a regular basis to ensure that fish lifting and sorting operations are conducted in an effective manner.

The fish lift isolation screens, maintenance gate bar rack and redesigned attraction water intake pipe installed in August 2007 will continue to be utilized during the 2010 season to help manage river debris. In addition, the Lockwood power canal is scheduled to be dewatered in August, at which time debris will be removed from the attraction water intake location.

NextEra Energy will hold river herring overnight to reduce the number of these fish passed downstream following capture at the fish lift. River herring will be held in two 1,250 gallon tanks (supplied with ambient river flow and oxygen as needed) until there are adequate numbers of fish to transport to upstream spawning locations.

2.3.1.3 American Shad Upstream Passage Studies

NextEra Energy plans to continue consultation with resource agencies on the results of the radio telemetry and ADCP hydraulic studies, determine what conclusions can be drawn from the studies, and then come to consensus regarding the implications of the results. In addition, based on the telemetry data that showed that one of the tagged shad entered the fish lift at 8 p.m., NextEra Energy will operate the fish lift until dark during the shad migration period in an effort to possibly increase shad passage. NextEra Energy will also make sure the video recorder is programmed to record daily from day break until dark.

2.3.2 Shawmut

The Shawmut Project will use the Lockwood fish lift and transport system as its means of upstream fish passage until at least the year 2012. Permanent upstream passage at Shawmut will be operational 2 years following the earlier to occur of either of the following biological triggers:

A. 15,000 American shad passed in any single season in the permanent passage facility at UAH-Hydro Kennebec; or
B. A biological assessment trigger initiated for Atlantic salmon, alewife or blueback herring.

However, in no event shall permanent upstream passage be required to be operational at Shawmut before May 1, 2012.

2.3.3 Weston

The Weston Project will use the Lockwood fish lift and transport system as its means of upstream fish passage until at least the year 2014. Permanent upstream passage at Weston will be operational 2 years following the earlier to occur of either of the following biological triggers.

A. 35,000 American shad passed in any single season in the permanent passage facility at UAH-Hydro Kennebec; or
B. A biological assessment trigger initiated for Atlantic salmon, alewife or blueback herring.

However, in no event shall permanent upstream passage be required to be operational at Weston before May 1, 2014.

3.0 UPSTREAM EEL PASSAGE

3.1 INTRODUCTION

Pursuant to the 1998 KHDG Agreement, the MDMR, NextEra Energy and Merimil have installed upstream passage facilities (eelways) for American eel at the hydroelectric projects in the lower Kennebec River watershed and have initiated upstream eel passage studies.

3.2 METHODS

3.2.1 Lockwood

The Lockwood eelway consisted of a 12-inch-wide by 4-inch-high aluminum trough with substrate consisting of a rigid, netted, mesh called *incamat*. The *incamat* is approximately 3/8-inches-high by 3/8-inches in diameter and covers the entire substrate of the eelway. This *incamat* has a flat back side which lies flat against the surface of the eelway. The eelway consists of two sections connected by one turn pool. Attraction water is supplied by a battery-operated, submersible pump which supplies two spray bars located at the exit chute and at the top of the turn pool. The eelway is approximately 20-feet-long. In addition, a collection trap is located under the eelway exit area and the eels can then be counted and weighed to quantify the number migrating through the facility.

3.2.2 Shawmut

The eelway entrance was located at the most eastern end of the spillway. The eelway consists of two sections connected by one turn pool. One section of the eelway channel runs parallel to the dam and the other section runs up and over the flashboards. The eelway is a 20-inch-wide by 4-inch-high aluminum trough, with substrate consisting of a rigid, netted, mesh called *incamat*. The *incamat* is approximately 1-inch-high and covers the entire substrate of the eel passage. Attraction water is supplied by a battery-operated, submersible pump which supplies two spray

bars located at the exit chute and at the turn pool. A hopper and set of rails were installed under the exit tube area. By using a hand winch to raise the hopper, the eels can be lifted and counted.

This eelway was not installed in 2009 due to the construction of the Shawmut rubber dam.

3.2.3 Weston

The eel passage facility at the Weston Project measured 24-inches-wide with 5-inch aluminum channel sides and a 1/8-inch aluminum floor. The eelway consisted of two sections connected by one turn pool, with the exit attached to the top of the stanchion gate. Attraction water was supplied by a submersible electric pump and two spray bars that are located at the intersection of the exit chute and the eelway exit. A hopper and set of rails were installed under the exit chute area. By using a hand winch to raise the hopper, the eels could be lifted to the top of the abutment and counted. The exit chute tube is also hinged to allow the hopper (holding pen) to be raised to the above walkway for tending.

3.3 RESULTS

3.3.1 Lockwood

Due to high river flows, the Lockwood flashboards were not installed until September 17, well after the peak of the upstream eel migration. As a result, the Lockwood eelway was not installed during the 2009 migration season.

3.3.2 Shawmut

Due to the installation of the new rubber dam on the Shawmut spillway the eelway was not installed during the 2009 migration season.

3.3.3 Weston

The Weston Project eelway was installed May 29. The eelway was in operation from June 10 through September 24. Based on prior successful migration seasons and adequate effectiveness study results in 2007, the Weston eelway had limited monitoring in 2009. The eelway was checked periodically during the migration season and was successfully passing migrating eels. The eelway was removed on September 24, 2009.

3.4 DISCUSSION AND FUTURE PLANS

3.4.1 Lockwood

The eelway will be installed and operational by June 15 or as soon as river conditions allow for safe installation, and will be removed on or about September 15. NextEra Energy will conduct effectiveness studies at the Lockwood eelway in 2010. These studies will be conducted following agency-approved methods used in the 2007 effectiveness studies at Shawmut and Weston. NextEra Energy will also collect and count the number of eels using the eelway.

3.4.2 Shawmut

NextEra Energy finished the installation of the rubber dam in the fall of 2009. The permanent eelway was not installed in 2009 because it would have interfered with completion of the rubber dam. In late fall of 2009, preliminary observations were done on the new 700-foot rubber dam sections which show there is little to no leakage. Elimination of leakage along the spillway could change the existing eel migration location. Nighttime visual observations and/or placement of temporary eelways will occur during the 2010 migration season to observe where eels are congregating. Based on the 2010 data, NextEra Energy, in consultation with resource agencies, will relocate or modify the existing eelway to provide permanent passage for the 2011 season.

3.4.3 Weston

The eelway will be installed and operational from June 15, or as soon as river conditions allow for safe installation, and will be removed on or about September 15.

Eels migrating up the eelway will be allowed to pass directly into the headpond. Due to the demonstrated passage effectiveness of the eelway in 2007 and the collection of countable numbers of eels since monitoring began (i.e., 758 eels in 2005, 6,893 eels in 2006 and 8,361 eels in 2007), no additional monitoring or effectiveness studies are planned at Weston in 2010.

4.0 DOWNSTREAM ANADROMOUS FISH PASSAGE

4.1 INTRODUCTION

As per the 1998 KHDG Agreement, NextEra Energy has also been providing interim measures for downstream anadromous fish passage at the Lockwood, Shawmut and Weston Projects. In 2007, the MDMR began stocking Atlantic salmon from the new Lockwood fish lift to above the Weston Project. The MDMR has been stocking Atlantic salmon eggs above the Weston Project since 2003. Since 2000, the MDMR has been stocking adult alewives above the Shawmut Project and juvenile shad above the Lockwood Project.

In 2009, NextEra Energy routinely monitored downstream passage at the Kennebec River projects to make sure the interim passage measures were open and operating properly.

4.2 METHODS

4.2.1 Lockwood

In the summer of 2009, NextEra Energy constructed and installed a new downstream fish passage facility in the Lockwood power canal. This facility consisted of a new 10-foot-deep floating boom leading to a new 7-foot-wide by 7-foot-deep sluice and associated mechanical over flow gate. Maximum flow through the gate is 6% of station capacity or 340 cfs. The sluice was located on the river side of the power canal just upstream of the Unit 1 trash rack and discharges directly into the river. The boom is 300-feet-long and was secured on the land side of

the canal and angles downstream to the new sluice gate. The boom had flotation, was suspended in the water column, and was constructed with 4 feet of an impervious rubber material manufactured by Slickbar Inc. followed by six feet of 7/16-inch Dyneema netting.

The Lockwood Project also includes an 875-foot-long spillway section with 15-inch wood flashboards. Annually, three orifices, 3-feet-long by 8-inches-high, are placed at three locations along the spillway. The purpose of the orifices is to pass a 50 cfs minimum flow for the protection of downstream fisheries. The orifices may also provide downstream passage routes even when the project is not spilling over the top of the flashboards. The hydraulic capacity of the seven generating units at the Project is approximately 5,660 cfs.

In accordance with the interim downstream passage requirements of the 1998 KHDG Agreement, NextEra Energy will use the new sluice, guidance device, and the spillway as a primary means of providing downstream passage for anadromous species.

4.2.2 Shawmut

The Shawmut Project has one sluice located on the right-hand side of the intake structure next to Unit 6 (see Figure 3, Shawmut Site Plan). The sluice next to Unit 6 is a manually-adjustable sluice containing three stoplogs. The sluice is 4-feet-wide by 22-inches-deep. With all stoplogs removed, this sluice passes flows in the range of 30 to 35 cfs. Flows from this sluice discharge over the face of the dam and drain into a man-made 3-foot-deep plunge pool connected to the river.

The Shawmut Project also includes a 1,100-foot-long spillway section that consists of a hinged flashboard section, a log sluice, and new in 2009 three sections of rubber dam that replaced the four-foot-high plywood flashboard section. The hydraulic capacity of the eight generating units at the Project is approximately 6,700 cfs.

In accordance with the interim downstream passage requirements of the 1998 KHDG Agreement, NextEra Energy uses the sluice and spillway as a means of providing downstream passage for anadromous species.

4.2.3 Weston

The Weston Project has one sluice located on the South Channel dam (see Figure 4, Weston Site Plan). The sluice was formerly used as a log sluice and is located near the Unit 4 intake. It is 18-feet-wide by 14-feet-high and resultant flows discharge into a deep plunge pool. Maximum flow through the gate at full pond is 2,250 cfs and, during the downstream migration period, the gate is opened 1.5 feet passing 120 cfs.

The Weston Project also includes two taintor gates, an inflatable rubber dam section, and stanchion gate sections. The hydraulic capacity of the four generating units at the Project is approximately 6,000 cfs.

In accordance with the interim downstream passage requirements of the 1998 KHDG Agreement, NextEra Energy uses the log sluice and spillage as a means of providing downstream passage for anadromous species.

4.3 RESULTS

4.3.1 Lockwood

NextEra Energy used late summer and fall of 2009 as a shake-down period for the new downstream passage facility and evaluated its resistance to tearing, debris loading and other structural issues. On several occasions in the fall, NextEra Energy observed juvenile clupeids being guided by the new floating boom and subsequently using the new surface gate. NextEra Energy also observed some juveniles on the downstream side of the boom, indicating they either sounded under the boom or more likely passed through tears in the boom as described below. There was limited bird and fish feeding activity observed in the tailrace area in the fall.

NextEra Energy did identify some issues with the new facility. These issues included the need for additional flotation, the need for upstream-facing tether lines securing the boom and possibly removing some of the existing "belly" in the boom. Some of these modifications were completed in 2009 (installing additional flotation and installing tether lines). In addition, some tearing of the boom fabric did occur; however, the boom generally stayed in place and did not separate completely. NextEra Energy is presently in discussions with the boom manufacturer to see if there are options to eliminate the tearing of the boom. In addition, NextEra Energy is also evaluating other boom options and will consult with the resource agencies prior to spring deployment. NextEra Energy's plan is to make any necessary modifications prior to the proposed spring 2010 downstream passage studies.

No adult alewives were observed migrating downstream through the Lockwood Project during 2009, similar to the results of previous years of observations. Reasons for the lack of post-spawn adult sightings may be attributed to: (1) subsequently low numbers of downstream migrants due to normal post-spawning mortality and attrition, and (2) the possibility that adults passed the Project during spill events or times when personnel were not at the Project. Also, the Project power canal was dewatered for maintenance from August 17 through August 27. During that time, all flow was diverted over the spillway section.

In 2009, the MDMR stocked 26 Atlantic salmon from the Lockwood fish lift in the Sandy River above the Weston Project. Additionally, some Atlantic salmon eggs had been placed in upstream stream-side incubators in prior years and would have over-wintered into 2009. NextEra Energy did not receive any reports of sightings of Atlantic salmon or salmon smolt at the Lockwood Project. Reasons for the lack of post-spawn adult and smolt sightings may be attributed to: (1) the relatively low numbers stocked above the Project and the low likelihood of actually observing these low numbers of downstream migrants, and (2) the possibility that they passed the Project during spill events or times when personnel were not at the project.

4.3.2 Shawmut

NextEra Energy personnel observed a limited number of adult alewives migrating downstream through the Shawmut Project during 2009, similar to the results of previous years of observations. Reasons for the limited number of post-spawn adult sightings may be attributed to: (1) subsequently low numbers of downstream migrants due to normal post-spawning mortality and attrition, and (2) the possibility that adults passed the Project during spill events.

The Shawmut tailrace area was checked four times total from May 18 until June 6, 2009, for the presence of fish mortalities. During that time, NextEra Energy personnel collected 8 river herring, one yellow perch, and one white sucker. During the 2009 migration season, the MDMR stocked 12,947 adult river herring into the Shawmut headpond and 10,207 into Wesserunsett.

In 2009, the MDMR stocked 26 Atlantic salmon from the Lockwood fish lift in the Sandy River above the Shawmut Project. Additionally, some Atlantic salmon eggs had been placed in upstream stream-side incubators in prior years and would have over-wintered into 2009. NextEra Energy did not receive any reports of sightings of Atlantic salmon or salmon smolt at the Shawmut Project. Reasons for the lack of post-spawn adult and smolt sightings may be attributed to: (1) the relatively low numbers stocked above the Project and the low likelihood of actually observing these low numbers of downstream migrants, and (2) the possibility that they passed the Project during spill events or times when personnel were not at the Project.

In 2009, the interim passage facility was opened in mid April and closed in mid December coincident with pending ice-in conditions.

4.3.3 Weston

In 2009, the MDMR stocked 26 Atlantic salmon from the Lockwood fish lift in the Sandy River above the Weston Project. Additionally, some Atlantic salmon eggs had been placed in upstream stream-side incubators in prior years and would have over-wintered into 2009. NextEra Energy did not receive any reports of sightings of Atlantic salmon or salmon smolt at the Weston Project. Reasons for the lack of post-spawn adult and smolt sightings may be attributed to: (1) the relatively low numbers stocked above the Project and the low likelihood of actually observing downstream migrants, and (2) the possibility that they passed the Project during spill events.

In 2009, the interim passage facility was opened in mid April and closed in mid December coincident with pending ice-in conditions.

4.4 DISCUSSION AND FUTURE PLANS

4.4.1 Lockwood

The resource agencies have requested that NextEra Energy operate the new downstream passage facility at Lockwood from April 1 - December 30 annually. Due to the absence of any specific Atlantic salmon smolt and kelt migration period data for the Kennebec drainage, it is difficult to say that April 1 - December 31 is the actual migration period. NextEra Energy hopes to further

consult with resource agencies on this time period as new data becomes available. NextEra Energy intends to open the new downstream facility from April 1-December 31 as river conditions (i.e., ice, debris and high water) allow. Fish may also pass the Project via the exiting canal surface sluice (open from mid April through mid December) and the spillway especially in the spring and fall.

On February 12, 2010, NextEra Energy filed a draft study plan with the resource agencies titled "Evaluation of Atlantic salmon smolt and kelt downstream passage at the Lockwood Project". NextEra Energy plans to undertake this pit tag study in May of 2010 after resource agency consultation. The purpose of the study is to evaluate the effectiveness of the new downstream passage facility. NextEra Energy received comments from NMFS on March 8, 2010, and MDMR and USFWS on March 9. The resource agency comments have been incorporated into a final study plan (see Appendix D). Based on agency comments, NextEra Energy will delay the testing of kelts until we have an opportunity to understand downstream smolt behavior at the Project. If results of smolt testing this spring indicate that the downstream fishway is effective, then kelt testing should proceed in 2011.

Additionally in 2010, NextEra Energy will undertake a pit tag study to evaluate adult river herring, adult shad and juvenile clupeid passage at the new downstream passage facility. The study plan for this work is being developed and will be submitted for resource agency consultation in spring of 2010.

4.4.2 Shawmut

NextEra Energy will operate interim downstream passage measures at Shawmut for Atlantic salmon smolt, Atlantic salmon kelts, and adult and juvenile alewife from April 1 - December 30 annually as river conditions allow.

4.4.2.1 Shawmut Downstream Passage Studies

NextEra Energy initially planned to conduct a radio telemetry study in 2010 for Atlantic salmon smolts and kelts at Shawmut due to a 2009 request from the MDMR. On September 23, 2009, NextEra Energy met with resource agencies to discuss the specifics of the study. NextEra Energy subsequently developed a draft study plan and submitted it to the resource agencies on October 19, 2009, for review and comment. The NMFS subsequently provided comments on November 19 and December 4, 2009, indicating that NMFS and MDMR were satisfied with the proposed study plan. In the meantime, NextEra Energy engineers and operations personnel were beginning to look at options to resolve some ongoing debris issues at Shawmut. NextEra Energy biologists got involved in this process and indicated that there were also some downstream anadromous and catadromous fish passage needs at the Project. They suggested that the options for debris resolution should be designed to also address downstream fish passage needs. In February of 2010, NextEra Energy contacted the resource agencies and indicated it would like to defer the proposed 2010 downstream passage studies due to ongoing work to address both the debris issue and fish passage needs at the Project. The resource agencies indicated that this appeared to be a reasonable request.

NextEra Energy is evaluating the use of either a new floating boom option and new surface sluice or a new, fixed, one-inch angle bar rack structure and new surface sluice. If the boom option is chosen, NextEra Energy is scheduled to install it in 2011 with evaluations to follow that year. NextEra Energy would consult with resource agencies on boom design during the summer/fall of 2010 and develop draft study plans (for agency review and comment) to assess downstream passage for smolts and kelts by October 30, 2010. If the angled rack option is chosen, this would be a major capital infrastructure project. NextEra Energy would design and permit it in 2010-2011 and install it in 2011-2012. Evaluations would begin in 2012 if construction is completed prior to the end of the downstream fish migration season. NextEra Energy would consult with resource agencies on angled rack design during 2010-2011 and develop draft study plans (for agency review and comment) to assess downstream passage for smolts and kelts by October 30, 2011.

NextEra Energy anticipates that the adult shad and river herring studies will begin when adult shad and additional numbers of river herring are stocked above the Shawmut dam and after further consultation with the MDMR, NMFS and USFWS.

4.4.3 Weston

NextEra Energy will operate the downstream passage facility at Weston for Atlantic salmon smolt and Atlantic salmon kelts from April 1 - June 15 and November 1 - December 30 annually as river conditions allow.

4.4.3.1 Weston Downstream Passage Studies

NextEra Energy initially planned to conduct a radio telemetry study in 2010 for Atlantic salmon smolts and kelts at Weston due to a 2009 request from the MDMR. On September 23, 2009, NextEra Energy met with resource agencies to discuss the specifics of the study. NextEra Energy subsequently developed a draft study plan and submitted it to the resource agencies on October 19, 2009, for review and comment. The NMFS subsequently provided comments on November 19 and December 4, 2009, indicating that NMFS and MDMR were satisfied with the proposed study plan. In the meantime, NextEra Energy engineers and operations personnel were beginning to look at options to resolve some ongoing debris issues at Weston. NextEra Energy biologists got involved in this process and indicated that there were also some downstream anadromous and catadromous fish passage needs at the Project. They suggested that the options for debris resolution should be designed to also address downstream fish passage needs. In February of 2010, NextEra Energy contacted the resource agencies and indicated it would like to defer the proposed 2010 downstream passage studies due to ongoing work to address both the debris issue and fish passage needs at the Project. The resource agencies indicated that this appeared to be a reasonable request.

NextEra Energy is evaluating floating boom options (similar to the new Lockwood concept) leading to the existing log sluice. The log sluice is being resurfaced this year as part of required maintenance and this resurfacing will also enhance fish passage. The new boom is scheduled to be installed in the spring of 2011 with passage evaluations to follow that spring. NextEra Energy will consult with resource agencies on boom design during the summer/fall of 2010 and develop

draft study plans (for agency review and comment) to assess downstream passage for smolts and kelts by October 30, 2010.

NextEra Energy anticipates that the adult shad and river herring studies will begin when adult shad and river herring are stocked above the Weston dam and after further consultation with the MDMR, NMFS and USFWS.

5.0 DOWNSTREAM EEL PASSAGE

5.1 METHODS

At Lockwood, the 2007 radio telemetry studies demonstrated effective downstream eel passage via the deep canal gate adjacent to Unit 1. This gate was opened during the 2009 downstream eel migration period.

At Shawmut, the 2008 radio telemetry studies demonstrated effective downstream eel passage via the deep canal gate adjacent to Unit 7 in conjunction with night time shut downs of Units 7 and 8. These measures were implemented during the 2009 downstream eel migration period.

The log sluice at Weston is opened 1.5 feet to provide interim downstream passage. In addition, unregulated spillage and turbine passage are routes that migrating eels may use.

In 2004, NextEra Energy began a program of systematic searches for dead fish or injured eels in the tailrace of each project. The program started by conducting periodic checks of the tailraces during the 2004 fall migration season with observations done by wading in certain areas of the tailraces. Information from these sampling episodes helped to identify areas where dead fish or injured eels collected (or may likely collect) in each of the tailraces and focused efforts and sampling techniques in 2005, 2006, 2007 and 2008. In 2009, observations were conducted in the morning generally on a daily basis from early September until late October at Lockwood and Shawmut and generally about two times per week at Weston**.**

5.1.1 Lockwood

The Lockwood wading observations were conducted generally daily along the west shoreline below the fish lift for approximately 200-300 yards.

In addition, NextEra Energy used a canoe, as well as an underwater camera and view tubes, to access and observe areas that could not otherwise be accessed by wading. At Lockwood, these areas included the Unit 1- 6 tailrace area, Ticonic Bay and both sides of the Kennebec River down below the mouth of the Sebasticook River. NextEra Energy personnel checked all possible areas in the Lockwood tailrace that were safe to wade or canoe on various occasions.

On various occasions, NextEra Energy personnel would use binoculars from specific vantage points to view inaccessible tailrace areas at the projects. At Lockwood, these vantage points included the second floor windows at the Lockwood powerhouse.

5.1.2 Shawmut

The Shawmut wading observations were conducted along the west shoreline below Units 7 and 8 tailrace areas for approximately 200-300 yards.

In addition, NextEra Energy used a canoe, as well as an underwater camera and view tubes, to access and observe areas that could not otherwise be accessed by wading during normal flows. At Shawmut, these areas included the Units 7 and 8 discharge canal and tailrace area below the canal, and an area below the Units 1-6 tailrace.

Also on various occasions, both sides of the Shawmut tailrace were checked down to the first set of power lines that cross the river, approximately ¾ of a mile below the Project. At this location, there are two small shallow island areas that were checked during the migration season. That section of river beyond the power lines is relatively deep which is unsafe to wade, even during low river flows.

At times of low river flows, NextEra Energy personnel were able to wade from Unit 7 and 8 discharge canal, downstream to the two islands and down to the power lines that cross the river. NextEra Energy personnel checked all possible areas in the Shawmut tailrace that were safe to wade or canoe on numerous occasions and under changing river flows.

On various occasions, NextEra Energy used binoculars from specific vantage points to view inaccessible tailrace areas at the projects. At Shawmut, these vantage points included the Units 1-6 powerhouse roof.

5.1.3 Weston

The Weston wading observations were conducted along the west shoreline below the south channel dam for approximately 200 yards.

On one occasion, NextEra Energy personnel conducted a river observation in an area known as the Big Eddy which is located approximately ¾ of a mile below the Project. This area was checked on October 14. There were no observations conducted further below this area as that stretch of river becomes much deeper therefore making wading impractical.

Also, NextEra Energy on various occasions used binoculars from specific vantage points to view inaccessible tailrace areas at the projects. At Weston, these vantage points included the foot bridge just below the South Channel dam and at the South Channel Dam.

5.2 RESULTS

NextEra Energy personnel found one eel mortality below the Lockwood Project and none below the Shawmut and Weston Projects during the 2009 downstream migration season.

5.3 DISCUSSION AND FUTURE PLANS

5.3.1 Lockwood

NextEra Energy will continue to use the deep sluice next to Unit 1 as the primary downstream passage measure for out-migrating adult American eels. Licensee will open the deep gate 8 hours a night during a six-week period between September 15 and November 15 inclusive. The gate will be set at approximately 1.5 feet passing approximately 300 cfs to provide effective passage.

5.3.2 Shawmut

NextEra Energy will continue to use the deep gate located adjacent to Unit 7 as the primary downstream passage measure for out-migrating adult American eels. Licensee will open the deep gate and turn off Units 7 and 8 at night, for 8 hours a night, during a six-week period between September 15 and November 15 inclusive. The gate will be set at approximately 2.5 feet passing approximately 425 cfs to provide effective passage. Licensee reserves the right to modify the above proposal in the future if other downstream eel passage measures are identified in consultation with resource agencies

5.3.3 Weston

Based on 2008 radio telemetry studies, the taintor gate, the obermeyer gates and the log sluice don't appear to be the preferred passage routes for eels. In addition, the Weston Station does not have an existing deep gate for eel passage like the Shawmut and Lockwood projects, and installation of a new deep gate would be difficult due to the stations "in river" location. Based on the above site constraints and based on the immediate turbine survival rates of 85.7% from the 2008 radio telemetry study, NextEra Energy was planning to consult with the resource agencies regarding possible next steps to address downstream eel passage at the project. As described in section 4.4.3.1 of this report, NextEra Energy engineers and operations personnel were beginning to look at options to resolve some ongoing debris issues at Weston. NextEra Energy biologists got involved in this process and indicated that there were also some downstream eel passage needs at the Project. They suggested that the options for debris resolution should be designed to also address downstream eel passage needs. NextEra Energy plans to consult with the resource agencies in 2010 during the development/design of options to address downstream eel passage and during development of study plans.

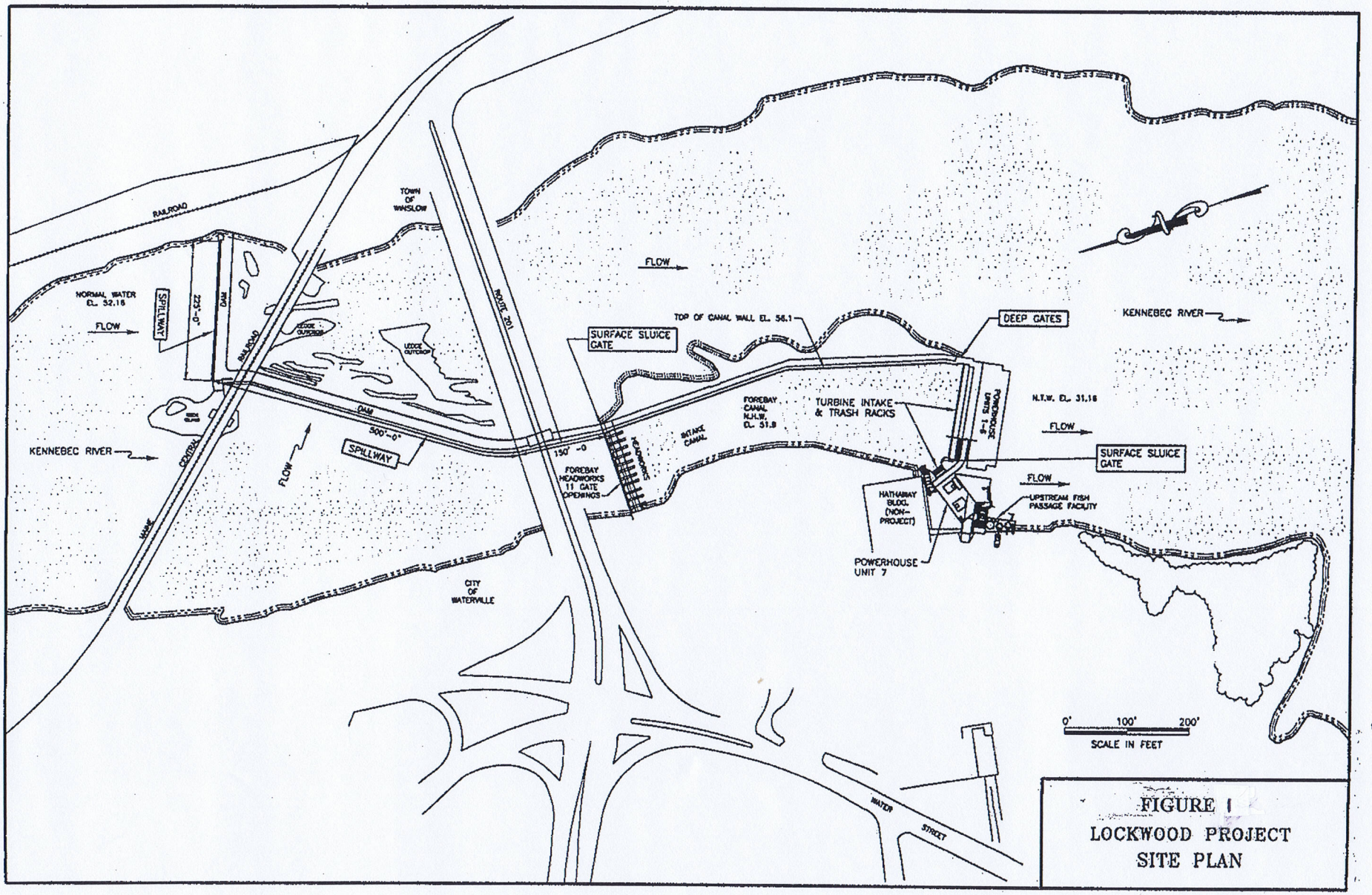
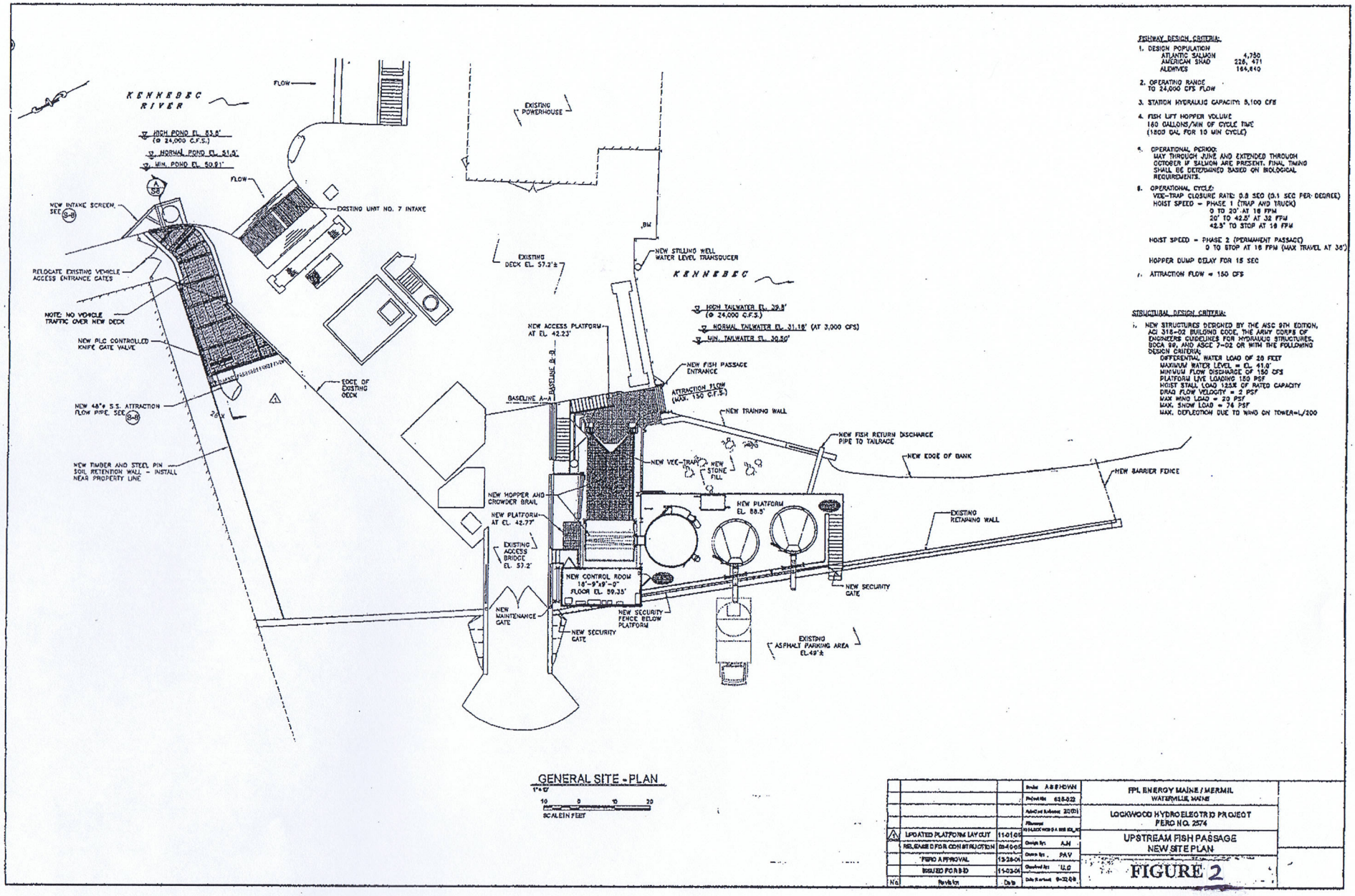


FIGURE 1
LOCKWOOD PROJECT
SITE PLAN



GENERAL SITE - PLAN

1"=10'

FISHWAY DESIGN CRITERIA:

1. DESIGN POPULATION
   ATLANTIC SALMON 4,750
   AMERICAN SHAD 228,471
   ALEWIVES 164,440
2. OPERATING RANGE TO 24,000 CFS FLOW
3. STATION HYDRAULIC CAPACITY: 5,100 CFS
4. FISH LIFT HOPPER VOLUME 160 GALLONS/MIN OF CYCLE TIME (1600 GAL FOR 10 MIN CYCLE)
5. OPERATIONAL PERIOD: MAY THROUGH JUNE AND EXTENDED THROUGH OCTOBER IF SALMON ARE PRESENT. FINAL TIMING SHALL BE DETERMINED BASED ON BIOLOGICAL REQUIREMENTS.
6. OPERATIONAL CYCLE:
   VEE-TRAP CLOSURE RATE: 0.8 SEC (0.1 SEC PER DEGREE)
   HOIST SPEED - PHASE 1 (TRAP AND TRUCK)
   0 TO 20' AT 16 FPM
   20' TO 42.5' AT 32 FPM
   42.5' TO STOP AT 16 FPM
   HOIST SPEED - PHASE 2 (PERMANENT PASSAGE)
   0 TO STOP AT 16 FPM (MAX TRAVEL AT 38')
   HOPPER DUMP DELAY FOR 15 SEC
7. ATTRACTION FLOW = 150 CFS

STRUCTURAL DESIGN CRITERIA:

1. NEW STRUCTURES DESIGNED BY THE ASCE 9TH EDITION, ACI 318-02 BUILDING CODE, THE ARMY CORPS OF ENGINEERS GUIDELINES FOR HYDRAULIC STRUCTURES, BOCA 99, AND ASCE 7-02 OR WITH THE FOLLOWING DESIGN CRITERIA:
   DIFFERENTIAL WATER LOAD OF 20 FEET
   MAXIMUM WATER LEVEL = EL. 41.0'
   MINIMUM FLOW DISCHARGE OF 150 CFS
   PLATFORM LIVE LOADING 150 PSF
   HOIST STALL LOAD 125% OF RATED CAPACITY
   DRAG FLOW VELOCITY = 2 PSF
   MAX WIND LOAD = 20 PSF
   MAX. SNOW LOAD = 74 PSF
   MAX. DEFLECTION DUE TO WIND ON TOWER=L/200

No.	Revision	Date
1	UPDATED PLATFORM LAYOUT	11-01-05
	RELEASED FOR CONSTRUCTION	09-00-05
	PERC APPROVAL	13-28-04
	ISSUED FOR BID	11-03-04

Scale: AS SHOWN
Project No.: 638-002
Approved Reference: 20101
Drawn by: AJH
Checked by: PAV
Approved by: LLO
Date Released: 9-22-04

FPL ENERGY MAINE / MERRIL
WATERVILLE, MAINE

LOCKWOOD HYDROELECTRIC PROJECT
FERC NO. 2574

UPSTREAM FISH PASSAGE
NEW SITE PLAN

FIGURE 2

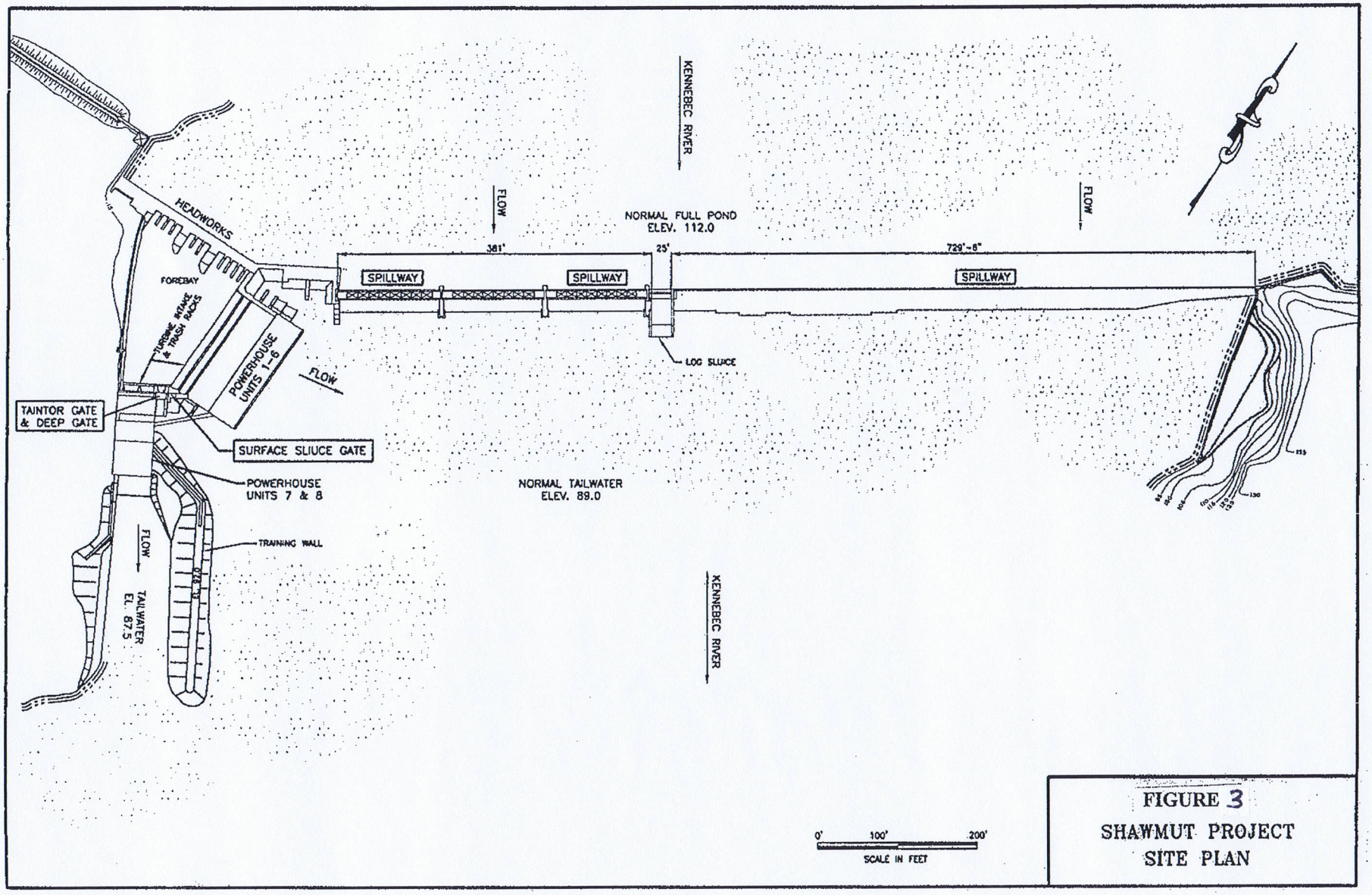


FIGURE 3

SHAWMUT PROJECT

SITE PLAN

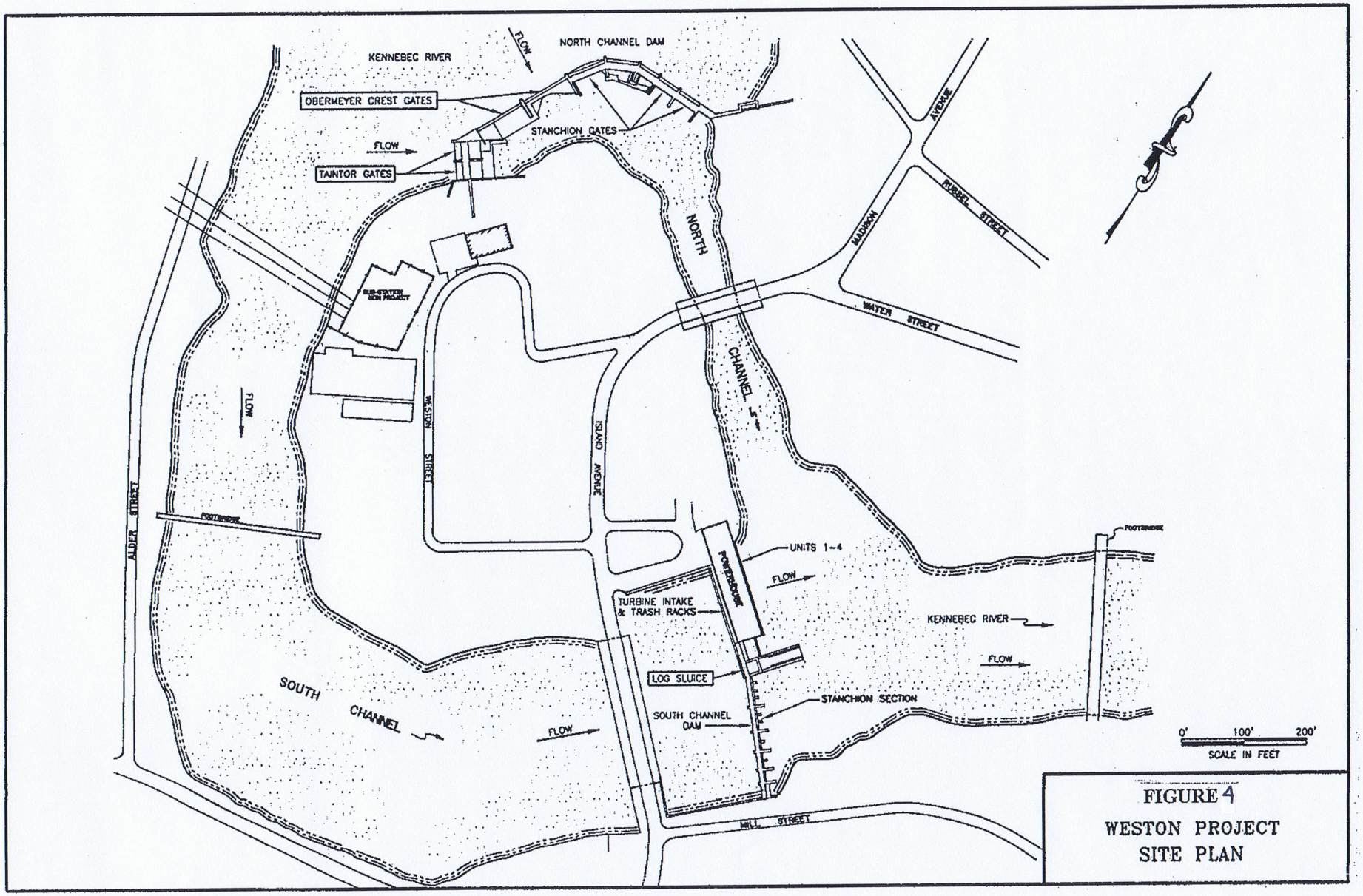


FIGURE 4

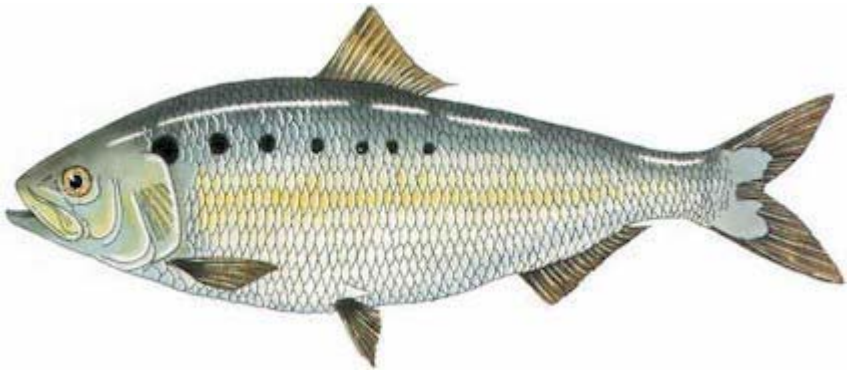
WESTON PROJECT

SITE PLAN

APPENDIX A

Lockwood Project Fish Lift
Upstream Radio Telemetry Effectiveness Study
For American Shad

LOCKWOOD PROJECT FISHLIFT UPSTREAM RADIO TELEMETRY EFFECTIVENESS STUDY FOR AMERICAN SHAD



Prepared for:

NextEra Energy Maine Hydro, LLC

Prepared by:

Aquatic Science Associates, Inc.
Brewer, Maine

29 April 2010

LOCKWOOD PROJECT FISHLIFT
AMERICAN SHAD RADIOTELEMETRY
FINAL REPORT

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EXECUTIVE SUMMARY

Seven radio receivers and automated data loggers were installed and tested at the Lockwood Project in mid-May 2009. Volunteers were recruited to catch American shad on rod and reel beginning in early June. Thirty American shad were radio tagged from 4 to 9 June 2009. Sex was determined to be 14 males and 16 females based on fish length and expressed gametes. The Kennebec River mean discharge during the tagging period was 140 m^3/s (4,940 cfs, close to station capacity). The water temperature increased from 15.5°C on 4 June to 17.8°C on 9 June, consistent with the onset of shad spawning. A second group of seven shad (4 male, 3 female) were tagged on 17 and 20 July following a period of heavy rains and high flows. The receivers and data loggers continuously monitored radio tagged shad presence at the following locations; (1) the tailrace, (2) the fish lift entrance, (3) the fish lift hopper, (4) the approach to the fish lift, (5) the lower bypass reach, (6) the upper bypass reach, and (7) the full width of the Kennebec River at 2.7km downstream of the powerhouse. Frequent mobile tracking by vehicle, boat and airplane supplemented the data logger contacts.

Many of the 30 shad in the first group were found during daylight in a holding area just downstream of the tailrace where they were often contacted by the tailrace data logger. They typically dropped downstream from this holding area near dusk and returned near dawn. Only two of these shad (#13 and #29) approached the fish lift. Two days after release on 10 June, shad #29 entered the fish lift at 20:07 and moved into the fish lift hopper where it spent nearly one hour before leaving—it was not lifted since it was after normal fish lift operating hours. One day after release, shad #13 approached the fish lift for 30 sec. at 18:30 and 121 sec. at 18:58. Shad #25 was also contacted outside the fish lift entrance, however, the contact lasted only 82 seconds and it occurred within minutes of the release from the live car just downstream of the fish lift entrance. Thus, it was not judged to represent volitional behavior and it was not included with the other two fish lift approaches. Four tagged shad approached the Lockwood bypass reach and two (5.4%) of these shad moved further upstream where they were logged for more than an hour on the upper bypass reach data logger.

The first group of 30 tagged shad began leaving the study area and returning downstream with the onset of high flows the evening of 12 June. The second group of seven tagged shad appeared to be post-spawners since the gonads were spent (e.g., eggs could not be expressed from the females) and these fish generally left the study area soon after tagging. Only two of these seven shad (29%) remained in the study area more than 4 days. None of these seven fish approached the fish lift, entered the bypass reach, or spent more than a total of six hours in the tailrace.

Aerial tracking downstream to Merrymeeting Bay and into the Androscoggin River indicated that the shad that left the study area returned to the ocean relatively quickly. After leaving the study area, shad #8 was found near Richmond 16.5 hours later, and shad #27 and #37 were found near Gardiner 8 and 17 hours later, respectively. Shad #4 and #10 returned to Lockwood after absences of five and 11 days, respectively—neither fish was found downstream in the Kennebec River while they were absent from the Waterville area. Thus, it appears they returned to the ocean while they were absent. None of the 37 tagged shad were found in the Sebasitcook River although shad #25 and #8 were not found for five and six days, respectively but did not pass the downstream data logger. This absence coincided with the onset of high flows in the Kennebec River and thus, these two shad may have entered the Sebasticook River to escape adverse turbidity or hydraulic conditions.

Many of the tagged shad exhibited diel movements between a daytime holding location just downstream of the tailrace (the area where all but one of the study fish were caught) and a presumed spawning area near Fort Halifax Park. A second holding area was documented between the Donald Carter bridge and the downstream data logger. Shad were often found here in daylight, and sometimes held throughout the night in this reach.

In summary, two of 30 shad (6.7%, excludes the seven post-spawn shad) approached the fish lift one to two days after release. This scarcity of fish lift approaches occurred despite the fact that tagged shad spent long periods of time in the capture/holding area located several hundred meters downstream of the powerhouse. Furthermore, only four shad (13%) approached the bypass reach and only two of these moved further up the bypass reach. These data indicate that shad were not generally approaching the fish lift. They were most often contacted at the holding area where they were caught, and also at the (presumed) spawning location near Fort Halifax Park just downstream of the holding area. These data indicate that most shad are holding and spawning at specific locations downstream of the project but do not appear to migrate further upstream.

ABBREVIATIONS

ASA	Aquatic Science Associates, Inc.
BSR	Bureau of Sea-Run Fisheries, Maine Department of Marine Resources
C	degrees centigrade
cfs	cubic feet per second
cms	cubic meters per second
FERC	Federal Energy Regulatory Commission
NextEra	NextEra Energy Maine Hydro, LLC
km	kilometers
KSTD	Kennebec Sanitary Treatment District
m	meters
MDEP	Maine Department of Environmental Protection
MDIFW	Maine Department of Inland Fisheries and Wildlife
MDMR	Maine Department of Marine Resources
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Administration
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

1.0 BACKGROUND

The Lockwood Dam Hydroelectric Project is partially owned by Kennebec Hydro Resources and operated by NextEra Energy Maine Hydro, LLC (NextEra). The Project is licensed with the Federal Energy Regulatory Commission (FERC) as Project No. 2574. The project consists of a dam, an intake canal, and a powerhouse with appurtenant facilities. The project is equipped with upstream passage facilities (hereafter "fish lift") that are operated for four anadromous species; Atlantic salmon, blueback herring, alewife and American shad. Atlantic salmon, blueback herring and alewife have been caught on a regular basis since the fish lift became operational in 2006. In 2007, 17 American shad were caught

The resource agencies requested, and NextEra agreed, to undertake an upstream radio telemetry effectiveness study for American shad at the Lockwood Project fish lift in 2009. Very limited numbers of shad have been captured at the fish lift in the last three years of operations and the resource agencies would like to know why. NextEra has indicated that it is difficult to provide any one specific reason why no shad were captured at the Lockwood fish lift in 2006-2008. Some of the possible reasons why no shad were captured include, (1) shad have adequate spawning habitat in historic spawning areas located downstream of the Lockwood Project and are not motivated by density dependent mechanisms to move further upstream, (2) shad are not adequately imprinted to spawning habitat above the Lockwood Project, (3) the presence of predatory striped bass near the fish lift entrance may inhibit shad movement to the fish lift entrance, (4) hydraulic issues associated with the entrance, gates, or other fish lift structures inhibit shad from entering the fish lift, or (5) other unknown reasons.

2.0 PROJECT LOCATION AND STUDY AREA

The Lockwood Project is located on the main stem of the Kennebec River in the city of Waterville. The powerhouse is located on the west shore downstream of the dam. A canal leads from the spillway section of the dam to the powerhouse intakes. The bypass reach is approximately 250m long. The Lockwood Project upstream fish lift is located at the west abutment of the powerhouse. The fish lift is a lift structure that can be operated manually or in an automatic mode. The fish lift is currently staffed for the May through October operating period. Staff lift the hopper periodically and in response to underwater video camera observations of fish entering the fish lift. It is operated in order to pass American shad, river herring and Atlantic salmon. The latter two species are trucked to upstream spawning locations.

The study area encompasses the Kennebec River from the Lockwood Project to the Kennebec Sanitary Treatment District (KSTD) sewage treatment plant located 2.7km downstream of the Lockwood powerhouse (Figure 2-1). Several common mobile contact locations are depicted on Figure 2-1. The level of monitoring effort was greatest within this 2.7km of the Lockwood Project—monitoring details are described in Section 3.2. Discrete areas within about 200m of the Lockwood Project were monitored continuously with radio receivers capable of logging the coded radio transmitter tag data. The river was also continuously monitored at the KSTD sewage treatment plant. Frequent (usually daily) mobile monitoring was conducted throughout this 2.7km reach between the dam and the sewage treatment plant.

Occasional monitoring by vehicle, boat and airplane was conducted beyond the 2.7km long study area. Vehicle tracking included the Kennebec River upstream to the Kennebec Hydro Project (the next dam upstream of the Lockwood Project), downstream to Gardiner, and in the Sebasticook River as far as Burnham. Boat tracking was conducted from the project downstream to the Sidney boat launch. Aerial tracking was conducted downstream to Merrymeeting Bay and in the Androscoggin River as far as the Brunswick dam.

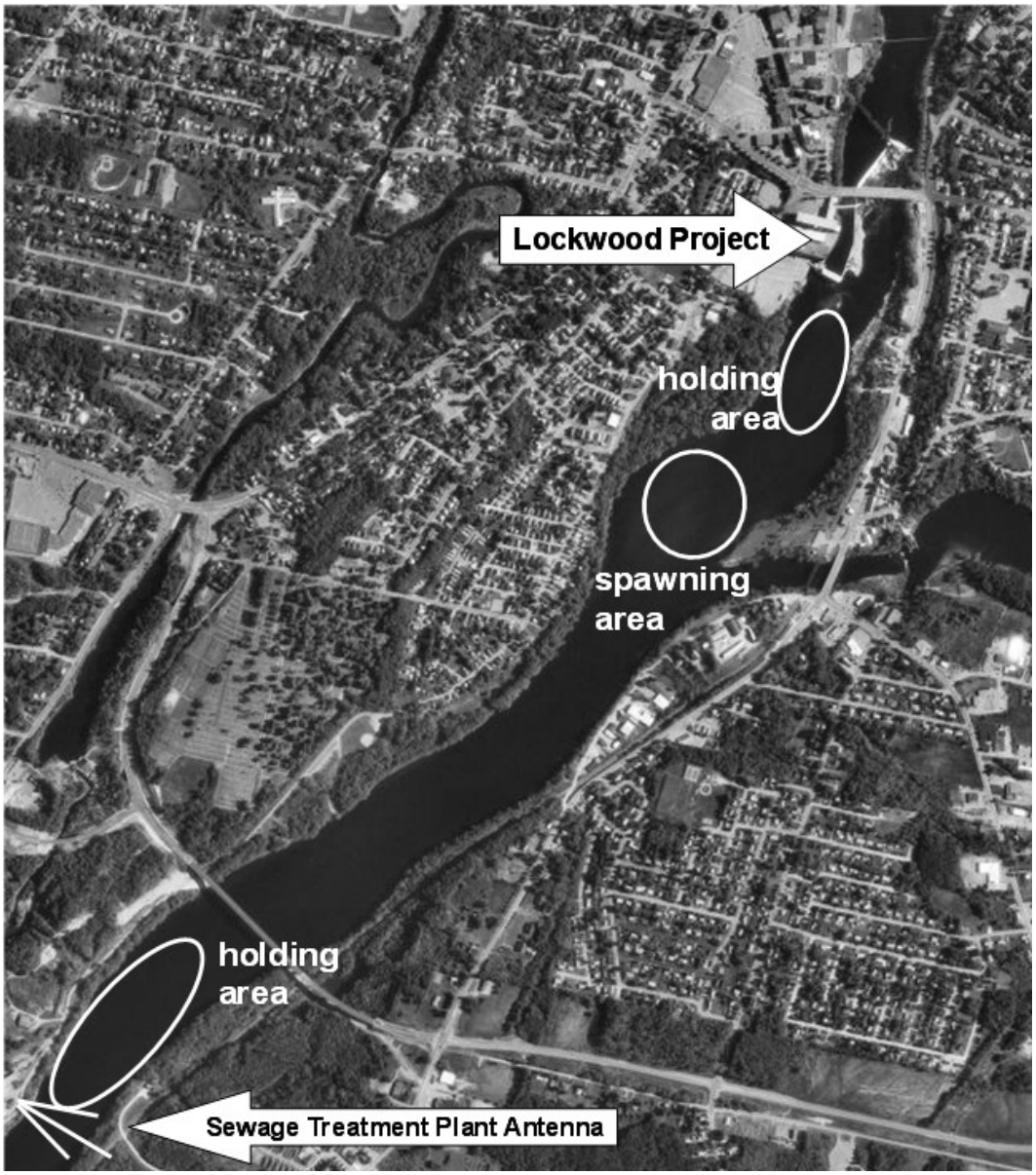


Figure 2-1 — Aerial photograph of 2.7km of the Kennebec River from the Lockwood Project downstream to the KSTD sewage treatment plant, showing the downstream antenna. Approximate holding and spawning locations described in the text are shown.

3.0 METHODS

3.1 Capture, Tagging and Release

Adult migrant shad were captured by angling from boats and from shore. Angling locations were selected based on the success of local anglers who were experienced with fishing for shad in the project area. These anglers identified two holding areas where shad could be found during the day and caught by rod and reel (approximate boundaries are shown on Figure 2-1). These anglers also described an area where spawning was presumed to occur based on shad behavior and successful angling at night (Figure 2-1). Several anglers began fishing in early June and reported their success to ASA. Up to three boats with one to two anglers in each boat were employed each day to capture study animals. Additional anglers fished from the west shore downstream of the powerhouse.

Anglers were instructed to land shad as soon as possible and cut off the leader if the fish was hooked in the throat. They transferred landed shad to a water filled cooler and immediately brought them to the shore-based tagging location. Upon reaching shore, most fish were immediately transferred to a tagging tub with anesthesia. They were quickly assessed for condition and suitability for tagging. Shad with persistent bleeding from a hooking wound, excessive scale loss, or other injuries were rejected and released. The length of acceptable shad was measured and their sex was determined by squeezing the gonads to express milt or ovarian fluid. A radio transmitter tag (Lotek model NTC-6-1, minimum tag life 63 days) was then activated and checked with a receiver to ensure proper function and identification. Shad were tagged by inserting the antennae wire into a tube and engorging the transmitter into the stomach by pushing the tube down the throat. The antennae wire was pulled from behind the posterior gill arch with a crochet hook and left trailing from the gill cover. Immediately after tagging, shad were transferred to a live car (about 0.7m depth and 3.5m diameter) in the river. The fish were monitored for one to four hours and then volitionally released just downstream of the dam. The only exception to these tagging procedures were for the shad that were tagged on 4 June, 17 July and 20 July. The first two shad tagged on 4 June were held in the fish lift holding tanks, tagged at the fish lift, and released just downstream. Shad tagged on 17 and 20 July were transferred by the anglers to the live car where they were later removed and tagged according to the normal procedure described above.

3.2 Automated Radio Frequency Monitoring

Antennae and receivers/data loggers (Lotek model SRX-400) were installed, tuned and tested from 12-19 May. Range testing and tuning of each station was done with a typical transmitter at various depths and ranges within each receiver field. This range testing determined the correct gain setting to receive signals from the desired location and depth. Actual reception depended upon relative gain (maximum 100), antenna type, antenna orientation, fish depth, and fish distance from the antenna. A total of seven stationary monitoring stations were installed at the Lockwood Dam and the Sewage Treatment Plant to monitor movements of tagged American shad. The powerhouse stations employing Yagi antennae are depicted in Figure 3-1. The stations were configured as follows:

Parameters	Coverage Description
Station 1 ID: TR-Yagi Ant: Yagi (3) Gain: 60	Monitored the tailrace using a three element Yagi antenna mounted upon the fish lift handrail. The receiver was tuned to monitor a wedge shaped area extending out to the end of the powerhouse and downstream about 180 m.
Station 2 ID: FW-Ent Ant: Underwater Gain: 10	Monitored the entrance of the fish lift using an underwater antenna placed in the fish lift just outside the V gates. The receiver was tuned to monitor *only within the fish lift.* A very low gain setting was used to ensure that shad outside the fish lift entrance were not contacted.
Station 3 ID: FW-Hopper Ant: Underwater Gain: 60	Monitored the lifting hopper of the fish lift using an underwater antenna placed inside the diffusion chamber (i.e., upstream of the hopper). Tuned to avoid contact in the fish lift entrance. A relatively high gain setting was used due to interference from the diffusion chamber grates.
Station 4 ID: TR-Dropper Ant: Underwater Gain: 60	Monitored the portion of the tailrace outside the fish lift entrance using an underwater antenna placed at the end of the retaining wall. Tuned to cover a semi-circular area approximately 25m along the shore and reaching out about 15m into the tailrace.
Station 5 ID: Bypass-Lower Ant: Yagi (3) Gain: 60	Monitored the lower portion of the bypass reach using a three element Yagi antenna mounted on the handrail at the end of the intake canal. The receiver was tuned to monitor an elliptical area extending across the river to the east shore.
Station 6 ID: Bypass-Upper Ant: Yagi (3) Gain: 60	Monitored the upper portion of the bypass reach using a three element Yagi antenna mounted on the handrail at the entrance of the intake canal. The receiver was tuned to monitor an elliptical area extending across the river below the ledges to the east shore.
Station 7 ID: Downstream Ant: Yagi (5) Gain: 85	Monitored the river at 2.7km downstream of the powerhouse using a five element Yagi antenna positioned near the roof of the Sewage Treatment Plant chlorination building. The receiver was tuned to monitor an elliptical area extending across the full width of the river.

Shad behavior and passage in and around the lift was determined by the pattern, duration, and timing of contacts. For example, repeated contacts at TR-Dropper without contact at FW-Ent could indicate that shad are unable or unwilling to enter the fish lift. Alternatively, repeated contact at TR-Yagi with intervening contacts at Downstream and no contact TR-Dropper, could indicate that a particular shad is not inclined to migrate further upstream.

Data were dumped from each of the receivers/data loggers three to six times per week to assess recent shad behavior and movement. The data were usually downloaded and reviewed upon arrival at the site. These preliminary analyses also assisted with mobile monitoring to be conducted that day. Data were stored on a lap top computer with back-up files stored on flash drives.

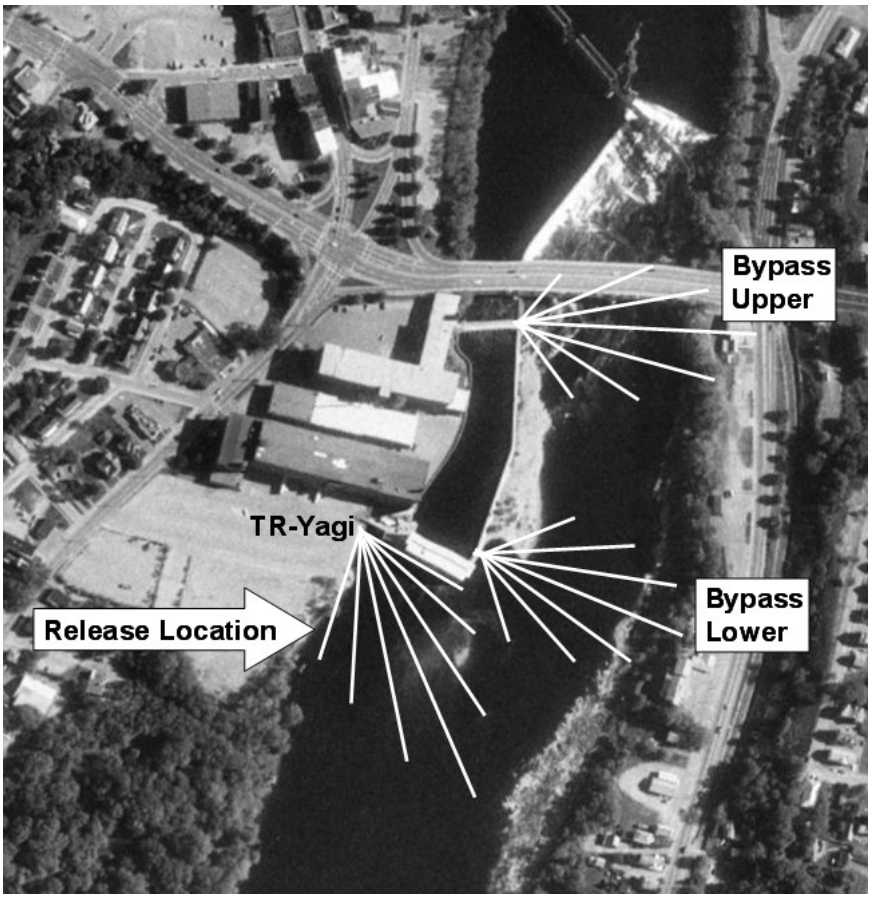


Figure 3-1 — Lockwood Project showing approximate antenna reception fields of the three data loggers with aerial Yagi antennae and the shore based tagging and release location.

ASA analyzed all data logger records and mobile contact data to make a final determination on passage and behavior. Statistics were computed including numbers of days contacted in the study area and cumulative contact time logged on each of the data loggers. Stations with aerial Yagi antenna were configured to accumulate contacts over 0.5 hour intervals. ASA reviewed data records and further accumulated contacts on each data logger to compress the records on individual tagged shad.

3.3 Mobile Radio Frequency Monitoring

Mobile monitoring was conducted daily after the first release until the study fish left the river or stopped moving. Mobile monitoring was conducted with a Lotek model SRX-400 receiver and either a hand-held directional three element Yagi antenna or a base loaded whip antennae. The whip antenna was mounted on the roof of the vehicle to make initial contacts. When tagged shad were contacted, positions were determined using the hand held Yagi antenna to triangulate the position and assess distance based on signal strength. Daily vehicle tracking was conducted on a circuit with multiple stops along 2.7km of Water Street, east over Bridge Street to Winslow, south on Bay Street, south on Lithgow Street, and finishing by crossing the Donald Carter (DC) Bridge back to Waterville. Daily monitoring by foot included the Lockwood Project tailrace, the west shore floodplain bordering Water Street, Fort Halifax Park, Waterville Boat Launch, and various additional locations along the streets listed above. Additional vehicle tracking was added to cover the Sebasitcook River to either Benton Falls Dam (two times) or to the Burnham Dam (one time). However, roads along the Sebasticook River were sometimes too far from the river to contact the transmitter tags.

Mobile monitoring by boat in the primary 2.7km long study area was conducted occasionally during the study. Boat monitoring was conducted with the Yagi and whip antennae. Boat tracking downstream to the Sidney boat launch was scheduled to be conducted weekly throughout the study. However, aerial tracking was substituted for some of the Lockwood to Sidney boat tracking in order to expand the monitoring area. Aerial tracking was conducted on 18 June and 23 July using the whip antenna mounted on a wing strut. The coverage included the Kennebec River from the Kennebec Hydro Project downstream to Merrymeeting Bay, the lower Androscoggin River to Brunswick, and the Sebasticook River to Benton Falls or Burnham.

Some transmitters stopped moving. Precise signal strength measurement and triangulation was used to determine that transmitters were actually stationary. An underwater antenna was sometimes used to assist with precise location of these tags. Fish with stationary transmitters were assigned a status

of mortality or regurgitation. Low rates of regurgitation are typical of esophogeal radio tagging and several of the stationary transmitters may have been regurgitated. Mortalities were most likely due to either predation (e.g., striped bass or eagles), recapture by anglers, post-spawning natural mortality, or stress reactions to capture and tagging.

3.4 Environmental Data Collection

ASA collected data on river flow and water temperature. Mean daily Kennebec River flow came from USGS data for the North Sidney gage (gage No. 01049265). Water temperature data came from daily data collected by the NextEra staff (1 May to 17 June) and an Onset Tidbit© temperature data logger (18 June to 6 August) that was deployed in the river just downstream of the fish lift entrance.

4.0 RESULTS

4.1 Capture, Tagging and Release

One of the volunteer anglers (Jim Thibedeau) reported catching shad in Gardiner near the mouth of Cobboseecontee Stream in late May. In the first few days of June he reported catching a few shad near Lockwood Dam and several other anglers had also begun to fish for shad in this area. ASA coordinated the efforts of several anglers beginning 4 June. Thirty American shad were tagged on 4-9 June; two the afternoon of 4 June, six on 5 June, six on 7 June, 13 on 8 June and the final three were tagged on 9 June (Table 4-1). Additional transmitter tags were purchased in July and more shad were captured and tagged shad on 17 July (five shad) and 20 July (two shad). Sex of the tagged fish was 18 males and 19 females (Table 4-1). Females had a mean fork length of 46 cm (range 41-50 cm) and males had a mean fork length of 38 cm (range 36-43 cm).

Additional shad were captured but rejected due to injuries such as, bleeding from a hooking wound, excessive scale loss, or wounds unrelated to capture. Four more shad (9.8%) were tagged but died during the holding period—the tags were removed from these fish and used later. All shad were caught on either spin casting or fly fishing gear. All but one of the shad were captured by experienced volunteer anglers. Shad used in the study were typically hooked in the jaw and landed quickly. More than half of the study fish were caught by Jim Thibedeau. Eight anglers with limited shad fishing experience caught a single shad that was used in the study. All shad except shad #7, were caught from boats in the upper holding area, about 200m downstream of the powerhouse (see Figure 2-1 for location of the holding area). Only shad #7 was caught from shore, just upstream of the shore-based tagging and release location (see Figure 3-1). Jim Thibedeau also reported catching shad about 2.5km downstream of the powerhouse at a location just downstream of the Donald Carter bridge, where he had successfully caught shad in the past. As the study progressed, shad were also reportedly caught in the evening in the shallow water near Fort Halifax Park. However, the Fort Halifax Park and Donald Carter bridge sites were not used to collect study fish due to the distance from suitable handling and tagging locations as well as the time of day these fish were typically caught.

Table 4-1 Lockwood Project American shad tagging data, 2009.

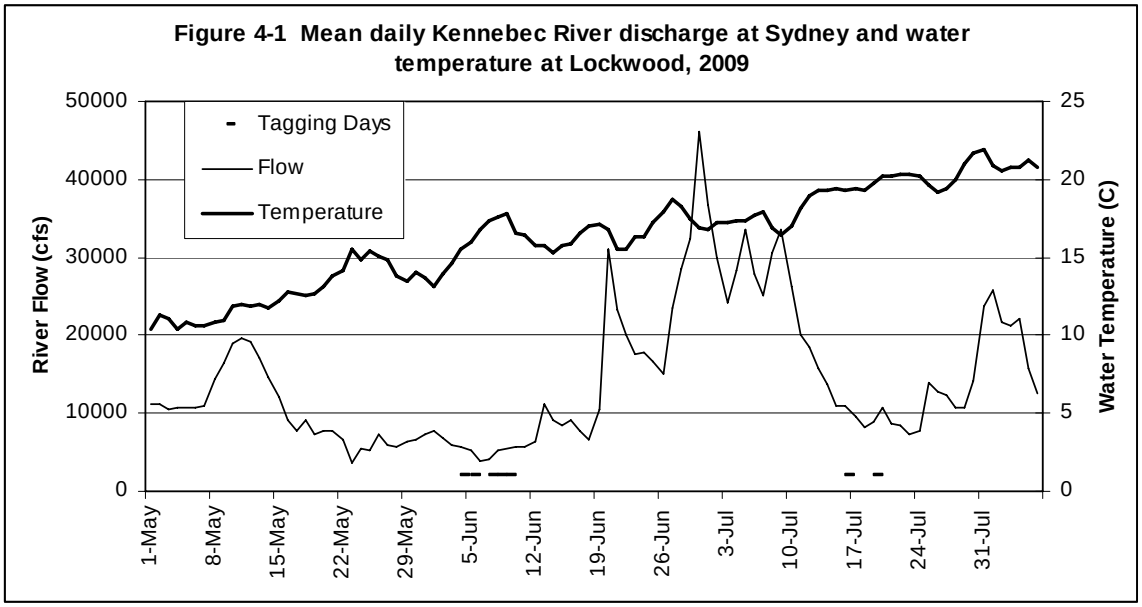
Tag No.	Time Caught	Time Tagged	Time Released	Caught by	Length (cm)	Sex	Condition Description
4 June (2 shad)							
2	1530	1610	1745	George Viles	38	M	excellent condition, presumed male
3	1630	1638	1745	Jim Thibodeau	42	F?	hooking injury right gill, bleeding stopped
5 June (6 shad)							
4	1000	1240	1530	Jim Thibodeau	50	F	excellent condition, no scale loss
5	1010	1245	1530	Willie Grenier	37	M	slight scale loss
6	1245	1255	1530	Jimmy Dunbar	37	M	scale loss on small area on left side
7	1250	1300	1530	Dick Ware	47	F	excellent condition, no scale loss
8	1308	1313	1530	Jim Thibodeau	48	F	slight bleeding, no scale loss
9	1530	1533	1650	Jim Thibodeau	38	M	excellent condition, no scale loss
7 June (6 shad)							
10	1038	1040	1315	Jim Thibodeau	47	F	excellent condition, no scale loss
11	1048	1055	1315	Jim Thibodeau	46	F	slight scale loss
12	1102	1108	1315	Jim Thibodeau	41	M	good condition
13	1215	1220	1315	Jimmy Dunbar	46	F	excellent condition, no scale loss
14	1232	1239	1555	Jim Thibodeau	37	M	slight scale loss, right side
15	1434	1440	1555	Jim Thibodeau	38	M	slight scale loss
8 June (13 shad)							
16	0813	0821	<0838	Jim Thibodeau	46	F	slight scale loss, escaped from live car
17	0838	0844	<0925	Jim Thibodeau	44	F	excellent condition, escaped from live car
18	0842	0848	1020	Jimmy Dunbar	46	F	excellent condition, no scale loss
19	1014	1025	1250	Jim Thibodeau	42	M	excellent condition, no scale loss
20	1016	1029	1250	Angie (w/D.Ware)	38	M	slight scale loss
21	1030	1035	1250	Ken Beland	43	M	excellent condition, no scale loss
22	1034	1039	1250	Jim Thibodeau	37	M	excellent condition, no scale loss
23	1122	1130	1250	Jim Thibodeau	38	M	excellent condition, no scale loss
24	1140	1150	1250	Angie (w/D.Ware)	38	M	slight scale loss
25	1258	1304	1655	Angie (w/D.Ware)	43	F	slight scale loss
26	1411	1415	1655	Jimmy Dunbar	39	M	slight scale loss
28	1527	1531	1655	Jim Thibodeau	46	F	slight scale loss
29	1540	1545	1655	Jim Thibodeau	48	F	excellent condition, no scale loss
9 June (3 shad)							
27	0818	0831	1030	Jim Thibodeau	50	F	slight scale loss
30	0919	0926	1030	Willie Grenier	43	F	slight scale loss
1	1056	1103	1230	Jim Thibodeau	41	F	excellent condition, no scale loss
17 July (5 shad)							
31	1040-1530	1520	1630	Jimmy Dunbar	37	M	slight scale loss
32	1040-1530	1529	1630	Jim Thibodeau	37	M	slight scale loss
33	1040-1530	1527	1630	Jim Thibodeau	36	M	slight scale loss, lower jaw hooking wound
34	1040-1530	1524	1630	Jimmy Dunbar	38	M	excellent condition, no scale loss
36	1040-1530	1535	1630	Jim Thibodeau	41	F?	slight scale loss, presumed F (post-spawn)
20 July (2 shad)							
37	1020-1110	1315	1438	Jimmy Dunbar	47	F	slight scale loss, presumed F (post-spawn)
38	1020-1110	1308	1438	Jimmy Dunbar	47	F	slight scale loss, presumed F (post-spawn)

All shad were delivered to the shore-based tagging and release location within minutes of capture. Most shad were immediately transferred to an anesthetic bath, although the 4 June and 17 & 20 July shad were initially held about 1-2 hours before tagging. Shad were assessed for injuries and condition and suitable fish were radio tagged according to the procedures described in section 3.1. After tagging, shad were immediately transferred to the live car where they were held for a median of 110 minutes (range 55-231 minutes) before being volitionally released. Shad #16 and #17 escaped from the live car before the end of the holding period.

4.2 Environmental Conditions

The first 30 shad were caught and tagged at mean river flow of 140 m^3/s (4,940 cfs) with a range of 112-162 m^3/s (3,950-5,720 cfs, Figure 4-1). The water temperature increased from 15.5 °C on 4 June to 17.8 °C on 9 June, consistent with the onset of spawning activity. On 13 June, the river flow more than doubled to 320 m^3/s (11,300 cfs) in response to heavy rains. Heavy rains continued and by 20 June the flow reached 881 m^3/s (31,110 cfs) and then 1,308 m^3/s (46,200 cfs) on 30 June. Water temperatures fluctuated but generally rose during this period (Figure 4-1). Although the river discharge dropped in late July, it did not return to the levels seen in early June. Tagging in late July was at a mean river discharge of 288 m^3/s (10,170 cfs) and mean temperature of 19.8 °C (Figure 4-1).

Figure 4-1 Mean daily Kennebec River discharge at Sydney and water temperature at Lockwood, 2009



4.3 Fish lift and Bypass Reach Movements

Shad #13 and shad #29 (6.7% of the pre-spawn study fish) approached the fish lift entrance (Table 4-2 and Appendix 1). Shad #29 was near the fish lift, where it was logged on the TR-Dropper data logger, three times on 9 June, the day after it was released. It was logged just after dawn at 04:46 for 1.5 minutes, again at dusk when it approached for about nine minutes at 19:28, and for about eight minutes at 20:41 (Appendix 1). It then left the tailrace but returned at 03:46 the next morning, 10 June. Fish #29 approached the fish lift at 20:01 that evening and entered the fish lift six minutes later. Three minutes later, it moved into the hopper where it stayed for 59 minutes then left through the V-gates returning to the entrance and immediately leaving the fish lift. It left the TR-Dropper reception field about six minutes later. Fish #29 stopped moving the day after leaving the fish lift. It remained about 50m southeast of the fish lift entrance for the duration of the study. It may have regurgitated the transmitter, been killed by predators (e.g., striped bass), or died from the stress of capture and handling. Fish #13 was near the fish lift entrance twice on 8 June (one day after release), for 30 seconds at 18:30 and then 131 seconds at 18:57. It then moved away from the area outside the fish lift entrance and left the tailrace at 22:19. However, fish #13 returned to the tailrace repeatedly through 19 June, after which it spent more time at the downstream holding area (Appendix 1). Fish #13 left the study area near dawn on 27 June during high flows. Although fish #25 was also near the fish lift entrance, this behavior was discounted since it was brief (82 seconds), and it occurred just minutes after it was released from the live car located just downstream of the fish lift entrance (Appendix 1).

Four shad (13% of the 30 pre-spawn shad) were contacted near the downstream end of the bypass reach (Table 4-2 and Appendix 1). Fishes #5 and #26 moved further up the bypass where they were contacted on the upper bypass data logger for a total of 1.46 and 1.20 hours, respectively (Table 4-2). Fish #5 was contacted repeatedly in the tailrace and upper holding area during daylight hours for 16 days, through 20 June when it left the study area. Fish #5 entered the bypass reach on the afternoon of 13 June, about midway through the period of contact in the study area (Appendix 1). Fish #26 was active throughout the 2.7km study area for 18 days. During this time, it frequented both the upstream and downstream holding areas (Appendix 1). It entered the bypass reach the afternoon of 23 June and then ceased movement upstream of the Donald Carter bridge on 25 June. It is most likely that it was killed by predators such as striped bass or regurgitated the transmitter. It is unlikely that the stress of capture and handling resulted in a mortality 18 days after release.

Table 4-2 Days in the study area and cumulative hours logged on data loggers.

		Total Hours of Contact on Data Loggers					
Tag No.	Days in Study Area[1]	Tailrace[2]	Fishway Approach	Fishway	Lower Bypass	Upper Bypass	Downstream
1	7	5.3	0	0	0	0	32.36
2	6	5.3	0	0	0	0	no data[4]
3	7	14.2	0	0	0	0	no data[4]
4	33	30.1	0	0	0	0	26.95
5	16	87.0	0	0	1.39	1.46	0.06
6	20	151.4	0	0	0.03	0	0.66
7	3-5	5.5	0	0	0	0	no data[4]
8	8	37.9	0	0	0	0	0.25
9	5	11.1	0	0	0	0	0
10	7	3.6	0	0	0	0	0.47
11	2	2.6	0	0	0	0	no data[4]
12	22	103.1	0	0	0	0	0.06
13	21	55.2	0.04	0	0.03	0	29.79
14	2	1.4	0	0	0	0	no data[4]
15	2	1.2	0	0	0	0	no data[4]
16	6	1.3	0	0	0	0	0.34
17	5	40.9	0	0	0	0	0.19
18	8	62.5	0	0	0	0	0.14
19	5	3.1	0	0	0	0	0.40
20	12	3.2	0	0	0	0	5.98
21	4	2.4	0	0	0	0	no data[4]
22	2	16.0	0	0	0	0	no data[4]
23	10	2.3	0	0	0	0	0.51
24	2	6.4	0	0	0	0	no data[4]
25	5	27.4	0.02	0	0	0	0.09
26	18	6.8	0	0	0.02	1.20	40.89
27	10	11.9	0	0	0	0	69.83
28	4	6.6	0	0	0	0	no data[4]
29	4	1418.9	1.59	1.07 [3]	0	0	0
30	4	48.1	0	0	0	0	0.08
31	1	1.6	0	0	0	0	0.09
32	2	2.3	0	0	0	0	299.17
33	13	1.0	0	0	0	0	0.04
34	3	5.8	0	0	0	0	16.80
36	4	1.3	0	0	0	0	0.13
37	3	3.4	0	0	0	0	0.06
38	9	1.8	0	0	0	0	34.77

Notes:
1. Number of days shad were active between the Lockwood Project and the downstream data logger.
2. Includes 1-4 hours logged on the tailrace data logger during holding/recovery in the live car.
3. Includes cumulative hours logged on the data loggers monitoring the the fishway entrance and hopper.
4. No data recorded from 6-June 14:00 to 11-June 16:00 due to power loss.
5. See Appendix 1 for data logger and mobile tracking details for each tagged shad.

4.4 General Shad Behavior

The first 30 shad were captured and tagged from 4-9 June during a period of increasing water temperature and moderate flow. The mean daily water temperature began to drop on 10 June and flows increased beginning 12 June with frequent rain storms and high flows from mid-June through mid-July. Within five days of tagging, 13 of the 37 tagged shad left the river (Table 4-3). Most of these initial downstream movements occurred before the beginning of the high flows. Another 15 tagged shad left the Kennebec River coincident with the high flows (Table 4-3). The downstream movement of these 15 shad coincided with unusually high flows that persisted through late June and most of July—the flow on 30 June exceeded 1,300 m^3/s (46,000 cfs), a discharge that is more typical of spring runoff than late June. These high flows were accompanied by very turbid water which may have contributed to shad emigration from the river. Aerial tracking to Merrymeeting Bay demonstrated that these fish left the river and were not holding at a downstream location. Four of these shad subsequently returned to the study area after absences of 5 to 11 days (Table 4-3). The seven shad tagged in late July behaved in a similar manner—with two exceptions, they left the river soon after tagging. However, it appeared that these shad had already spawned prior to capture which may account for leaving the river.

Table 4-3 Common behaviors exhibited by radio tagged American shad, Kennebc River, 2009.

Behavior Description	No. of Shad	Tag Numbers
Left study area during high flows	15	1, 4, 5, 6, 8, 10, 12, 13, 16, 18, 20, 23, 25, 27, 33
Left Kennebec less than 5 days after tagging	13	7, 11, 14, 15, 19, 21, 24, 28, 30, 31, 34, 36, 37
Returned after absence (no. of days)	4	4 (5 days), 8 (6 days), 10 (11 days), 25 (5 days)
Regurgitation, predated or tagging mortality (days post tagging that movement stopped)	5	9 (6 days), 22 (5 days), 26 (18 days), 29 (3 days), 32 (1 day)
Long periods of contact in:		
Upper holding area	16	2, 3, 5, 6, 8, 12, 17-19, 25, 29, 30, 33, 34, 36, 37
Lower holding area	6	1, 10, 20, 23, 32, 38
Events in both holding areas	4	4, 13, 26, 27

Most of the tagged shad that remained in the study area for more than a few days exhibited consistent movement patterns. As described earlier, several of the volunteer anglers reported that shad could be caught at one of two areas—several hundred meters downstream of the tailrace where all but one of the study fish were caught, and downstream of the Donald Carter bridge. They also reported spawning behavior at night in shallow water near the Fort Halifax Park. Twenty of the study animals were

found during daylight in the holding area just downstream of the tailrace where they were often contacted by the tailrace data logger (Table 4-3). They typically arrived in this area near dawn, held throughout the day, and left near dusk, presumably to return to the spawning area near Fort Halifax Park. The area downstream of the Donald Carter bridge provided a similar daylight refuge, although some of the ten tagged shad found here stayed throughout the night as well. In addition, four tagged shad spent periods of time in both of the two holding areas (Table 4-3).

Five transmitters ceased movement (Table 4-3). This could be due to either regurgitating the transmitter or mortality. Mortalities could have occurred as a result of predation, stress reactions (i.e., elevated cortisol and/or lactic acid from capture, handling and tagging), recapture by anglers, natural mortality after spawning, or other unknown causes. Past experience with radio telemetry studies indicates that regurgitation and tagging related mortalities are most likely to occur within a few days of release. Shad #32 stopped moving one day after release at the downstream holding area. Shad #29 stopped moving three days after release near the fish lift. Shad #22 stopped moving after five days (possibly less) at a location about 6km downstream of the project. All three of these stationary transmitters could be explained by regurgitation or mortality from tagging-related stress although other causes cannot be ruled out. Shad #9 stopped moving at the spawning area after six days and shad #26 stopped moving near the Donald Carter bridge after 18 days of activity. Given the time frame, it is unlikely that these two shad stopped moving as a result of regurgitation or tagging-related stress.

5.0 CONCLUSIONS

The data show that very few shad approached the project and attempted to move upstream through either the fish lift or the bypass reach. Only a few shad approached the powerhouse or the bypass reach. Fish #29 approached the fish lift several times and appeared to find and enter the fish lift without difficulty, however, it was not lifted since fish lift operations were finished for the day. This fish ceased movement near the entrance of the fish lift shortly after leaving the fish lift. Large striped bass are commonly present in this area and it may have been predated. Fishes #5, #13 and #26 were all very active throughout the study area for two to three weeks. During this time, #13 briefly approached both the fish lift and the bypass reach while #5 and #26 each entered the bypass reach for about 1.5 hours. These fish demonstrated the type of seeking behavior that is consistent with active upstream migratory behavior. No other shad moved upstream to the project tailrace or bypass.

Instead of approaching the Lockwood project, many of the tagged shad took up station in certain locations where they generally held during the day and then moved to different locations at night. The most common behavior was to hold in an area several hundred meters downstream of the powerhouse during the day and move downstream from this area at night…apparently moving a short distance downstream to the spawning area near Fort Halifax Park where the volunteer anglers reported nightly spawning behavior.

Many of the study fish left the river and were not found again. Only shad #22 was stationary at a downstream location. A few of the study fish were found in Gardiner or Richmond as they departed the river. Four shad subsequently returned to the study area after absences of five to 11 days. Since most of the shad that moved downstream were not found again, it is likely that they returned to the marine environments where radio frequency signals cannot be propagated from the saline water. Most of the shad that left the river did so during high flows…flows that increased by an order of magnitude in the three weeks after tagging. Heavy rains and high river discharge was the overriding environmental influence from mid-June through the end of the study. It is possible that either the high river discharge itself, or the turbidity created by heavy rains, caused most of the study fish to abandon their spawning migration and return to the ocean. Nearly half of these departures were less than five days after tagging and thus, their downstream movement could also be related to recovery from the stress of capture, handling and tagging.

6.0 FUTURE PLANS

NextEra Energy plans to continue consultation with resource agencies on the results of the radio telemetry study, determine what conclusions can be drawn from the study, and then come to consensus regarding the implications of the results.

APPENDIX A – Summary of radio tagged American shad movements, disposition, data logger contacts and mobile contacts.

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
1	TR-Yagi	9-Jun 11:02:19	9-Jun 12:32:30	1:30:11	Data logger--tailrace	tagging, holding, post-release
1	Mobile	9-Jun 13:00			tailrace area	lots of tagged shad in tailrace
1	Mobile	10-Jun 12:30			2.5km from powerhouse	from bridge
1	Mobile	11-Jun 13:30			2.6km S of powerhouse	
1	Downstream	12-Jun 12:50:31	13-Jun 18:40:47	29:50:16	Data logger--at 2.7km downstream	
1	Mobile	12-Jun 13:00			2.6km S of powerhouse	
1	Mobile	13-Jun 10:20			2.6km S of powerhouse	boat tracking
1	Mobile	14-Jun 17:20			2.5km from powerhouse	
1	Downstream	14-Jun 21:21:47	14-Jun 23:52:50	2:31:03	Data logger--at 2.7km downstream	during darkness
1	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
1	Summary	This fish moved downstream to the lower holding area where it was detected the next five days. It moved back downstream after the first flow increase and was not detected again.				
2	TR-Yagi	4-Jun 16:11:13	4-Jun 17:59:07	1:47:54	Data logger--tailrace	tagging, holding, post-release
2	TR-Yagi	5-Jun 4:00:46	5-Jun 4:12:07	0:11:21	Data logger--tailrace	
2	Mobile	5-Jun 16:00			upper holding area	
2	TR-Yagi	6-Jun 17:00:47	6-Jun 18:14:00	1:13:13	Data logger--tailrace	
2	TR-Yagi	7-Jun 8:22:18	7-Jun 9:35:16	1:12:58	Data logger--tailrace	
2	Mobile	7-Jun 11:50			Near Winslow shore	
2	TR-Yagi	7-Jun 13:34:22	7-Jun 14:27:28	0:53:06	Data logger—tailrace	
2	Mobile	8-Jun 11:10			Capture area, ~200m from powerhouse	
2	TR-Yagi	8-Jun 14:54:27	8-Jun 14:55:06	0:00:39	Data logger—tailrace	
2	Mobile	9-Jun 13:00			tailrace area	lots of tagged shad in tailrace
2	Downstream	9-11 June			passed during loss of power	
2	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
2	Summary	This fish was contacted in the tailrace and upper holding area for five days. It was not detected after 9 June at 13:00 and probably moved back downstream the night of 9 June (the Downstream logger was not operating due to power loss) before the first high flow event.				
3	TR-Yagi	4-Jun 16:38:26	4-Jun 19:05:25	2:26:59	Data logger--tailrace	tagging, holding, post-release
3	TR-Yagi	6-Jun 12:17:42	6-Jun 16:30:38	4:12:56	Data logger--tailrace	
3	TR-Yagi	6-Jun 18:23:39	6-Jun 19:21:24	0:57:45	Data logger--tailrace	

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
3	Mobile	7-Jun 11:50			tailrace area	
3	TR-Yagi	7-Jun 13:20:06	7-Jun 18:29:00	5:08:54	Data logger--tailrace	
3	Mobile	7-Jun 16:15			About 300m from powerhouse	
3	TR-Yagi	8-Jun 8:30:46	8-Jun 9:57:42	1:26:56	Data logger--tailrace	
3	Mobile	8-Jun 11:10			Capture area, ~200m from powerhouse	
3	Mobile	9-Jun 13:30			300m S of powerhouse	from park
3	Downstream	9-11 June			passed during loss of power	
3	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
3	Summary	This fish was contacted in the tailrace and upper holding area for five days. It was not detected after 9 June at 13:30 and probably moved back downstream the night of 9 June (the Downstream logger was not operating due to power loss) before the first high flow event.				
4	TR-Yagi	5-Jun 12:43:41	5-Jun 19:13:22	6:29:41	Data logger--tailrace	tagging, holding, post-release
4	TR-Yagi	7-Jun 10:03:18	7-Jun 10:22:12	0:18:54	Data logger--tailrace	
4	Mobile	8-Jun 13:40			800m S of powerhouse	near Sebasticook junction
4	Mobile	9-Jun 13:00			tailrace area	lots of tagged shad in tailrace
4	TR-Yagi	10-Jun 8:00:49	10-Jun 10:41:55	2:41:06	Data logger--tailrace	
4	Mobile	11-Jun 13:30			tailrace area	from NAPA
4	TR-Yagi	11-Jun 15:41:25	11-Jun 16:20:27	0:39:02	Data logger--tailrace	
4	Mobile	12-Jun 15:30			Capture area, ~200m from powerhouse	
4	TR-Yagi	12-Jun 15:58:38	12-Jun 18:19:13	2:20:35	Data logger--tailrace	
4	Mobile	13-Jun 10:10			Near Fort Halifax Park	boat tracking
4	TR-Yagi	14-Jun 10:23:41	14-Jun 13:28:47	3:05:06	Data logger--tailrace	
4	Mobile	14-Jun 16:15			tailrace area	
4	TR-Yagi	15-Jun 6:00:54	15-Jun 14:08:23	8:07:29	Data logger--tailrace	
4	Mobile	15-Jun 9:00			tailrace area	FW, NAPA and FHP
4	TR-Yagi	16-Jun 5:59:26	16-Jun 12:22:46	6:23:20	Data logger--tailrace	
4	Mobile	16-Jun 14:25			Near Fort Halifax Park	also from west shore woods
4	Mobile	17-Jun 11:15			Near Fort Halifax Park	strong at FHP
4	Mobile	18-Jun 11:15			Near Fort Halifax Park	strong at FHP (ground only)
4	Mobile	19-Jun 13:15			tailrace area	
4	Mobile	21-Jun 9:25			2.3km from powerhouse	strong at DC, also on water street
4	Downstream	21-Jun 20:49:17	21-Jun 21:20:13	0:30:56	Data logger--at 2.7km downstream	during darkness

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
4	Downstream	22-Jun 5:20:30	22-Jun 10:03:40	4:43:10	Data logger--at 2.7km downstream	
4	Downstream	22-Jun 12:25:19	22-Jun 16:36:11	4:10:52	Data logger--at 2.7km downstream	
4	Downstream	22-Jun 13:58:46	22-Jun 16:36:11	2:37:25	Data logger--at 2.7km downstream	
4	Downstream	22-Jun 19:42:20	23-Jun 1:40:07	5:57:47	Data logger--at 2.7km downstream	during darkness
4	Mobile	23-27 June			No contact for 5 days	moved back downstream
4	Downstream	28-Jun 6:32:18	28-Jun 6:44:03	0:11:45	Data logger--at 2.7km downstream	
4	TR-Yagi	28-Jun 9:33:42	28-Jun 9:33:54	0:00:12	Data logger--tailrace	
4	Downstream	29-Jun 21:24:51	29-Jun 21:37:57	0:13:06	Data logger--at 2.7km downstream	during darkness
4	Downstream	1-Jul 12:13:28	1-Jul 12:39:01	0:25:33	Data logger--at 2.7km downstream	
4	Downstream	1-Jul 20:20:42	2-Jul 4:20:55	8:00:13	Data logger--at 2.7km downstream	during darkness
4	Mobile	13-Jul 16:25			FHP	no tracking from 1-12 July
4	Mobile	17-Jul 10:10			north end of FHP	
4	Mobile	18-Jul 14:10			FHP/mid-river	
4	Mobile	20-Jul 11:00			N end of FHP, ~1/3 from east side	by boat
4	Downstream	20-Jul 22:40:02	20-Jul 22:45:58	0:05:56	Data logger--at 2.7km downstream	during darkness
4	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
4	Summary	For the first 11 days, this fish moved between the tailrace and the upper holding area. It was detected in the spawning area for the next four days, then the downstream holding area for 2 days, then returned downstream for 5 days returning on 28 June. Most contacts over the next three weeks were in the spawning area with no approaches to the tailrace.				
5	TR-Yagi	5-Jun 12:46:43	5-Jun 18:42:52	5:56:09	Data logger--tailrace	tagging, holding, post-release
5	TR-Yagi	6-Jun 8:09:37	6-Jun 17:44:50	9:35:13	Data logger--tailrace	
5	TR-Yagi	7-Jun 6:25:33	7-Jun 14:30:58	8:05:25	Data logger--tailrace	
5	Mobile	7-Jun 16:15			within 0.25 miles of TR	also some 255
5	TR-Yagi	8-Jun 7:59:34	8-Jun 16:19:36	8:20:02	Data logger--tailrace	
5	Mobile	8-Jun 11:10			Capture area, ~200m from powerhouse	
5	Mobile	9-Jun 13:30			300m S of powerhouse	from park
5	TR-Yagi	10-Jun 8:46:37	10-Jun 8:59:53	0:13:16	Data logger--tailrace	
5	TR-Yagi	11-Jun 10:09:19	11-Jun 10:44:47	0:35:28	Data logger--tailrace	
5	Mobile	11-Jun 15:30			Near Fort Halifax Park	
5	Mobile	12-Jun 14:45			Near Fort Halifax Park	
5	TR-Yagi	13-Jun 8:44:22	13-Jun 9:06:00	0:21:38	Data logger--tailrace	

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
5	Mobile	13-Jun 10:05			Capture area, ~200m from powerhouse	boat tracking
5	TR-Yagi	13-Jun 11:09:36	13-Jun 13:46:43	2:37:07	Data logger--tailrace	
5	Bypass-Down	13-Jun 14:34:54	13-Jun 15:55:23	1:20:29	Bypass data logger--east of powerhouse	
5	Bypass-Up	13-Jun 14:41:07	13-Jun 16:08:43	1:27:36	Bypass data logger--downstream of spillway	
5	Bypass-Down	13-Jun 16:10:37	13-Jun 16:13:23	0:02:46	Bypass data logger--east of powerhouse	
5	TR-Yagi	13-Jun 16:17:32	13-Jun 18:13:44	1:56:12	Data logger--tailrace	
5	Mobile	14-Jun 16:55			Capture area, ~200m from powerhouse	strongest at FHP
5	TR-Yagi	15-Jun 6:33:57	15-Jun 19:18:09	12:44:12	Data logger--tailrace	
5	Mobile	15-Jun 9:00			tailrace area	very strong FW, NAPA and FHP
5	TR-Yagi	16-Jun 5:14:24	16-Jun 19:04:39	13:50:15	Data logger--tailrace	
5	Mobile	16-Jun 13:55			tailrace area	
5	TR-Yagi	17-Jun 4:49:01	17-Jun 18:57:05	14:08:04	Data logger--tailrace	
5	Mobile	17-Jun 11:15			Capture area, ~200m from powerhouse	strong at FHP
5	TR-Yagi	18-Jun 4:16:12	18-Jun 12:51:21	8:35:09	Data logger--tailrace	
5	Mobile	18-Jun 11:15			Capture area, ~200m from powerhouse	strong at FHP
5	Mobile	19-Jun 13:15			Capture area, ~200m from powerhouse	weak from TR
5	Downstream	20-Jun 4:11:52	20-Jun 4:15:21	0:03:29	Data logger--at 2.7km downstream	during darkness
5	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
5	Summary	For two weeks, this fish moved between the tailrace, the upper holding area, and the spawning area. It was one of two fish to briefly enter the bypass reach. It moved back downstream on 20 June when flows increased rapidly to 881 cms (31,100 cfs).				
6	TR-Yagi	5-Jun 13:04:26	5-Jun 15:22:01	2:17:35	Data logger--tailrace	tagging, holding, post-release
6	TR-Yagi	5-Jun 17:55:43	5-Jun 20:18:08	2:22:25	Data logger--tailrace	evening in tailrace
6	TR-Yagi	6-Jun 8:44:25	6-Jun 19:29:30	10:45:05	Data logger--tailrace	all day in tailrace
6	TR-Yagi	7-Jun 6:48:46	7-Jun 11:05:35	4:16:49	Data logger--tailrace	morning in tailrace
6	Mobile	7-Jun 11:50			Capture area, ~200m from powerhouse	
6	TR-Yagi	7-Jun 14:32:02	7-Jun 14:43:48	0:11:46	Data logger--tailrace	
6	TR-Yagi	8-Jun 5:50:09	8-Jun 20:40:37	14:50:28	Data logger--tailrace	
6	Mobile	8-Jun 11:10			Capture area, ~200m from powerhouse	
6	TR-Yagi	9-Jun 4:02:41	9-Jun 9:59:39	5:56:58	Data logger--tailrace	
6	Mobile	9-Jun 13:00			East side, downstream of bypass reach	from both sides of river
6	TR-Yagi	9-Jun 15:43:30	9-Jun 20:21:09	4:37:39	Data logger--tailrace	

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
6	TR-Yagi	10-Jun 5:31:27	10-Jun 20:02:29	14:31:02	Data logger--tailrace	
6	Mobile	10-Jun 15:00			tailrace area	from two locations, lots of tags
6	TR-Yagi	11-Jun 14:32:00	11-Jun 22:19:00	7:47:00	Data logger--tailrace	
6	Mobile	11-Jun 15:30			Capture area, ~200m from powerhouse	from FHP and NAPA
6	TR-Yagi	12-Jun 7:15:32	12-Jun 20:13:57	12:58:25	Data logger--tailrace	
6	Mobile	12-Jun 15:30			Capture area, ~200m from powerhouse	very strong, multiple contacts
6	TR-Yagi	13-Jun 5:35:31	13-Jun 18:49:26	13:13:55	Data logger--tailrace	
6	Mobile	13-Jun 10:05			tailrace area	boat tracking
6	TR-Yagi	14-Jun 5:33:51	14-Jun 18:55:54	13:22:03	Data logger--tailrace	
6	Mobile	14-Jun 16:15			tailrace area	
6	TR-Yagi	15-Jun 5:16:41	15-Jun 18:47:43	13:31:02	Data logger--tailrace	
6	Bypass-Down	15-Jun 8:55:23	15-Jun 8:56:32	0:01:09	Bypass data logger--east of powerhouse	also logged on TR-Yagi
6	Mobile	15-Jun 9:00			tailrace area	dam, NAPA and FHP
6	Bypass-Down	15-Jun 10:54:23	15-Jun 10:55:12	0:00:49	Bypass data logger--east of powerhouse	also logged on TR-Yagi
6	TR-Yagi	16-Jun 5:41:38	16-Jun 18:43:51	13:02:13	Data logger--tailrace	
6	Mobile	16-Jun 13:55			tailrace area	
6	TR-Yagi	17-Jun 5:34:48	17-Jun 18:37:35	13:02:47	Data logger--tailrace	
6	Mobile	17-Jun 13:30			tailrace area	
6	TR-Yagi	18-Jun 4:58:34	18-Jun 9:34:45	4:36:11	Data logger--tailrace	
6	Mobile	18-Jun 11:15			tailrace area	flight & ground
6	Mobile	19-Jun 13:30			150m S of powerhouse	strong signal
6	Downstream	19-Jun 20:54:30	19-Jun 21:01:55	0:07:25	Data logger--at 2.7km downstream	during darkness
6	Downstream	21-Jun 18:52:54	21-Jun 19:21:40	0:28:46	Data logger--at 2.7km downstream	
6	Mobile	23-Jun 11:00			spawning area	
6	Downstream	24-Jun 1:40:30	24-Jun 1:43:47	0:03:17	Data logger--at 2.7km downstream	during darkness
6	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
6	Summary	For two weeks, this fish moved between the tailrace and the upper holding area. With the onset of high flows, movement extended to the downstream holding area for several days. It moved back downstream on 24 June during high flows.				
7	TR-Yagi	5-Jun 12:57:35	5-Jun 16:17:56	3:20:21	Data logger--tailrace	tagging, holding, post-release
7	TR-Yagi	5-Jun 18:59:52	5-Jun 19:14:56	0:15:04	Data logger--tailrace	
7	TR-Yagi	5-Jun 21:08:07	5-Jun 23:03:41	1:55:34	Data logger--tailrace	

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
7	Mobile	8-Jun 16:00			300m S of powerhouse	
7	Downstream	8-Jun?			passed during loss of power	
7	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
7	Summary	This fish was detected in the tailrace and upper holding area for several days after tagging. It was not found after 16:00 on 8 June and probably moved back downstream that night.				
8	TR-Yagi	5-Jun 13:17:08	5-Jun 16:45:02	3:27:54	Data logger--tailrace	tagging, holding, post-release
8	Mobile	5-Jun 16:00			tailrace area	
8	TR-Yagi	6-Jun 8:14:10	6-Jun 15:42:33	7:28:23	Data logger--tailrace	
8	TR-Yagi	6-Jun 16:52:29	6-Jun 20:44:08	3:51:39	Data logger--tailrace	
8	TR-Yagi	7-Jun 9:01:49	8-Jun 0:07:42	15:05:53	Data logger--tailrace	
8	Mobile	7-Jun 11:50			tailrace area	
8	Mobile	7-Jun 16:15			within 0.25 miles of TR	also some 255
8	TR-Yagi	8-Jun 6:45:15	8-Jun 10:02:52	3:17:37	Data logger--tailrace	
8	Mobile	8-Jun 11:10			Capture area, ~200m from powerhouse	
8	TR-Yagi	8-Jun 16:04:14	8-Jun 16:14:27	0:10:13	Data logger--tailrace	
8	TR-Yagi	9-Jun 8:26:12	9-Jun 8:48:36	0:22:24	Data logger--tailrace	
8	Mobile	9-Jun 14:05			300m S of powerhouse	from Water St. stairs
8	TR-Yagi	10-Jun 9:24:06	10-Jun 11:00:48	1:36:42	Data logger--tailrace	
8	TR-Yagi	11-Jun 13:04:53	11-Jun 13:43:00	0:38:07	Data logger--tailrace	
8	Mobile	11-Jun 15:30			Near Fort Halifax Park	triangulated from multiple stations
8	TR-Yagi	11-Jun 21:32:57	11-Jun 23:28:30	1:55:33	Data logger--tailrace	
8	Mobile	12-17 June			No contact for 6 days	may be in Sebasticook River
8	Downstream	17-Jun 19:06:46	17-Jun 19:21:48	0:15:02	Data logger--at 2.7km downstream	
8	Mobile	18-Jun 11:50			~1km N of Richmond bridge	flight only, 53km in 16.5 hours
8	Disposition				Departed study area, 1 downriver contact	
8	Summary	For six days, this fish moved between the tailrace and the upper holding area. It was not found for the next six days and may have been in the Sebasticook River. It left the study area on 17 June at 19:21 and was found 51km downstream 16.5 hours later.				
9	TR-Yagi	5-Jun 15:44:54	5-Jun 17:27:00	1:42:06	Data logger--tailrace	tagging, holding, post-release
9	TR-Yagi	6-Jun 8:06:14	6-Jun 17:32:40	9:26:26	Data logger--tailrace	
9	Mobile	7-Jun 16:15			about 300m S of powerhouse	
9	Mobile	8-Jun 11:10			Capture area, ~300m from powerhouse	

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
9	Mobile	9-Jun 14:05			300m S of powerhouse	from Water St. stairs
9	Mobile	11-Jun 15:30	6-Aug 8:50		Near Fort Halifax Park (~400m S PH)	stationary
9	Disposition				Stationary (regurgitation or mortality)	
9	Summary	This fish was found in the tailrace the day after tagging. It was found in the upper holding area the next three days and in the spawning area the next day. It did not move after 11 June.				
10	TR-Yagi	7-Jun 10:39:23	7-Jun 14:15:08	3:35:45	Data logger--tailrace	tagging, holding, post-release
10	Mobile	8-Jun 14:05			2.6km from powerhouse	
10	Mobile	9-Jun 14:25			2.5km from powerhouse	upstream from previous
10	Mobile	10-Jun 12:30			~2.5km from powerhouse	from DC bridge
10	Mobile	11-Jun 14:25			1.9km S of powerhouse	
10	Downstream	11-Jun			passed during loss of power	
10	Mobile	12-22 June			No contact for 11 days	including aerial & boat tracking
10	Downstream	23-Jun 0:11:17	23-Jun 0:36:52	0:25:35	Data logger--at 2.7km downstream	darkness, absent since 11 June
10	Mobile	23-Jun 12:53			1km from powerhouse (Lithgow St.)	absent since 11 June
10	Downstream	24-Jun 2:29:52	24-Jun 2:32:12	0:02:20	Data logger--at 2.7km downstream	during darkness
10	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
10	Summary	This fish was found at the downstream holding area for four days after tagging. It went back downstream (beyond Merrymeeting Bay) for 11 days and returned to the study area on 23 June. It went back downstream 26 hours later and was not found again.				
11	TR-Yagi	7-Jun 10:58:15	7-Jun 13:16:22	2:18:07	Data logger--tailrace	tagging, holding, post-release
11	TR-Yagi	7-Jun 16:32:16	7-Jun 16:47:14	0:14:58	Data logger--tailrace	
11	Mobile	8-Jun 16:00			300m S of powerhouse	
11	Downstream	8-Jun?			passed during loss of power	
11	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
11	Summary	This fish was found in the upper holding area the day after tagging. It was not found after 16:00 on 8 June and probably moved back downstream that night.				
12	TR-Yagi	7-Jun 11:08:10	7-Jun 14:37:40	3:29:30	Data logger--tailrace	tagging, holding, post-release
12	TR-Yagi	8-Jun 7:59:14	8-Jun 19:41:52	11:42:38	Data logger--tailrace	
12	Mobile	8-Jun 11:10			Capture area, ~200m from powerhouse	
12	TR-Yagi	9-Jun 5:55:39	9-Jun 12:36:47	6:41:08	Data logger--tailrace	
12	Mobile	9-Jun 13:00			Capture area, ~200m from powerhouse	from TR and park
12	TR-Yagi	9-Jun 14:46:25	9-Jun 17:44:11	2:57:46	Data logger--tailrace	

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
12	TR-Yagi	10-Jun 7:11:15	10-Jun 15:53:03	8:41:48	Data logger--tailrace	
12	TR-Yagi	11-Jun 7:34:12	11-Jun 10:41:49	3:07:37	Data logger--tailrace	
12	Mobile	11-Jun 13:30			tailrace area	
12	TR-Yagi	11-Jun 14:28:19	11-Jun 17:58:32	3:30:13	Data logger--tailrace	
12	TR-Yagi	12-Jun 8:42:57	12-Jun 18:46:08	10:03:11	Data logger--tailrace	
12	Mobile	12-Jun 12:30			tailrace area	
12	TR-Yagi	13-Jun 8:27:29	13-Jun 10:14:45	1:47:16	Data logger--tailrace	
12	Mobile	13-Jun 10:05			tailrace area	
12	TR-Yagi	13-Jun 12:43:58	13-Jun 13:50:31	1:06:33	Data logger--tailrace	
12	TR-Yagi	14-Jun 5:43:27	14-Jun 11:20:03	5:36:36	Data logger--tailrace	
12	TR-Yagi	14-Jun 15:33:25	14-Jun 18:32:33	2:59:08	Data logger--tailrace	
12	Mobile	14-Jun 16:55			Capture area, ~200m from powerhouse	weak at FHP north
12	Mobile	15-Jun 8:00			Near Fort Halifax Park	
12	TR-Yagi	16-Jun 5:21:35	16-Jun 17:44:04	12:22:29	Data logger--tailrace	
12	Mobile	16-Jun 13:55			Near Fort Halifax Park	
12	TR-Yagi	17-Jun 3:46:38	17-Jun 18:40:03	14:53:25	Data logger--tailrace	
12	Mobile	17-Jun 11:15			Capture area, ~200m from powerhouse	from FHP
12	TR-Yagi	18-Jun 3:04:38	18-Jun 13:24:29	10:19:51	Data logger--tailrace	
12	Mobile	18-Jun 11:15			Capture area, ~200m from powerhouse	from FHP & flight
12	Mobile	19-Jun 13:15			tailrace area	strong at TR and NAPA
12	Mobile	21-Jun 9:15			Capture area, ~200m from powerhouse	from FHP
12	TR-Yagi	22-Jun 19:02:41	22-Jun 19:50:11	0:47:30	Data logger--tailrace	
12	Mobile	23-Jun 10:45			Capture area, ~200m from powerhouse	strong on PH (west) side
12	TR-Yagi	23-Jun 12:51:57	23-Jun 14:00:05	1:08:08	Data logger--tailrace	
12	Mobile	25-Jun 15:30			1km S of powerhouse	near Lithgow St
12	TR-Yagi	25-Jun 17:53:37	25-Jun 17:54:54	0:01:17	Data logger--tailrace	
12	TR-Yagi	26-Jun 2:17:20	26-Jun 2:34:50	0:17:30	Data logger--tailrace	
12	TR-Yagi	28-Jun 1:53:05	28-Jun 3:24:00	1:30:55	Data logger--tailrace	
12	Downstream	28-Jun 6:59:53	28-Jun 7:03:15	0:03:22	Data logger--at 2.7km downstream	
12	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
12	Summary	This fish moved between the tailrace, upper holding area, and spawning area for 22 days. It moved back downstream on 28 June.				

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
13	TR-Yagi	7-Jun 12:37:03	7-Jun 13:18:27	0:41:24	Data logger--tailrace	tagging, holding, post-release
13	TR-Yagi	7-Jun 17:24:40	8-Jun 2:53:00	9:28:20	Data logger--tailrace	return to tailrace, stay overnight
13	Mobile	8-Jun 11:10			Capture area, ~200m from powerhouse	
13	TR-Yagi	8-Jun 17:06:07	8-Jun 22:19:03	5:12:56	Data logger--tailrace	evening in tailrace
13	TR-Dropper	8-Jun 18:30:04	8-Jun 18:30:34	0:00:30	Data logger outside fish lift	briefly near fish lift
13	TR-Dropper	8-Jun 18:56:37	8-Jun 18:58:48	0:02:11	Data logger outside fish lift	briefly near fish lift
13	TR-Yagi	9-Jun 14:54:40	9-Jun 15:34:16	0:39:36	Data logger--tailrace	briefly in tailrace
13	Mobile	11-Jun 16:00			Capture area, ~200m from powerhouse	
13	Mobile	12-Jun 15:30			Capture area, ~200m from powerhouse	
13	Mobile	13-Jun 10:10			Capture area, ~200m from powerhouse	boat tracking
13	TR-Yagi	13-Jun 13:32:07	13-Jun 19:14:04	5:41:57	Data logger--tailrace	afternoon in tailrace
13	Downstream	14-Jun 0:26:14	14-Jun 1:56:23	1:30:09	Data logger--at 2.7km downstream	during darkness
13	TR-Yagi	14-Jun 18:35:40	14-Jun 18:45:02	0:09:22	Data logger--tailrace	briefly in tailrace
13	TR-Yagi	15-Jun 12:14:48	15-Jun 17:02:34	4:47:46	Data logger--tailrace	afternoon in tailrace
13	TR-Yagi	16-Jun 5:50:39	16-Jun 12:23:08	6:32:29	Data logger--tailrace	morning in tailrace
13	TR-Yagi	16-Jun 15:26:53	16-Jun 18:47:31	3:20:38	Data logger--tailrace	afternoon in tailrace
13	Mobile	16-Jun 16:15			Capture area, ~200m from powerhouse	
13	TR-Yagi	17-Jun 11:53:05	17-Jun 18:31:32	6:38:27	Data logger--tailrace	afternoon in tailrace
13	Mobile	17-Jun 13:30			150m S of powerhouse	
13	TR-Yagi	18-Jun 5:06:52	18-Jun 13:24:29	8:17:37	Data logger--tailrace	morning in tailrace
13	Mobile	18-Jun 13:30			150m S of powerhouse	flight & ground
13	Mobile	19-Jun 13:15			tailrace area	strong at TR and NAPA
13	Bypass-Down	20-Jun 6:07:21	20-Jun 6:09:00	0:01:39	Bypass data logger--east of powerhouse	
13	Downstream	20-Jun 10:50:31	20-Jun 10:58:00	0:07:29	Data logger--at 2.7km downstream	
13	Downstream	21-Jun 7:03:40	21-Jun 7:24:13	0:20:33	Data logger--at 2.7km downstream	
13	Mobile	21-Jun 9:45			2.6km S of powerhouse	
13	Downstream	21-Jun 19:59:01	22-Jun 3:57:45	7:58:44	Data logger--at 2.7km downstream	during darkness
13	Downstream	22-Jun 5:15:24	22-Jun 9:10:56	3:55:32	Data logger--at 2.7km downstream	
13	Downstream	23-Jun 6:22:36	23-Jun 6:29:11	0:06:35	Data logger--at 2.7km downstream	
13	Downstream	23-Jun 15:36:33	23-Jun 15:46:32	0:09:59	Data logger--at 2.7km downstream	
13	Downstream	24-Jun 17:29:07	24-Jun 19:54:17	2:25:10	Data logger--at 2.7km downstream	during darkness

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
13	Downstream	24-Jun 23:34:12	25-Jun 12:45:00	13:10:48	Data logger--at 2.7km downstream	
13	Mobile	25-Jun 15:13			2.4km S of powerhouse	
13	TR-Yagi	26-Jun 5:16:29	26-Jun 8:59:05	3:42:36	Data logger--tailrace	
13	Downstream	27-Jun 4:31:54	27-Jun 4:34:21	0:02:27	Data logger--at 2.7km downstream	during darkness
13	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
13	Summary	For two weeks, this fish moved between the tailrace and the upper holding area. It was near the fish lift the evening of 8 June. With the onset of high flows, movement extended to the downstream holding area for one more week. It moved back downstream on 27 June during high flows.				
14	TR-Yagi	7-Jun 14:36:41	7-Jun 16:02:17	1:25:36	Data logger--tailrace	tagging, holding, post-release
14	Mobile	8-Jun 16:00			300m S of powerhouse	
14	Downstream	8-Jun?			passed during loss of power	
14	Disposition				Departed study area, no further contact	
14	Summary	This fish was found in the upper holding area the day after tagging. It was not found after 8 June and probably moved back downstream that night.				
15	TR-Yagi	7-Jun 14:41:51	7-Jun 15:55:27	1:13:36	Data logger--tailrace	tagging, holding, post-release
15	Mobile	8-Jun 15:40			300m S of powerhouse	from FHP
15	Downstream	8-Jun?			passed during loss of power	
15	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
15	Summary	This fish was found in the upper holding area the day after tagging. It was not found after 8 June and probably moved back downstream that night.				
16	TR-Yagi	8-Jun 8:17:18	8-Jun 8:58:34	0:41:16	Data logger--tailrace	tagging, holding, escaped from live car
16	TR-Yagi	8-Jun 16:47:57	8-Jun 16:48:37	0:00:40	Data logger--tailrace	
16	TR-Yagi	9-Jun 9:21:44	9-Jun 9:56:06	0:34:22	Data logger--tailrace	
16	Mobile	12-Jun 12:30			tailrace area	brief contact (weak tag?)
16	TR-Yagi	12-Jun 16:17:36	12-Jun 16:21:22	0:03:46	Data logger--tailrace	
16	Downstream	13-Jun 23:43:14	14-Jun 0:03:54	0:20:40	Data logger--at 2.7km downstream	during darkness
16	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
16	Summary	This fish was released early (escaped from the live car) and was found in the tailrace four times over the next four days. It moved back downstream the night of 13 June during the first spike in river flow and was not detected again.				
17	TR-Yagi	8-Jun 8:40:08	8-Jun 9:20:39	0:40:31	Data logger--tailrace	tagging, holding, escaped from live

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
						car
17	Mobile	8-Jun 11:10			Capture area, ~200m from powerhouse	
17	TR-Yagi	8-Jun 11:10:42	8-Jun 11:39:34	0:28:52	Data logger--tailrace	
17	TR-Yagi	8-Jun 13:11:16	8-Jun 15:32:02	2:20:46	Data logger--tailrace	
17	TR-Yagi	8-Jun 17:04:30	8-Jun 21:06:34	4:02:04	Data logger--tailrace	
17	TR-Yagi	9-Jun 5:10:17	9-Jun 16:09:31	10:59:14	Data logger--tailrace	
17	Mobile	9-Jun 13:00			Near bypass reach	from both sides of river
17	TR-Yagi	10-Jun 6:23:35	10-Jun 20:07:19	13:43:44	Data logger--tailrace	
17	Mobile	10-Jun 15:00			tailrace area	from two locations, lots of tags
17	TR-Yagi	11-Jun 5:17:15	11-Jun 13:56:17	8:39:02	Data logger--tailrace	
17	Mobile	11-Jun 13:30			tailrace area	
17	Mobile	12-Jun 14:45			Near Fort Halifax Park	
17	Downstream	12-Jun 20:08:13	12-Jun 20:19:28	0:11:15	Data logger--at 2.7km downstream	during darkness
17	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
17	Summary	This fish was released early (escaped from the live car) and was most often found in the tailrace over the next four days. For three days (9, 10, 11-June), it was in the tailrace during the day and moved downstream at night. It left the study area the night of 12 June.				
18	TR-Yagi	8-Jun 8:47:47	8-Jun 12:22:42	3:34:55	Data logger--tailrace	tagging, holding, post-release
18	TR-Yagi	9-Jun 14:06:36	9-Jun 15:54:49	1:48:13	Data logger--tailrace	
18	TR-Yagi	10-Jun 5:15:54	10-Jun 12:13:26	6:57:32	Data logger--tailrace	
18	TR-Yagi	11-Jun 4:43:41	11-Jun 10:56:09	6:12:28	Data logger--tailrace	
18	Mobile	11-Jun 16:00			Capture area, ~200m from powerhouse	
18	TR-Yagi	12-Jun 5:20:21	12-Jun 20:23:57	15:03:36	Data logger--tailrace	
18	Mobile	12-Jun 12:30			~150m S of powerhouse	
18	TR-Yagi	13-Jun 7:45:02	13-Jun 9:52:17	2:07:15	Data logger--tailrace	
18	Mobile	13-Jun 10:05			150m S of powerhouse	boat tracking
18	TR-Yagi	13-Jun 13:25:31	13-Jun 20:29:15	7:03:44	Data logger--tailrace	
18	TR-Yagi	14-Jun 5:19:54	14-Jun 16:54:31	11:34:37	Data logger--tailrace	
18	Mobile	14-Jun 16:55			Capture area, ~200m from powerhouse	from TR and FHP
18	TR-Yagi	15-Jun 6:07:15	15-Jun 14:12:44	8:05:29	Data logger--tailrace	
18	Mobile	15-Jun 9:00			tailrace area	Realty and FHP
18	Downstream	15-Jun 14:46:33	15-Jun 14:55:00	0:08:27	Data logger--at 2.7km downstream	

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
18	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
18	Summary	After release, this fish diurnal pattern of moving upstream to the tailrace during the day and back downstream at night. It departed the night of 15 June during high flows and was not detected again.				
19	TR-Yagi	8-Jun 10:20:56	8-Jun 13:17:51	2:56:55	Data logger--tailrace	tagging, holding, post-release
19	TR-Yagi	9-Jun 10:31:45	9-Jun 10:33:51	0:02:06	Data logger--tailrace	
19	Mobile	9-Jun 13:30			300m S of powerhouse	from park
19	TR-Yagi	10-Jun 8:53:29	10-Jun 8:57:43	0:04:14	Data logger--tailrace	
19	Mobile	11-Jun 15:30			Near Fort Halifax Park	
19	Mobile	12-Jun 14:45			~350m S of powerhouse	FHP to mid-river fishing area
19	Downstream	12-Jun 23:12:49	12-Jun 23:36:32	0:23:43	Data logger--at 2.7km downstream	during darkness
19	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
19	Summary	This fish was most frequently contacted in the spawning are and upper holding area. After four days in the study area, it moved downstream the night of 12 June with the onset of high flows and was not detected again.				
20	TR-Yagi	8-Jun 10:22:10	8-Jun 12:52:13	2:30:03	Data logger--tailrace	tagging, holding, post-release
20	TR-Yagi	8-Jun 18:30:22	8-Jun 19:10:04	0:39:42	Data logger--tailrace	
20	Mobile	9-Jun 13:40			downstream of junction of Sebasticook	from park
20	Mobile	10-Jun 12:30	14-Jun 17:20		2.1km S of powerhouse	daily mobile contacts
20	Mobile	15-Jun 7:30			1.2km from powerhouse	
20	Mobile	16-Jun 14:25			Near Fort Halifax Park	
20	Downstream	17-Jun 5:51:57	17-Jun 11:12:54	5:20:57	Data logger--at 2.7km downstream	
20	Mobile	17-Jun 11:00			~2.3km from powerhouse	weak signal from DC bridge
20	Downstream	17-Jun 13:29:50	17-Jun 14:03:58	0:34:08	Data logger--at 2.7km downstream	
20	Mobile	18-Jun 11:00			2.5km from powerhouse	from flight and ground (weak)
20	Mobile	19-Jun 15:00			2.4km from powerhouse	DC bridge and boat launch
20	Downstream	19-Jun 23:03:18	19-Jun 23:06:54	0:03:36	Data logger--at 2.7km downstream	during darkness
20	Disposition				Departed study area, no further contact	no contact to Merrymeeting Bay
20	Summary	This fish was most frequently contacted in the downstream holding area and nearby locations, including the data logger. It left the study area and moved back downstream the night of 12 June.				
21	TR-Yagi	8-Jun 10:37:44	8-Jun 12:59:00	2:21:16	Data logger--tailrace	tagging, holding, post-release
21	Mobile	9-Jun 13:40			downstream of junction of Sebasticook	from park and Lithgow St.
21	TR-Yagi	10-Jun 7:17:10	10-Jun 7:17:10	0:00:00	Data logger--tailrace	

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
21	TR-Yagi	11-Jun 9:26:13	11-Jun 9:26:13	0:00:00	Data logger--tailrace	
21	Downstream	11 Jun			passed during loss of power	
21	Disposition				Departed study area, no further contact	
21	Summary	This fish moved back downstream on 11 June between 9:26 and 16:00 and was not contacted again.				
22	TR-Yagi	8-Jun 10:43:24	8-Jun 20:31:25	9:48:01	Data logger--tailrace	tagging, holding, post-release
22	TR-Yagi	9-Jun 4:36:50	9-Jun 10:46:01	6:09:11	Data logger--tailrace	
22	Downstream	9-11 Jun			passed during loss of power	
22	Mobile	13-Jun 11:30			~5.7km S of Project (N of first rapids)	boat tracking
22	Mobile	18-Jun 11:15			~5.7km S of Project (N of first rapids)	aerial tracking
22	Mobile	23-Jul 16:25			~5.7km S of Project (N of first rapids)	aerial tracking
22	Disposition				Stationary (regurgitation or mortality)	
22	Summary	This fish moved back downstream between 9 Jun 10:46 and 11 Jun 16:00. It remained stationary about 5.7km south of the Lockwood Project, just north of the rapids.				
23	TR-Yagi	8-Jun 11:34:03	8-Jun 13:54:03	2:20:00	Data logger--tailrace	tagging, holding, post-release
23	Mobile	9-Jun 13:40			downstream of junction of Sebasticook	from park and Lithgow St.
23	Mobile	10-Jun 12:30	14-Jun 17:20		2.0km S of powerhouse	daily mobile contacts
23	Mobile	15-Jun 7:30			1.2km from powerhouse	
23	Mobile	16-Jun 13:40			2.1km S of powerhouse	
23	Downstream	17-Jun 3:04:22	17-Jun 3:34:56	0:30:34	Data logger--at 2.7km downstream	during darkness
23	Disposition				Departed study area, no further contact	
23	Summary	This fish was most frequently contacted in the downstream holding and near the boat launch. It did not approach the tailrace and left the study area early on 17 June.				
24	TR-Yagi	8-Jun 11:51:43	8-Jun 17:56:57	6:05:14	Data logger--tailrace	tagging, holding, post-release
24	TR-Yagi	9-Jun 9:39:46	9-Jun 9:59:07	0:19:21	Data logger--tailrace	
24	Downstream	9-11 Jun			passed during loss of power	
24	Disposition				Departed study area, no further contact	
24	Summary	This fish was found in the tailrace the day after tagging. It was not found after 9 June and probably moved back downstream that night.				
25	TR-Yagi	8-Jun 13:01:41	8-Jun 20:07:04	7:05:23	Data logger--tailrace	tagging, holding, post-release
25	TR-Dropper	8-Jun 17:13:32	8-Jun 17:14:54	0:01:22	Data logger outside fish lift	right after release
25	Mobile	9-Jun 13:30			300m S of powerhouse	from park
25	TR-Yagi	9-Jun 15:42:31	9-Jun 16:57:06	1:14:35	Data logger--tailrace	

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
25	TR-Yagi	10-Jun 7:12:37	10-Jun 20:23:00	13:10:23	Data logger--tailrace	
25	Mobile	10-Jun 15:00			tailrace area	from two locations, lots of tags
25	TR-Yagi	11-Jun 7:55:47	11-Jun 13:48:44	5:52:57	Data logger--tailrace	
25	Mobile	11-Jun 15:30			Near Fort Halifax Park	stronger on west side
25	Mobile	12-16 June			No contact for 5 days	may be in Sebasticook River
25	Mobile	17-Jun 11:15			Capture area, ~200m from powerhouse	from FHP
25	Downstream	17-Jun 23:04:12	17-Jun 23:09:32	0:05:20	Data logger--at 2.7km downstream	during darkness
25	Disposition				Departed study area, no further contact	
25	Summary	For four days, this fish moved between the tailrace and the upper holding area. It was not found for the next five days and may have entered the Sebasticook River. It left the study area on 17 June at 11:15 and was not found again.				
26	TR-Yagi	8-Jun 14:11:06	8-Jun 17:48:57	3:37:51	Data logger--tailrace	tagging, holding, post-release
26	Mobile	9-Jun 13:30			300m S of powerhouse	from park
26	TR-Yagi	10-Jun 8:24:01	10-Jun 9:21:28	0:57:27	Data logger--tailrace	
26	Mobile	11-Jun 15:30			Near Fort Halifax Park	closer to mid-river angling area
26	TR-Yagi	12-Jun 12:54:39	12-Jun 13:02:00	0:07:21	Data logger--tailrace	briefly in tailrace
26	Mobile	12-Jun 15:30			Capture area, ~200m from powerhouse	also TR and FHP, strong signal
26	Mobile	13-Jun 10:10			Near Fort Halifax Park	boat tracking
26	TR-Yagi	14-Jun 5:34:09	14-Jun 5:45:05	0:10:56	Data logger--tailrace	briefly in tailrace
26	TR-Yagi	14-Jun 10:12:31	14-Jun 11:12:35	1:00:04	Data logger--tailrace	briefly in tailrace
26	Mobile	14-Jun 16:55			Near Fort Halifax Park	one contact
26	Downstream	14-Jun 18:34:14	14-Jun 18:56:55	0:22:41	Data logger--at 2.7km downstream	
26	Downstream	15-Jun 3:43:22	15-Jun 4:15:44	0:32:22	Data logger--at 2.7km downstream	during darkness
26	Downstream	15-Jun 19:43:43	15-Jun 19:59:10	0:15:27	Data logger--at 2.7km downstream	during darkness
26	Downstream	16-Jun 3:50:02	16-Jun 16:58:12	13:08:10	Data logger--at 2.7km downstream	
26	Mobile	16-Jun 15:00			2.6km S of powerhouse	
26	Downstream	17-Jun 4:25:46	17-Jun 16:39:01	12:13:15	Data logger--at 2.7km downstream	
26	Mobile	17-Jun 13:15			2.6km S of powerhouse	
26	Downstream	18-Jun 3:22:02	18-Jun 17:28:28	14:06:26	Data logger--at 2.7km downstream	
26	Mobile	18-Jun 13:15			2.6km S of powerhouse	flight & ground
26	Mobile	19-Jun 13:30			Capture area, ~200m from powerhouse	also NAPA
26	Downstream	19-Jun 15:06:12	19-Jun 15:09:51	0:03:39	Data logger--at 2.7km downstream	

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
26	Downstream	22-Jun 17:30:56	22-Jun 17:42:32	0:11:36	Data logger--at 2.7km downstream	
26	TR-Yagi	23-Jun 10:51:01	23-Jun 10:55:21	0:04:20	Data logger--tailrace	
26	Mobile	23-Jun 11:00			tailrace area	
26	TR-Yagi	23-Jun 12:53:36	23-Jun 13:41:23	0:47:47	Data logger--tailrace	
26	Bypass-Down	23-Jun 13:43:25	23-Jun 13:43:25	0:00:00	Bypass data logger--east of powerhouse	
26	Bypass-Up	23-Jun 13:50:29	23-Jun 15:02:37	1:12:08	Bypass data logger--downstream of spillway	
26	Bypass-Down	23-Jun 15:01:41	23-Jun 15:03:02	0:01:21	Bypass data logger--east of powerhouse	
26	TR-Yagi	23-Jun 15:04:12	23-Jun 15:09:18	0:05:06	Data logger--tailrace	
26	Mobile	25-Jun 15:10	6-Aug 9:22		~200m N of DC bridge, ~1/3 from east side	mult. days and locations incl. boat
26	Disposition				Stationary (regurgitation or mortality)	
26	Summary	This fish was detected in the tailrace and upper holding area for six days after tagging, then frequently found in the downstream holding area for the next ten days. It was stationary near the downstream holding area from 25 June to the end of the study.				
27	TR-Yagi	9-Jun 8:40:39	9-Jun 10:47:51	2:07:12	Data logger--tailrace	tagging, holding, post-release
27	Mobile	9-Jun 13:30			300m S of powerhouse	from park
27	TR-Yagi	10-Jun 8:27:07	10-Jun 8:44:50	0:17:43	Data logger--tailrace	
27	TR-Yagi	10-Jun 9:56:35	10-Jun 11:42:20	1:45:45	Data logger--tailrace	
27	TR-Yagi	10-Jun 15:31:02	10-Jun 17:38:45	2:07:43	Data logger--tailrace	
27	TR-Yagi	11-Jun 6:17:14	11-Jun 11:55:13	5:37:59	Data logger--tailrace	
27	Mobile	11-Jun 15:30			Near Fort Halifax Park	very strong
27	Downstream	12-Jun 13:38:35	12-Jun 20:04:47	6:26:12	Data logger--at 2.7km downstream	during darkness
27	Mobile	12-Jun 14:05			2.1km S of powerhouse	
27	Mobile	13-Jun 10:20			2.1km S of powerhouse	boat tracking
27	Downstream	13-Jun 18:30:03	14-Jun 2:20:53	7:50:50	Data logger--at 2.7km downstream	during darkness
27	Downstream	14-Jun 3:54:20	14-Jun 19:46:44	15:52:24	Data logger--at 2.7km downstream	
27	Mobile	15-Jun 7:30			1.2km from powerhouse	strong
27	Downstream	16-Jun 4:03:32	17-Jun 19:37:09	39:33:37	Data logger--at 2.7km downstream	
27	Mobile	16-Jun 15:00			2.6km S of powerhouse	
27	Mobile	17-Jun 13:15			2.6km S of powerhouse	also on data logger
27	Downstream	18-Jun 3:29:02	18-Jun 3:35:30	0:06:28	Data logger--at 2.7km downstream	during darkness
27	Mobile	18-Jun 11:30			Gardiner (36km movement)	flight only (8 hours from DWN)
27	Disposition				No contact after Gardiner	

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
27	Summary	This fish was detected in the tailrace and upper holding area for three days, then found in the downstream holding area for the next seven days. It then moved 36km downstream in about 8 hours.				
28	TR-Yagi	8-Jun 15:26:41	8-Jun 17:52:27	2:25:46	Data logger--tailrace	tagging, holding, post-release
28	TR-Yagi	9-Jun 7:00:39	9-Jun 9:21:16	2:20:37	Data logger--tailrace	
28	TR-Yagi	10-Jun 8:34:43	10-Jun 10:25:25	1:50:42	Data logger--tailrace	
28	Mobile	11-Jun 14:45			2.1km S of powerhouse	
28	Downstream	11 Jun			passed during loss of power	
28	Disposition				Departed study area, no further contact	
28	Summary	This fish was contacted several times in the tailrace and then departed on 11 June between 14:45 and 16:00.				
29	TR-Yagi	8-Jun 15:48:58	9-Jun 23:31:57	31:42:59	Data logger--tailrace	tagging, holding, post-release
29	TR-Dropper	9-Jun 4:46:02	9-Jun 4:47:31	0:01:29	Data logger outside fish lift	
29	Mobile	9-Jun 13:00			capture area	lots of tagged shad in tailrace
29	TR-Dropper	9-Jun 19:28:20	9-Jun 19:37:35	0:09:15	Data logger outside fish lift	
29	TR-Dropper	9-Jun 20:40:37	9-Jun 20:48:26	0:07:49	Data logger outside fish lift	
29	TR-Yagi	10-Jun 3:45:55	6-Aug 22:59:00	1387:13:05	Data logger--tailrace	for duration of study
29	Mobile	10-Jun 15:00			Tailrace area	from two locations, lots of tags
29	TR-Dropper	10-Jun 20:01:38	10-Jun 21:18:15	1:16:37	Data logger outside fish lift	
29	FW-Ent	10-Jun 20:07:27	10-Jun 21:11:51	1:04:24	Fish lift entrance data logger	
29	FW-Hopper	10-Jun 20:10:22	10-Jun 21:09:04	0:58:42	Fish lift hopper data logger	
29	Mobile	11-Jun 13:30	6-Aug 8:20		about 50m SE of fish lift entrance	very strong signal
29	Disposition				Stationary (regurgitation or mortality)	
29	Summary	This fish remained near the fish lift entrance and entered the fish lift 2 days after release. It became stationary shortly after leaving the fish lift and may have regurgitated the transmitter or been predated near the fish lift.				
30	TR-Yagi	9-Jun 9:21:01	9-Jun 19:58:00	10:36:59	Data logger--tailrace	tagging, holding, post-release
30	Mobile	9-Jun 13:00			Tailrace area	lots of tagged shad in tailrace
30	TR-Yagi	10-Jun 5:07:45	10-Jun 19:33:06	14:25:21	Data logger--tailrace	returned to tailrace in morning
30	Mobile	10-Jun 15:00			tailrace area	from two locations, lots of tags
30	TR-Yagi	11-Jun 5:42:55	11-Jun 17:44:00	12:01:05	Data logger--tailrace	returned to tailrace in morning
30	Mobile	11-Jun 13:30			tailrace area	very strong, also contacted at FHP
30	TR-Yagi	12-Jun 6:22:16	12-Jun 12:54:00	6:31:44	Data logger--tailrace	returned to tailrace in morning
30	Mobile	12-Jun 14:45			Near Fort Halifax Park	

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
30	TR-Yagi	12-Jun 15:08:32	12-Jun 19:39:32	4:31:00	Data logger--tailrace	returned to tailrace in afternoon
30	Downstream	12-Jun 20:26:21	12-Jun 20:31:00	0:04:39	Data logger--at 2.7km downstream	during darkness
30	Disposition				Departed study area, no further contact	
30	Summary	This fish was most often contacted in the tailrace, spawning area and upper holding area for four days. It moved downstream the night of 12 June with the onset of high flows and was not detected again.				
31	TR-Yagi	17-Jul 15:19:03	17-Jul 16:55:12	1:36:09	Data logger--tailrace	tagging, holding, post-release
31	Mobile	17-Jul 16:45			mid-river near capture location	TR and NAPA
31	Downstream	17-Jul 23:01:19	17-Jul 23:06:55	0:05:36	Data logger--at 2.7km downstream	during darkness
31	Disposition				Departed study area, no further contact	
31	Summary	This fish returned to the capture area then left the study area that night. It was not contacted again.				
32	TR-Yagi	17-Jul 15:28:56	17-Jul 17:04:34	1:35:38	Data logger--tailrace	tagging, holding, post-release
32	Mobile	17-Jul 16:45			mid-river near capture location	TR and NAPA
32	TR-Yagi	17-Jul 19:32:04	17-Jul 20:14:40	0:42:36	Data logger--tailrace	
32	Downstream	18-Jul 2:49:46	18-Jul 3:54:20	1:04:34	Data logger--at 2.7km downstream	during darkness
32	Mobile	20-Jul 12:00			N. of Sewage Plant near W shore	by boat
32	Mobile	22-Jul 17:40			near sewage treatment plant	from sewage plant
32	Downstream	23-Jul 19:27:11	23-Jul 19:48:12	0:21:01	Data logger--at 2.7km downstream	
32	Downstream	25-Jul 0:40:45	6-Aug 10:25:37	297:44:52	Data logger--at 2.7km downstream	
32	Mobile	27-Jul 8:50			near sewage treatment plant	also on data logger
32	Mobile	6-Aug 8:20			near sewage treatment plant	
32	Disposition				Stationary (regurgitation or mortality)	
32	Summary	This fish moved to the downstream holding area the night after tagging. It remained in that area through the end of the study.				
33	TR-Yagi	17-Jul 15:27:30	17-Jul 16:30:08	1:02:38	Data logger--tailrace	tagging, holding, post-release
33	Mobile	17-Jul 16:45			mid-river near capture location	TR and NAPA
33	Mobile	18-Jul 14:10			mid-river angling area	
33	Mobile	20-Jul 11:25			Just downstream storm culvert, W shore	by boat
33	Mobile	22-Jul 17:10			Just downstream storm culvert, W shore	from TR and FHP
33	Mobile	23-Jul 16:25			upper holding area	aerial tracking
33	Mobile	27-Jul 11:00			upper holding area near W shore	
33	Downstream	29-Jul 23:10:23	29-Jul 23:12:35	0:02:12	Data logger--at 2.7km downstream	during darkness
33	Disposition				Departed study area, no further contact	

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
33	Summary	This fish returned to the upper holding area for 11 days. It left the study area 29-Jul and was not contacted again.				
34	TR-Yagi	17-Jul 15:06:02	17-Jul 17:01:57	1:55:55	Data logger--tailrace	tagging, holding, post-release
34	Mobile	17-Jul 16:45			mid-river near capture location	TR and NAPA
34	TR-Yagi	18-Jul 1:19:30	18-Jul 5:13:19	3:53:49	Data logger--tailrace	Tailrace
34	Mobile	18-Jul 14:10			FHP/mid-river	
34	Downstream	19-Jul 8:04:23	20-Jul 0:52:33	16:48:10	Data logger--at 2.7km downstream	during darkness
34	Disposition				Departed study area, no further contact	
34	Summary	This fish moved back to the capture area for two days, then the lower holding area for one day. It left on 19 July and was not contacted again.				
36	TR-Yagi	17-Jul 15:34:16	17-Jul 16:50:45	1:16:29	Data logger--tailrace	tagging, holding, post-release
36	Mobile	18-Jul 14:10			FHP/mid-river	
36	Downstream	20-Jul 1:35:21	20-Jul 1:43:21	0:08:00	Data logger--at 2.7km downstream	during darkness
36	Disposition				Departed study area, no further contact	
36	Summary	This fish moved back to the capture area for one day and then left the study area on 20 July and was not contacted again.				
37	TR-Yagi	20-Jul 13:05:51	20-Jul 16:29:38	3:23:47	Data logger--tailrace	tagging, holding, post-release
37	Mobile	20-Jul 16:30			tailrace	right after release
37	Mobile	22-Jul 17:10			mid-river angling area	from TR and FHP
37	Downstream	22-Jul 23:38:36	22-Jul 23:41:57	0:03:21	Data logger--at 2.7km downstream	during darkness
37	Mobile	23-Jul 16:45			~1.2km N of Gardiner bridge	aerial tracking
37	Disposition				No contact after Gardiner	
37	Summary	This fish moved back to the capture area for three days, then left the river that night. It was contacted about 35km downstream 17 hours later.				
38	TR-Yagi	20-Jul 13:04:51	20-Jul 14:51:50	1:46:59	Data logger--tailrace	tagging, holding, post-release
38	Mobile	20-Jul 16:45			~200m from powerhouse	
38	Downstream	21-Jul 12:49:15	21-Jul 16:43:49	3:54:34	Data logger--at 2.7km downstream	
38	Downstream	21-Jul 21:08:01	22-Jul 4:53:12	7:45:11	Data logger--at 2.7km downstream	during darkness
38	Mobile	22-Jul 17:10			S of DC bridge	from bridge and sewage plant
38	Downstream	22-Jul 20:33:38	23-Jul 4:15:46	7:42:08	Data logger--at 2.7km downstream	during darkness
38	Mobile	23-Jul 16:25			just S of DC bridge	aerial tracking
38	Downstream	24-Jul 12:17:24	24-Jul 13:55:22	1:37:58	Data logger--at 2.7km downstream	
38	Downstream	24-Jul 19:38:42	25-Jul 3:58:25	8:19:43	Data logger--at 2.7km downstream	during darkness

Tag No.	Data Source	Start Time	End Time	Duration (hh:mm:ss)	Location Description	Mobile Tracking Notes
38	Downstream	25-Jul 22:57:48	26-Jul 3:55:33	4:57:45	Data logger--at 2.7km downstream	during darkness
38	Mobile	27-Jul 11:25			just S of DC bridge	
38	Downstream	28-Jul 4:49:50	28-Jul 5:10:51	0:21:01	Data logger--at 2.7km downstream	during darkness
38	Downstream	28-Jul 19:19:57	28-Jul 19:27:40	0:07:43	Data logger--at 2.7km downstream	
38	Disposition				Departed study area, no further contact	
38	Summary	This fish moved to the downstream holding area the day after tagging. It remained in that area for eight days, then left the river and was not contacted again.				

APPENDIX B:

River Flow, River Temperature, and Fish Lift Operational Status at the Lockwood Project

Lockwood Fish Lift River Temperature, River Flow and Fish Lift Status

May 2009

Date	River Temp. °C	River Flow (cfs)	Fish Lift Status
1-May	10.4	11,800	**Operational**
2-May	11.3	11,600	**Operational**
3-May	11.1	11,500	**Operational**
4-May	10.4	10,800	**Operational**
5-May	10.8	10,800	**Operational**
6-May	10.6	10,900	**Operational**
7-May	10.6	11,500	**Operational**
8-May	10.8	13,600	**Operational**
9-May	11	17,500	**Operational**
10-May	11.9	17,100	**Operational**
11-May	12	18,600	**Operational**
12-May	11.9	19,300	**Operational**
13-May	12	17,100	**Operational**
14-May	11.8	13,600	**Operational**
15-May	12.2	12,900	**Operational**
16-May	12.8	10,400	**Operational**
17-May	12.7	8,270	**Operational**
18-May	12.6	9,520	**Operational**
19-May	12.7	8,090	**Operational**
20-May	13.1	7,910	**Operational**
21-May	13.8	8,600	**Operational**
22-May	14.1	7,800	**Operational**
23-May	15.5	3,330	**Operational**
24-May	14.8	6,830	**Operational**
25-May	15.4	5,600	**Operational**
26-May	15.1	7,980	**Operational**
27-May	14.8	7,370	**Operational**
28-May	13.8	6,100	**Operational**
29-May	13.5	7,100	**Operational**
30-May	14	7,000	**Operational**
31-May	13.7	9,000	**Operational**

Lockwood Fish Lift River Temperature, River Flow and Fish Lift Status

June 2009

Date	River Temp. °C	River Flow (cfs)	Fish Lift Status
1-Jun	13.1	8,000	**Operational**
2-Jun	13.9	7,440	**Operational**
3-Jun	14.6	6,040	**Operational**
4-Jun	15.5	6,330	**Operational**
5-Jun	16	6,070	**Operational**
6-Jun	16.8	4,360	**Operational**
7-Jun	17.3	4,530	**Operational**
8-Jun	17.6	6,690	**Operational**
9-Jun	17.8	5,750	**Operational**
10-Jun	16.6	6,290	**Operational**
11-Jun	16.4	5,380	**Operational**
12-Jun	15.7	5,410	**Operational**
13-Jun	15.7	10,900	**Operational**
14-Jun	15.3	9,910	**Operational**
15-Jun	15.7	8,010	**Operational**
16-Jun	15.9	9,830	**Operational**
17-Jun	16.5	8,490	**Operational**
18-Jun	17	7,370	**Operational**
19-Jun	17.1	7,060	**Operational**
20-Jun	16.8	31,800	Shutdown
21-Jun	15.5	24,700	Shutdown
22-Jun	15.5	21,200	**Operational**
23-Jun	16.4	18,300	**Operational**
24-Jun	16.5	18,300	**Operational**
25-Jun	16.8	17,100	**Operational**
26-Jun	17.8	15,800	**Operational**
27-Jun	18	22,000	Shutdown
28-Jun	18.5	31,000	Shutdown
29-Jun	18.1	25,100	Shutdown
30-Jun	17.1	49,100	Shutdown

Lockwood Fish Lift River Temperature, River Flow and Fish Lift Status

July 2009

Date	River Temp. °C	River Flow (cfs)	Fish Lift Status
1-Jul	16.8	38,300	Shutdown
2-Jul	17.3	31,500	Shutdown
3-Jul	17.2	25,000	Shutdown
4-Jul	17.4	26,000	Shutdown
5-Jul	17.3	35,000	Shutdown
6-Jul	17.5	30,500	Shutdown
7-Jul	18.4	22,700	Shutdown
8-Jul	17.4	28,400	Shutdown
9-Jul	16.1	34,700	Shutdown
10-Jul	16.7	29,300	Shutdown
11-Jul	18.3	19,600	**Operational**
12-Jul	18.7	19,400	**Operational**
13-Jul	19	16,500	**Operational**
14-Jul	19	14,500	**Operational**
15-Jul	19.3	10,800	**Operational**
16-Jul	19.3	11,300	**Operational**
17-Jul	19.3	10,500	**Operational**
18-Jul	19.5	9,130	**Operational**
19-Jul	19.7	8,710	**Operational**
20-Jul	20.2	11,600	**Operational**
21-Jul	20.2	9,280	**Operational**
22-Jul	20.4	8,940	**Operational**
23-Jul	20.3	8,380	**Operational**
24-Jul	20.1	6,160	**Operational**
25-Jul	19.8	11,300	**Operational**
26-Jul	19	13,300	**Operational**
27-Jul	19.2	12,200	**Operational**
28-Jul	20.2	11,700	**Operational**
29-Jul	20.7	10,200	**Operational**
30-Jul	21.6	12,000	**Operational**
31-Jul	22.3	24,600	Shutdown

Lockwood Fish Lift River Temperature, River Flow and Fish Lift Status

August 2009

Date	River Temp. °C	River Flow (cfs)	Fish Lift Status
1-Aug	20.9	24,800	Shutdown
2-Aug	20.8	23,800	Shutdown
3-Aug	20.4	19,000	Shutdown
4-Aug	21.2	24,100	Shutdown
5-Aug	21.9	18,000	**Operational**
6-Aug	21	12,900	**Operational**
7-Aug	21.6	12,600	**Operational**
8-Aug	21.3	9,700	**Operational**
9-Aug	21.4	8,900	**Operational**
10-Aug	21.5	9,050	**Operational**
11-Aug	21.4	8,090	**Operational**
12-Aug	21.8	9,790	**Operational**
13-Aug	22	11,500	**Operational**
14-Aug	22	8,980	**Operational**
15-Aug	23	8,990	**Operational**
16-Aug	23.5	8,000	**Operational**
17-Aug	23.8	8,640	**Annual Shutdown**
18-Aug	24.1	9,210	**Annual Shutdown**
19-Aug	24.2	8,100	**Annual Shutdown**
20-Aug	24.5	6,720	**Annual Shutdown**
21-Aug	23.8	5,290	**Annual Shutdown**
22-Aug	23.9	8,900	**Annual Shutdown**
23-Aug	24	9,000	**Annual Shutdown**
24-Aug	23	11,800	**Annual Shutdown**
25-Aug	23.2	9,000	**Annual Shutdown**
26-Aug	23	9,910	**Annual Shutdown**
27-Aug	22	7,940	**Annual Shutdown**
28-Aug	22.5	8,300	**Shutdown**
29-Aug	22	8,000	**Shutdown**
30-Aug	21.7	7,900	**Shutdown**
31-Aug	20.4	8,600	**Operational**

Lockwood Fish Lift River Temperature, River Flow and Fish Lift Status

September 2009

Date	River Temp. °C	River Flow (cfs)	Fish Lift Status
1-Sep	20.6	6,830	**Operational**
2-Sep	19.5	6,360	**Operational**
3-Sep	19.6	5,440	**Operational**
4-Sep	20.5	5,560	**Operational**
5-Sep	20.7	5,200	**Operational**
6-Sep	20.7	4,600	**Operational**
7-Sep	20.8	4,100	**Operational**
8-Sep	20.9	4,140	**Operational**
9-Sep	21.2	4,060	**Operational**
10-Sep	21.1	4,030	**Operational**
11-Sep	20.1	4,000	**Operational**
12-Sep	20.3	3,700	**Operational**
13-Sep	20.2	3,360	**Operational**
14-Sep	20.4	3,480	**Operational**
15-Sep	20.1	3,380	**Operational**
16-Sep	20.2	3,380	**Operational**
17-Sep	19.5	4,060	**Operational**
18-Sep	18.8	3,790	**Operational**
19-Sep	17.9	3,400	**Operational**
20-Sep	18.2	3,300	**Operational**
21-Sep	18.4	3,240	**Operational**
22-Sep	18.1	3,530	**Operational**
23-Sep	18.6	3,770	**Operational**
24-Sep	19.2	2,670	**Operational**
25-Sep	18.3	2,740	**Operational**
26-Sep	18	2,490	**Operational**
27-Sep	18	2,500	**Operational**
28-Sep	17.8	2,600	**Operational**
29-Sep	18.1	2,780	**Operational**
30-Sep	17.7	3,210	**Operational**

Lockwood Fish Lift River Temperature, River Flow and Fish Lift Status

October 2009

Date	River Temp. °C	River Flow (cfs)	Fish Lift Status
1-Oct	17	3,300	**Operational**
2-Oct	17.1	2,900	**Operational**
3-Oct	16.3	2,800	**Operational**
4-Oct	16.5	3,000	**Operational**
5-Oct	15.7	6,930	**Operational**
6-Oct	15.3	5,530	**Operational**
7-Oct	14.4	4,220	**Operational**
8-Oct	14	5,780	**Operational**
9-Oct	13.1	6,290	**Operational**
10-Oct	12.8	5,100	**Operational**
11-Oct	12.5	5,500	**Operational**
12-Oct	11.9	5,200	**Operational**
13-Oct	11.7	3,640	**Operational**
14-Oct	10.8	4,870	**Operational**
15-Oct	10.5	3,770	**Operational**
16-Oct	11.8	2,700	**Operational**
17-Oct	11.6	2,300	**Operational**
18-Oct	10.2	2,000	**Operational**
19-Oct	9.7	3,010	**Operational**
20-Oct	9.8	3,000	**Operational**
21-Oct	10.1	2,900	**Operational**
22-Oct	9.7	2,700	**Operational**
23-Oct	9.4	2,980	**Operational**
24-Oct	9.3	2,300	**Operational**
25-Oct	9.7	24,000	Shutdown
26-Oct	8.3	22,300	Shutdown
27-Oct	8.5	12,800	**Operational**
28-Oct	8.7	10,200	**Operational**
29-Oct	8.5	10,700	**Operational**
30-Oct	8	9,170	**Operational**
31-Oct	8.2	6,000	Shutdown

APPENDIX C

Hydraulic Study of Flows in and Around the Lockwood Fish Lift

Hydraulic Study of Flows in and Around the Lockwood Fish Lift

Draft Submitted: March 12, 2010

Revised: May 7, 2010

Testing and Reporting done by Lakeside Engineering, Inc.

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1.0 INTRODUCTION

1.1 BACKGROUND

In October 2008, NextEra Energy attended a fall fish passage planning meeting with the resource agencies. During that meeting, the agencies requested that NextEra Energy undertake a hydraulic study of the Lockwood Project fish lift attraction flows in 2009 in conjunction with an upstream radio telemetry study for American shad. The main reason for these studies was to try to explain why limited numbers of shad have been captured at the Lockwood fish lift from 2006-2008.

1.2 PROJECT DESCRIPTION

The Lockwood Project is located at river mile 63 and is the first dam on the main stem of the Kennebec River. The Lockwood Project includes an 81.5-acre reservoir, an 875-foot-long and 17-foot-high dam with two spillway sections and a 160-foot-long forebay headworks section, a 450-foot-long forebay canal and two powerhouses. The dam and forebay headworks span the Kennebec River immediately upstream of the U.S. Route 201 Bridge along a site known as Ticonic Falls. From the headworks, the forebay canal directs water to two powerhouses located on the west bank of the Kennebec River. The original powerhouse contains six generating units and the second powerhouse contains one generating unit. Total maximum unit flow is 5,810 cfs.

In accordance with the FERC license, Merimil Limited Partnership, licensee for the Lockwood Project, completed construction of a fish lift, trap, sort, and transport system in the spring of 2006. The fish lift discharges a 150 cfs attraction flow on the shore side of the tailrace.

1.3 OBJECTIVE

The objective of this study was to conduct a hydraulic evaluation of the flows in and around the fish lift entrance in order to evaluate if there are any hydraulic issues that may be impacting adult shad egress to the fish lift entrance. Fish lift attraction water velocity, continuity, and direction were evaluated with both a dyed water release and Acoustic Doppler Current Profiler (ADCP) velocity measurement transects.

2.0 METHODS AND MATERIALS

Due to logistical issues associated with adequate and consistent flow conditions, ADCP availability and equipment problems, only one flow test (approximately 5,900 cfs) was completed. During this test, all units were operating at or near 100% gate. This flow represents the 50% exceedence flow for the month of June and would be a flow encountered by shad during their upstream migration period. This test was completed on October 9, 2009.

2.1 DYE TEST

A biodegradable, FDA-approved, dye solution was discharged just upstream of the fish lift hopper isolation screen. Different concentrations were tested to develop a defined plume out of the fishway entrance. The dyed water was mixed with the 150 cfs fish lift attraction flow and

flowed out the fish lift entrance which was set at the normal operational opening of 3 feet. Four dye releases were performed.

The dye test was recorded with a Sanyo model xacti digital movie camera set next to the east side of the main powerhouse on the deck at a location that recorded the flow patterns downstream of the fishway.

2.2 ACOUSTIC DOPPLER CURRENT PROFILER – ADCP

A broadband 1200 kHz ADCP manufactured by RD Instruments was used to obtain the water velocity measurements. A 1200 kHz ADCP unit was used because this unit can produce 0.25 meter cells at a range of 11 meters. The minimum range for the 1200 kHz unit to get usable (readable) data is 1.2 meters plus. A minimum distance is needed for the sound to travel and bounce back. A laptop PC with an external monitor displayed real time data, as well as graphic presentations, and stored the data. A 19-foot aluminum boat was used for the equipment platform (Photo1). The ADCP was hung over the side, 0.2 meters below the water surface. The transects were replicated using dead reckoning visual clues.

Photo 1: Boat, ADCP instrument, and data collection computer.

The ADCP works by emitting sound bursts and measuring the frequency change of the echo as a function of depth to determine the water velocity. The units have four 20-degree beam angle transmitters, with three used to determine a vector and location while the fourth serves as a check. The water velocity is measured in a series of equal-thickness layers called depth cells for the full depth of the water column, except for a cell at the surface and a cell the bottom interface. The equipment was sized so the first upper interface cell is 1 meter, and each subsequent cell was approximately 0.25 meters. The 1-meter top and 0.5-meter bottom interface cells do not show in the output data. The velocity accuracy under ideal conditions is +/- 0.25% of the (water + boat) velocity +/– 2.5 cm/sec. To compensate for air entrainment from the turbines, the typical transect speed was as slow as practical to develop higher accuracy. The ADCP records the velocity in three dimensions and the software has graphics that allow color-coded or vector presentations, as well as river bottom contours.

Ten transect locations using ADCP were done (A through J on Figure 1) with a minimum of three transects per location to check the consistency of the data obtained. The internal flux gate compass oriented the flow and the bottom track and contours.

The testing was done on a cloudy day which benefitted the computer work but diminished the dye contrast.

3.0 RESULTS

3.1 DYE TEST

The dye test provided a good visual analysis of the continuity of surface flows. The surface dye jet was continuous for at least 150-feet downstream of the fish lift entrance. There was dilution of the color as it advanced downstream. There was an undyed area between the shore and the jet where some small back eddies occurred. There were no major back eddies or upwelling that broke the continuity of the jet. Figure 2 is an approximate representation of the dye jet.

Photos 2, 3, and 4 are three snapshots from one of the dye tests starting at the fishway gate and moving downstream.

3.2 ADCP TEST

After the dye test was performed, it was determined that additional transects would be valuable. Consequently, the number of transect locations was increased from four to ten (Figure 1). Three of the original transect locations were deleted due to difficulty in maneuvering the boat across the tailrace. These transects were at the fish lift entrance, 25-foot location, and at the 50-foot location downstream of the fish lift. To gather the data in this area, upstream and downstream transects along the centerline of the fish lift discharge, the edge of the fish lift gate, and centerline of #7 turbine were performed.

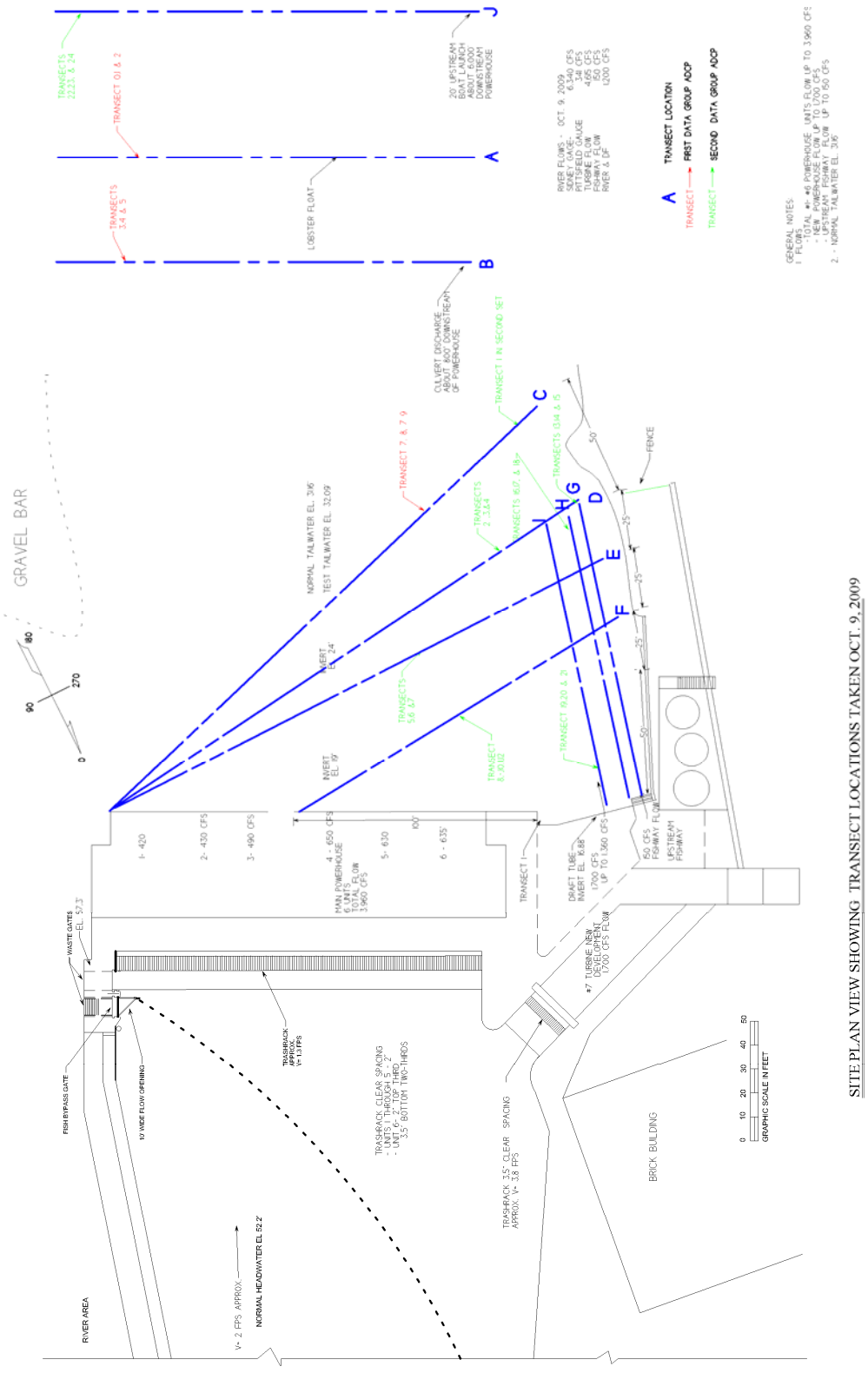


Figure 1: Approximate ADCP transect locations.

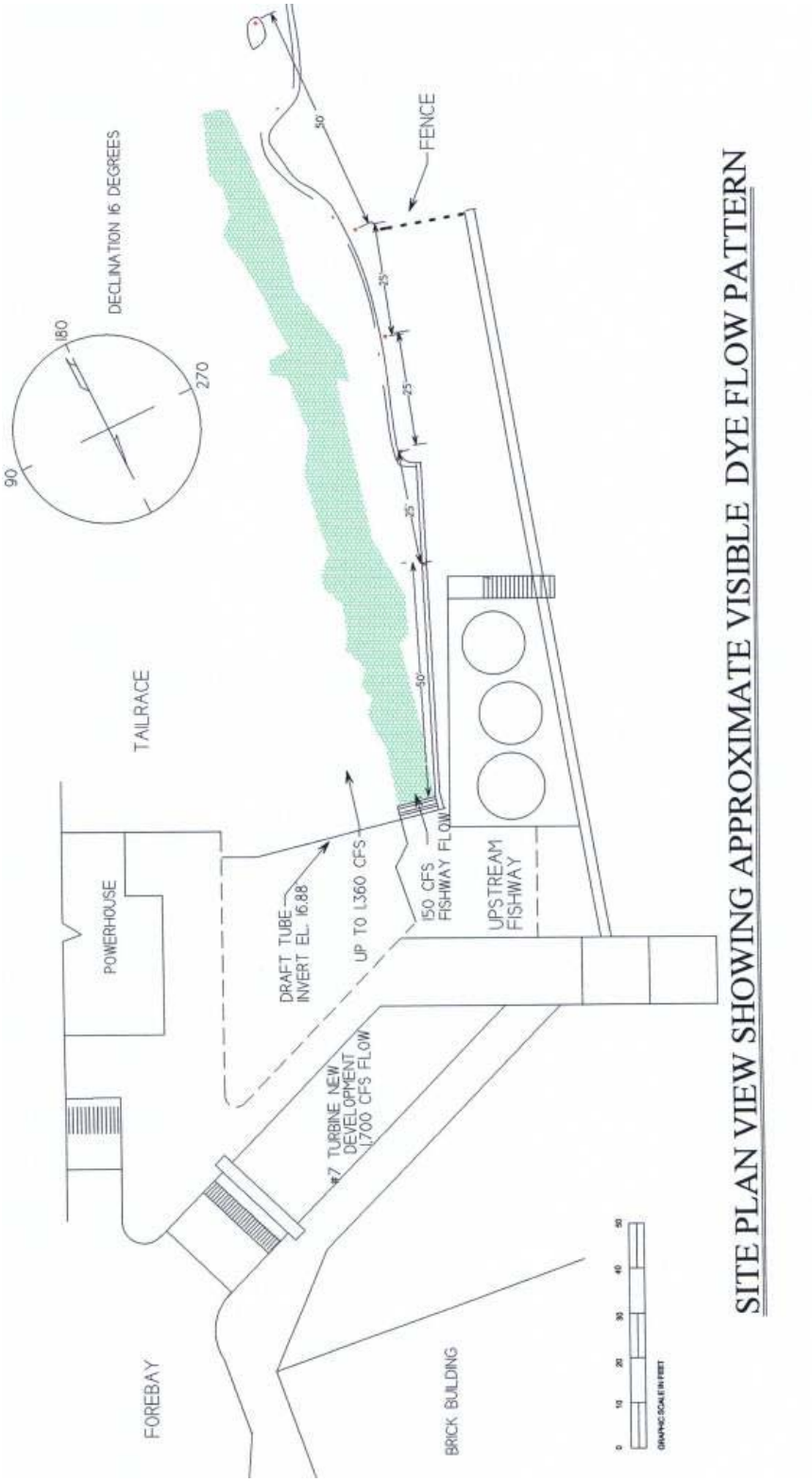


Figure 2: An approximate representation of the visual flow pattern from the dye release.

Photo 2: Between 0 and 75’ downstream of fishway entrance area.

Photo 3: Between approximately 25’ and 100’ downstream of fishway entrance area.

Photo 4: Downstream 75' plus downstream of fishway entrance area.

There were 31 individual transects taken. As stated above, at least 3 transects were taken for each location. The location transects were grouped, evaluated against one another, and evaluated for the percent of bad ensembles (group of sound bursts used to determine a bin) and bad bins. Bad bins occur when the computer calculates that the ensembles are not valid. The computer then throws the information out and shows "no data".

The ADCP software graphically displays results in a variety of formats. In each scenario, the scale can be adjusted for the desired display:

- Vertical transects showing water surface and bottom profile. The upper and lowest areas and cells are left blank due to not meeting accuracy criteria.

- There is a variety of ways to show the vertical transects for this report. It was determined that the direction, magnitude, and vertical components (in the tailrace area) would be adequate.

- The transect plan-views show red bottom track line and vector sticks. These can be the average for the transect or one can pick an elevation of interest throughout the water column in 25 cm (0.8 ft) intervals. Since the fish lift entrance is in the upper portion of the water column, the average of all data and the information from the 3.5-foot-down cell was presented.

The graphs are in sectional-view and plan-view. The sectional-view vertical axis has the depth from the water surface in feet. The horizontal axis gives the distance along the transect from the starting point. At the top of the graph is a color-coded legend which illustrates either the water velocity or the direction in degrees. The plan-view of each transect, or vector sticks, has the distance east on the horizontal axis and the distance north on the vertical axis. The legend is on the top of the stick ship track. The blue sticks show the velocity and scaled magnitude either averaged or at a specific depth. The scaling factor (shown on the vertical axis) changes. The red line on the graph is the ship track on the river bottom. (Note: Though the intent was to traverse directly across the river, currents distorted the boat travel.)

Below each transect, some comments are given about that specific transect. In addition, report section 5.0 portrays some of the ADCP transect data via an aerial view of location, water depth and flow direction.

4.0 CONCLUSIONS

4.1 DYE TEST

The dye test indicated a good surface flow with no major back eddies or upwelling that broke the continuity of the jet. There was an undyed area between the shore and the jet where some small back eddies occurred. This flow should provide adequate attraction for upstream migrating shad for 150 feet downstream of the fishway entrance.

4.2 ADCP TEST

The ADCP test demonstrated that the areas within the measured transects near the fish lift entrance are within the acceptable range of the swimming capabilities for shad. Though the maximum velocity was 7 ft/sec, the majority of the velocity ran about 3 ft/sec. This is less than the prolonged swim speed of 5 body lengths/sec for shad. There are some stick vectors (Transect G) which indicate flows going perpendicular to the centerline of the fishway flow. This may be attributed to side lobes interacting with the concrete wall or the transducer coming out of the water. The perpendicular flows don't show as pronounced (Transect H) on the river side of the fishway entrance.

There is an abrupt grade change just downstream of the entrance (about 10 ft. downstream of the fishway entrance that drops about 2.5 ft.) that could be due to ADCP side lobe reaction with the concrete training wall or could be a river bottom feature. Based on the ADCP measurements in this area, the area still appears to be conducive to shad passage.

At the culvert transect (B), about 800 feet downstream of the fish lift, there appears to be a good leading flow that should be conducive to upstream shad migration. There is an insignificant back eddie on the Winslow shore line.

At the MDMR monitoring buoy transect (A), about 1,000 feet downstream of the fish lift along the Waterville side of the river, there appears to be a good leading flow that should be conducive to upstream shad migration. At the MDMR buoy transect, there is a shoal about 5.5 feet below

the water surface and an eddie that directs the flow upstream along the Winslow side of the river. This eddie could redirect shad downstream however; the extent or duration is unknown.

The last transect near the boat ramp shows that the majority of the flow has moved to the Winslow side of the river. There is no indication of back eddies.

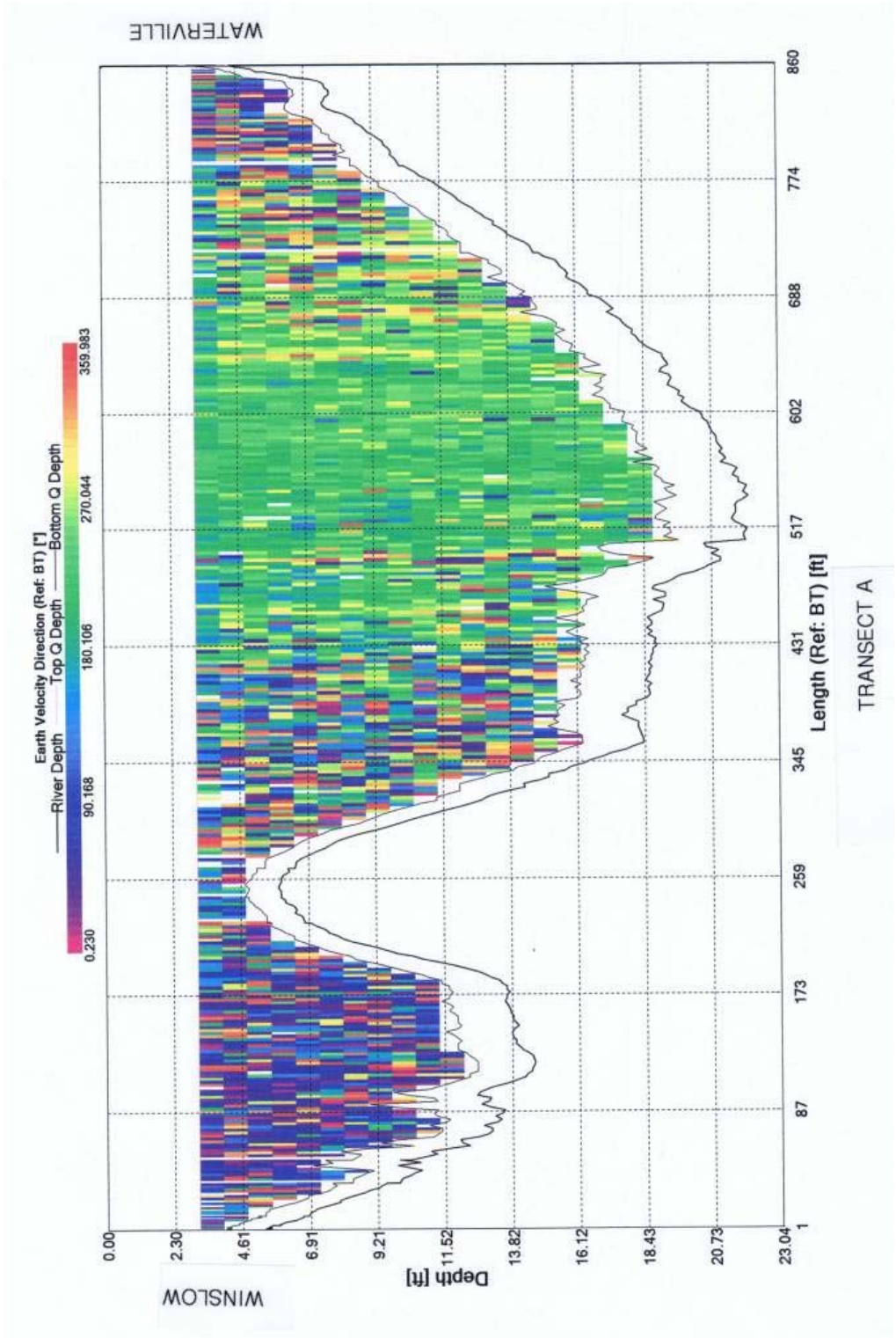


Figure 3: Transect A at MDMR buoy illustrating direction

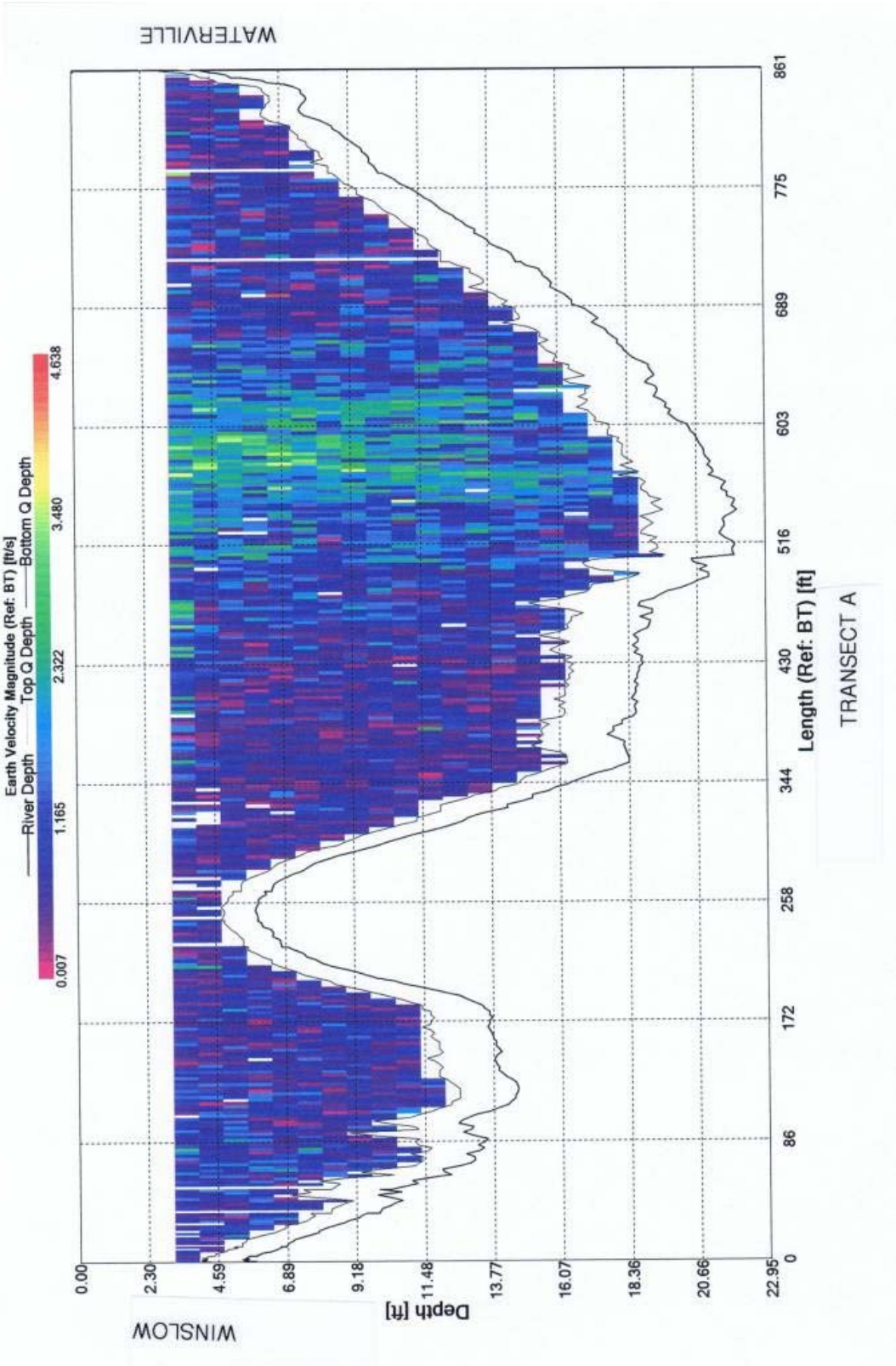


Figure 4: Transect A at MDMR buoy illustrating magnitude

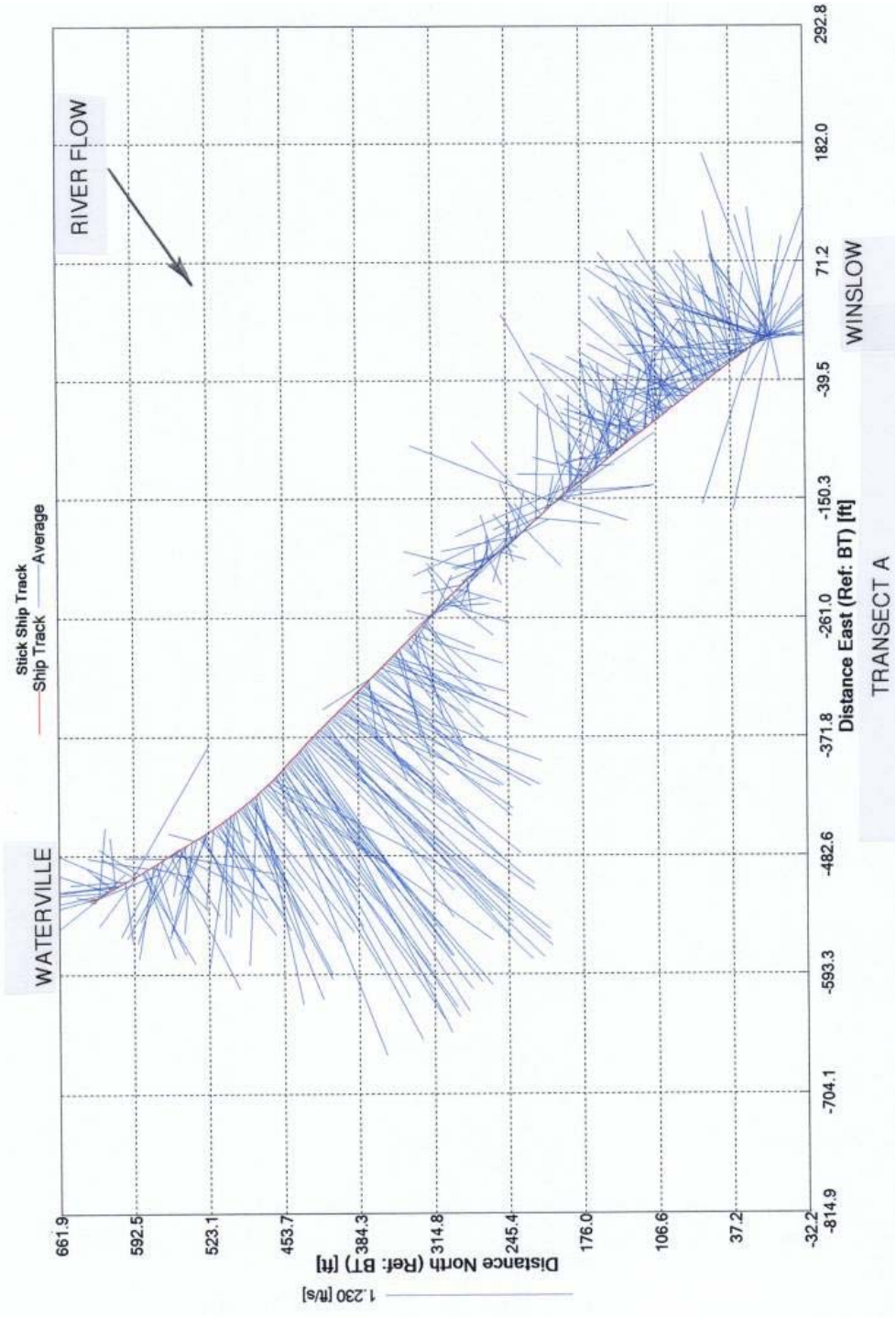


Figure 5: Transect A ship track plan-view vector sticks showing average direction and velocity

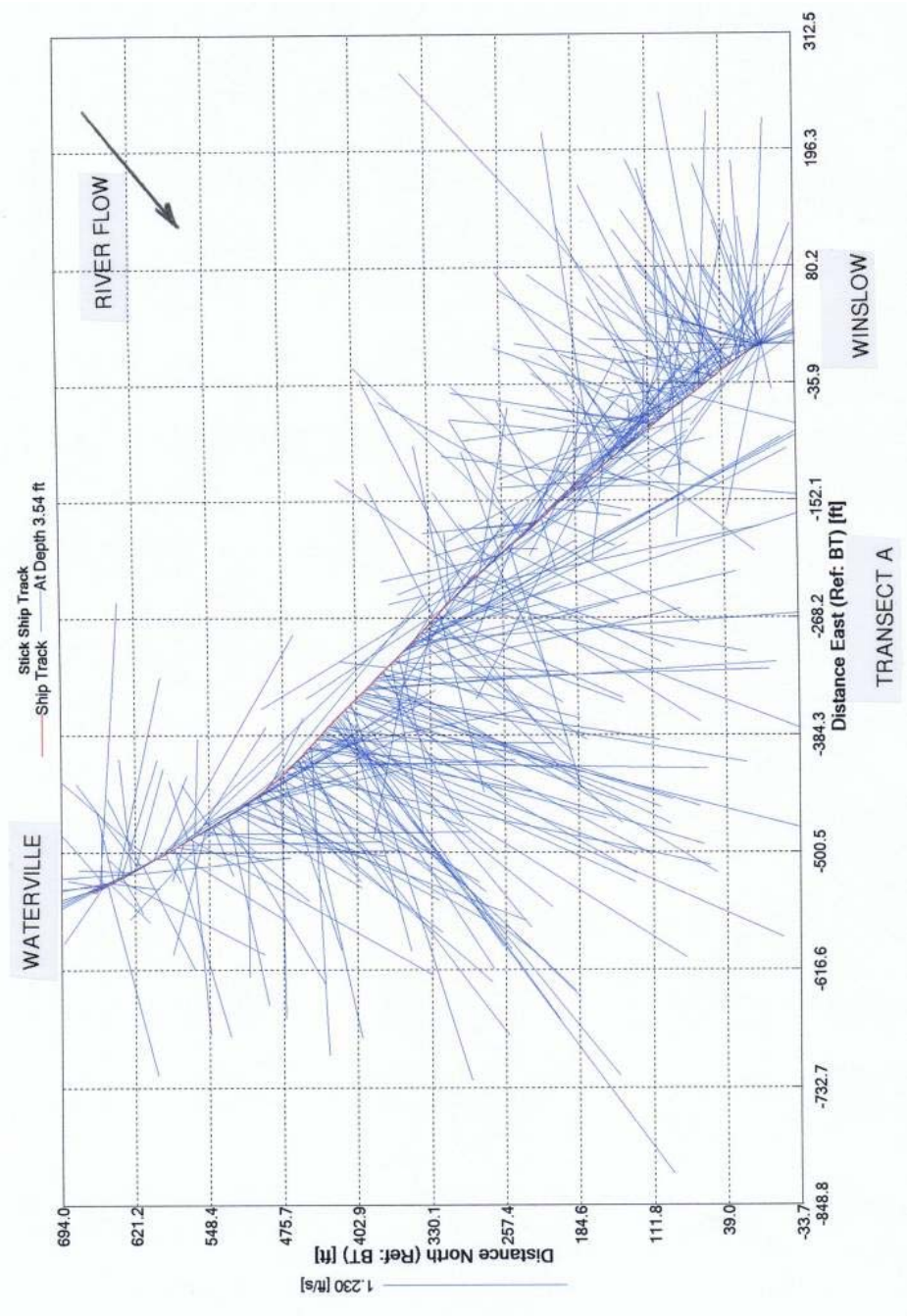


Figure 6: Transect A ship track plan-view vector sticks 3.5’ below water surface

Transect A Notes: Transect length about 870’, Max. depth 22.3’, Mean depth 14.3’, Mean vel. 0.4 ft/sec. Max. vel. 4.6 ft/sec. There is a high point in the river bottom about 250’ off the Winslow shore. Highest velocity occurred about 250’ off the Waterville shore. There is a circular flow pattern with the Waterville side downstream and the Winslow side upstream. The flow pattern on the Winslow side could redirect shad downstream but the Waterville side flow dominates.

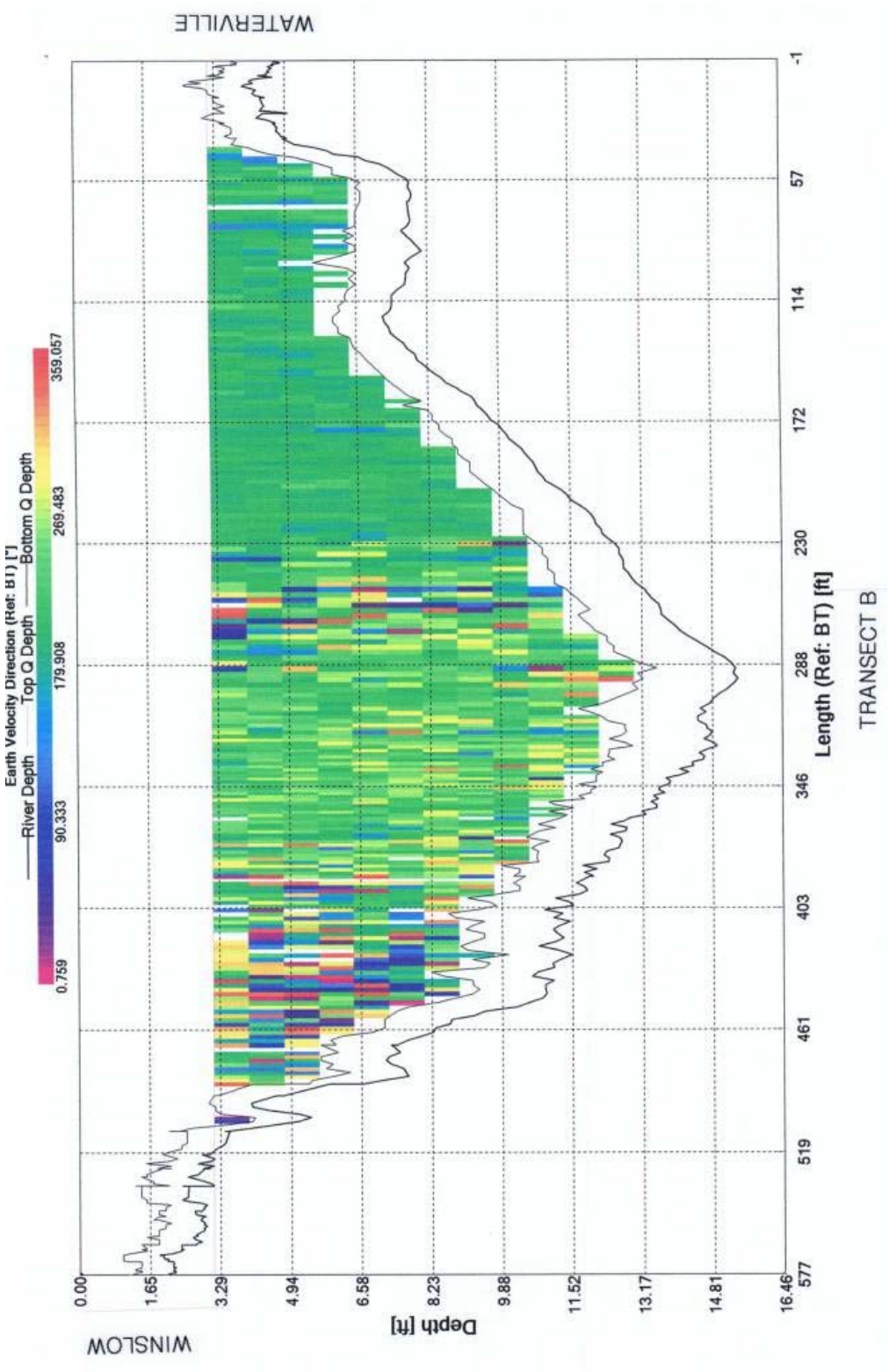


Figure 7: Transect B at storm drain illustrating direction

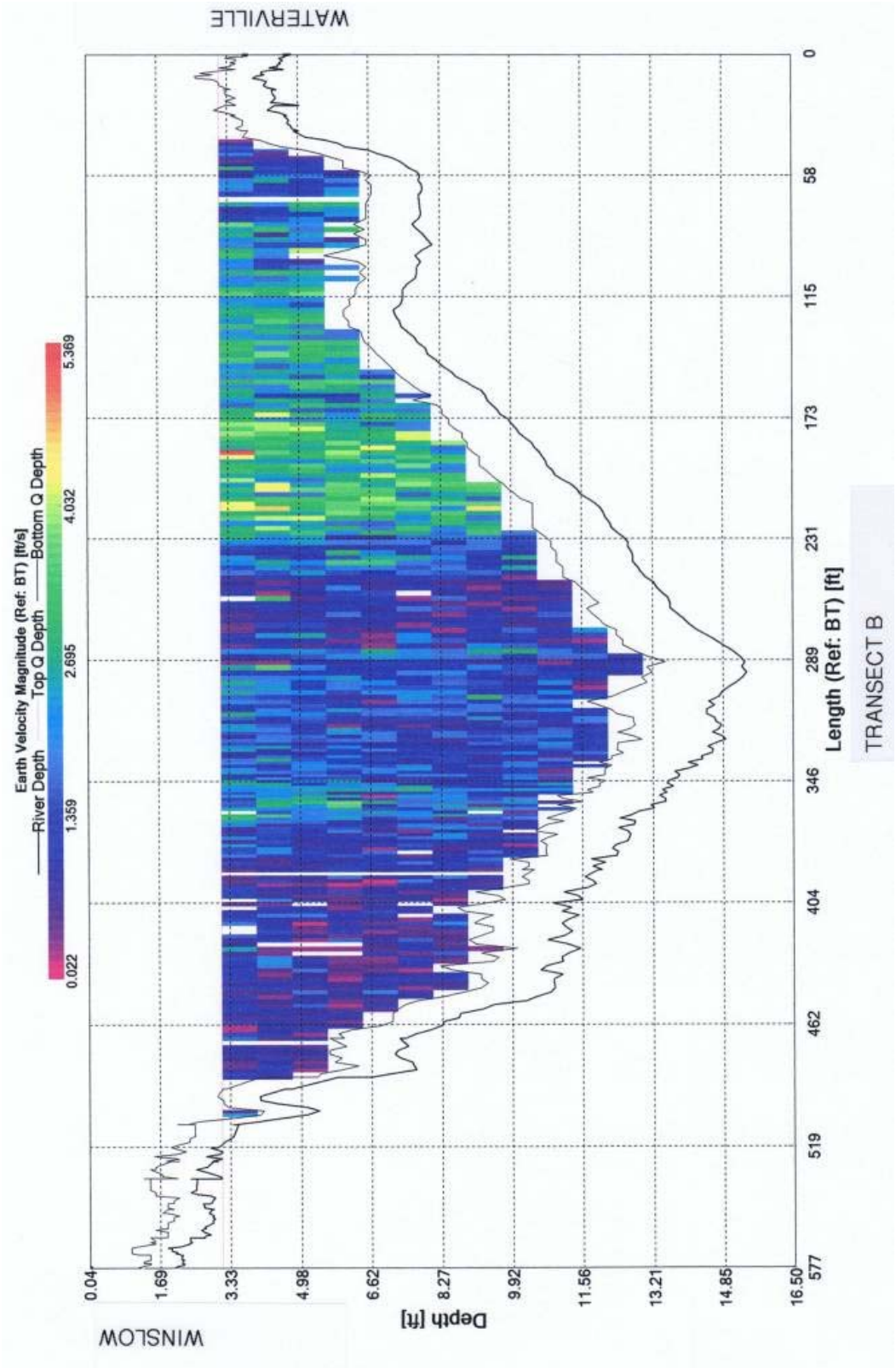


Figure 8: Transect B storm drain illustrating magnitude

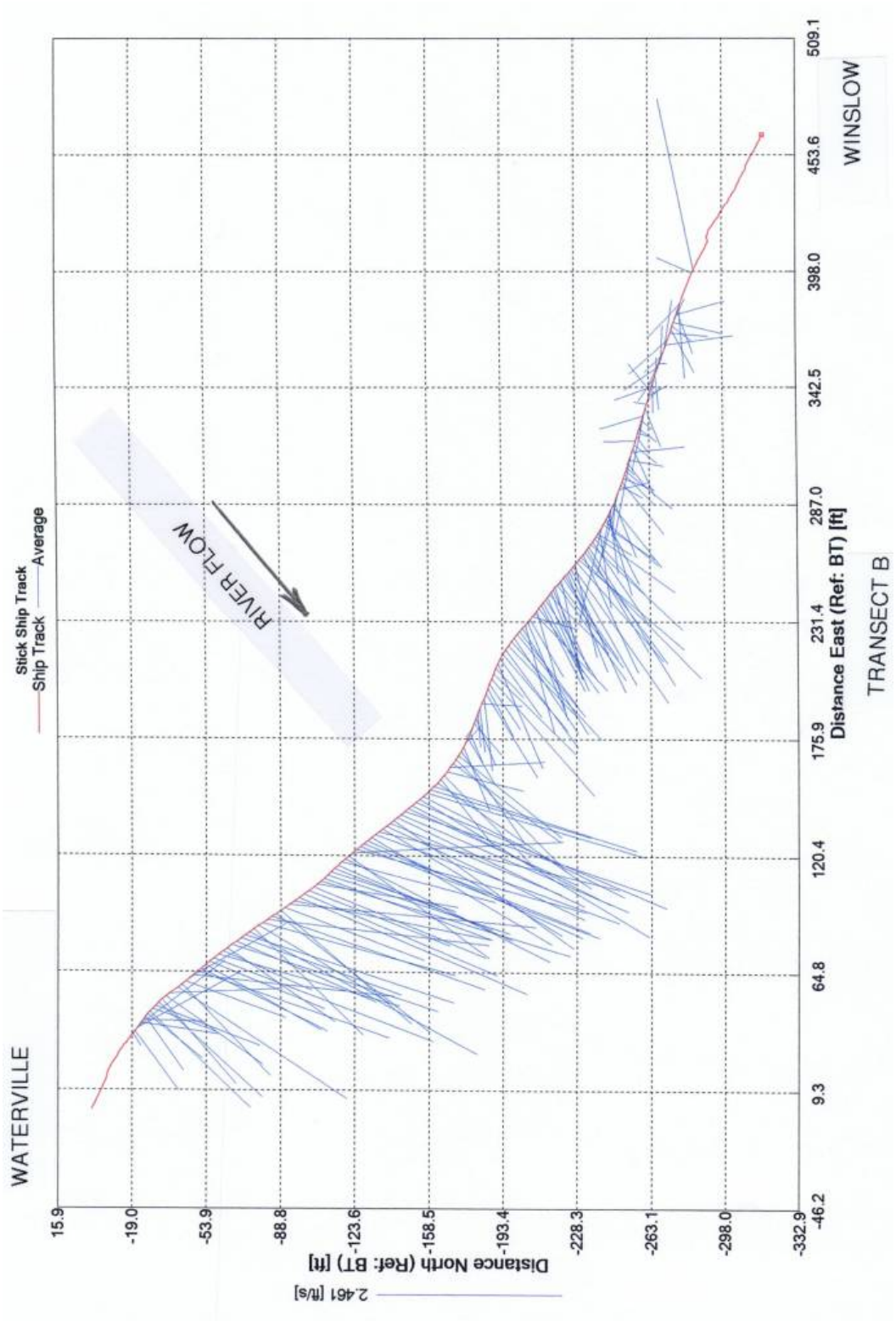


Figure 9: Transect B ship track plan-view vector sticks average direction and velocity

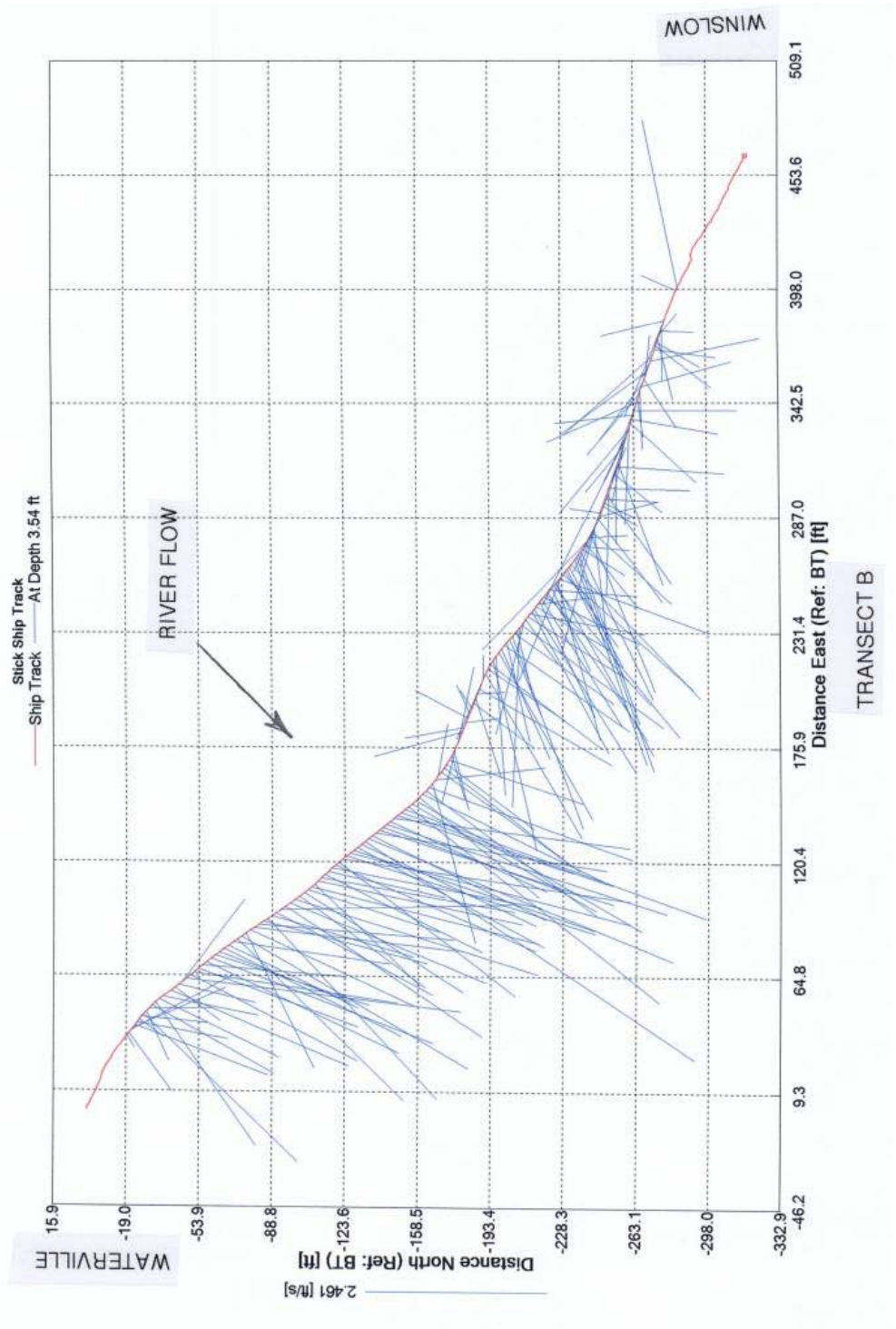


Figure 10: Transect B ship track plan-view vector sticks 3.5’ below water surface

Transect B Notes: Transect length about 580’, Max. depth 15.4’, Mean depth 9’, Max. vel. 5.4 ft/sec. Mean vel. about 1 ft/sec. Highest water velocity zone about 200’ off Waterville shore.

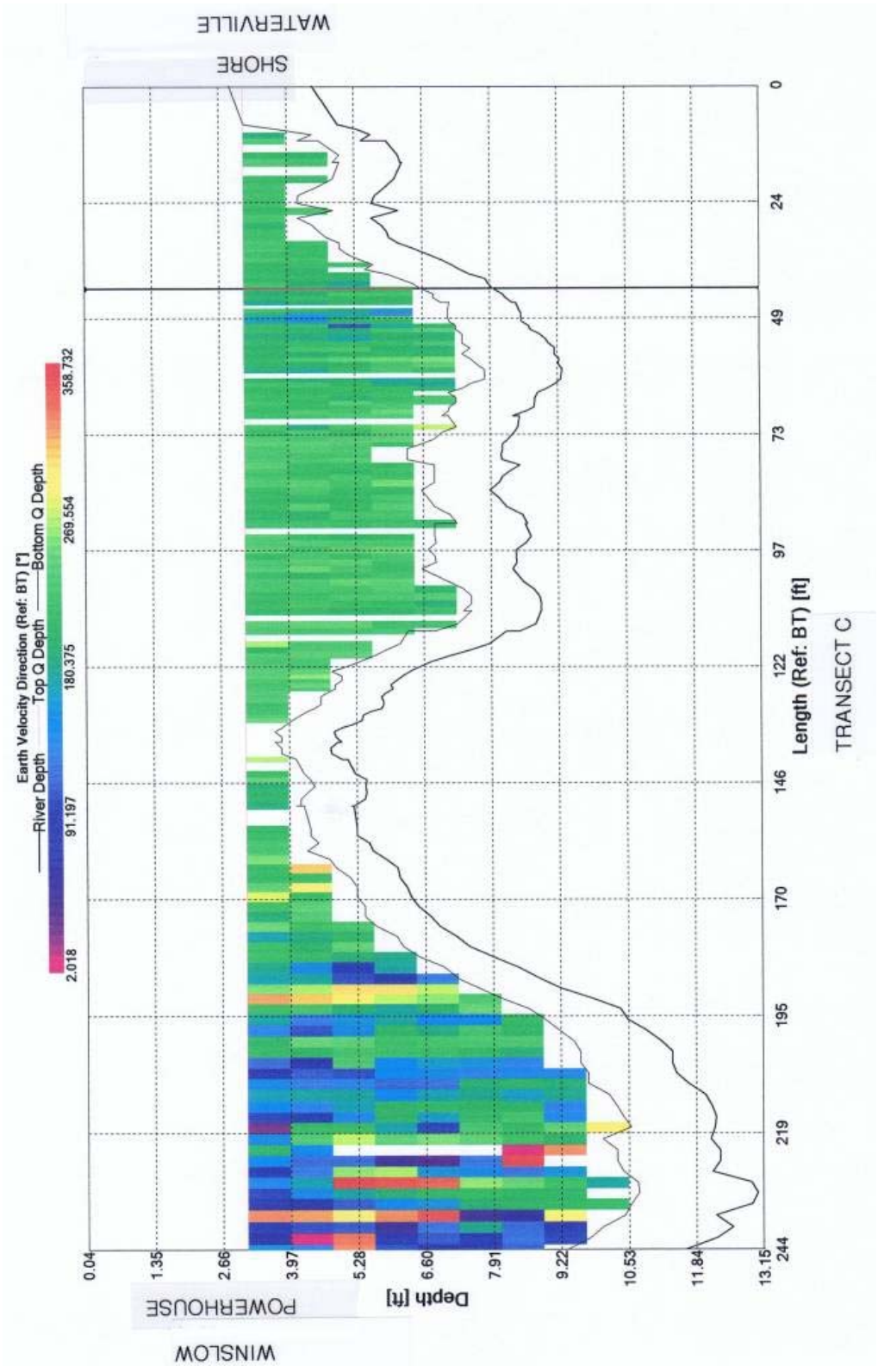


Figure 11: Transect C at tailrace illustrating direction

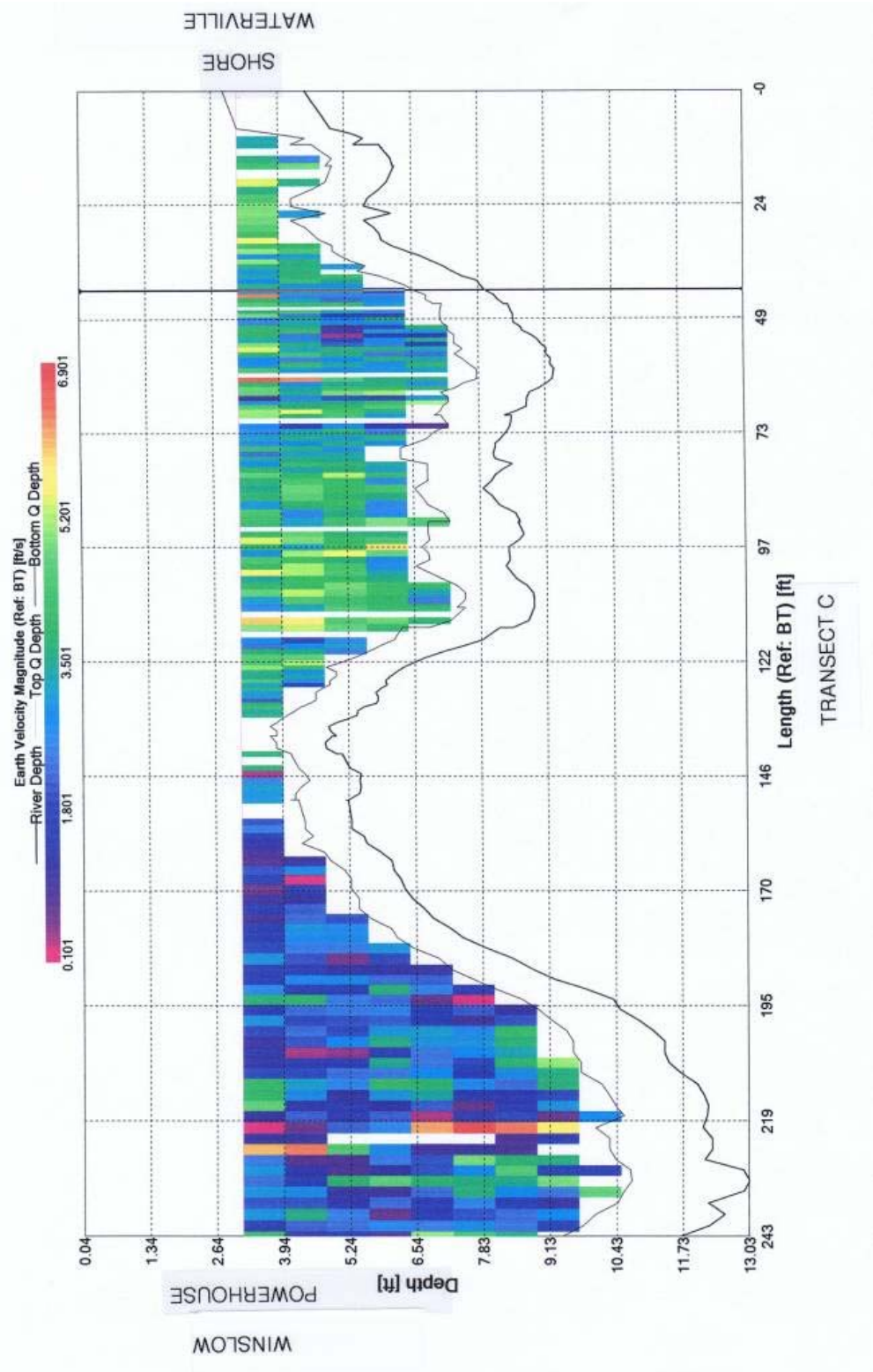


Figure 12: Transect C at tailrace illustrating magnitude

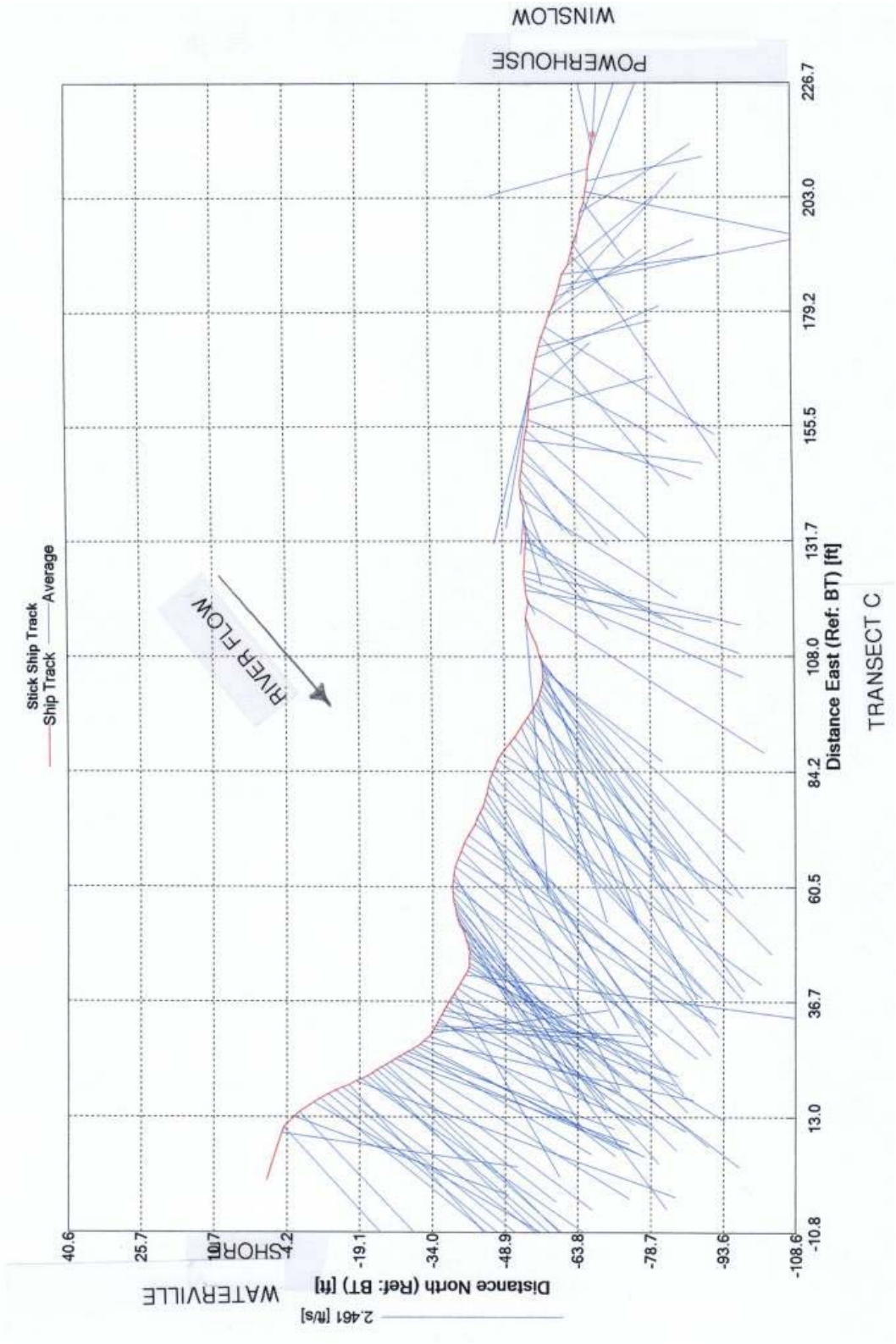


Figure 13: Transect C ship track plan-view vector sticks illustrating average direction

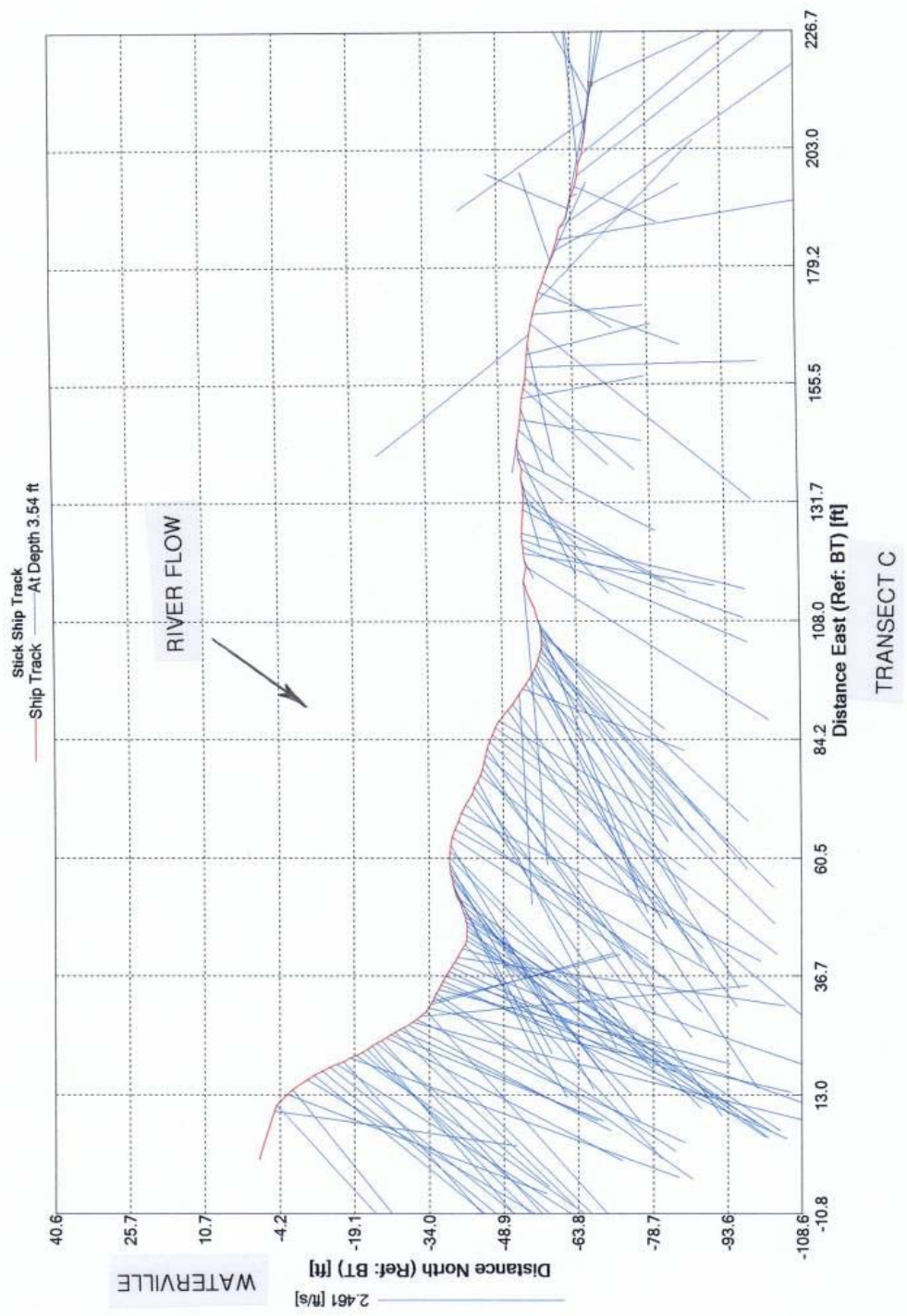


Figure 14: Transect C ship track plan-view vector sticks 3.5’ below water surface

Transect C Notes: Transect length about 240’, Max. depth 13.4’, Mean depth 7.3’, Max. vel. 7 ft/sec. Mean vel. about 2.2 ft/sec. There is a highpoint on the river bottom about 140’ off the Waterville shore.

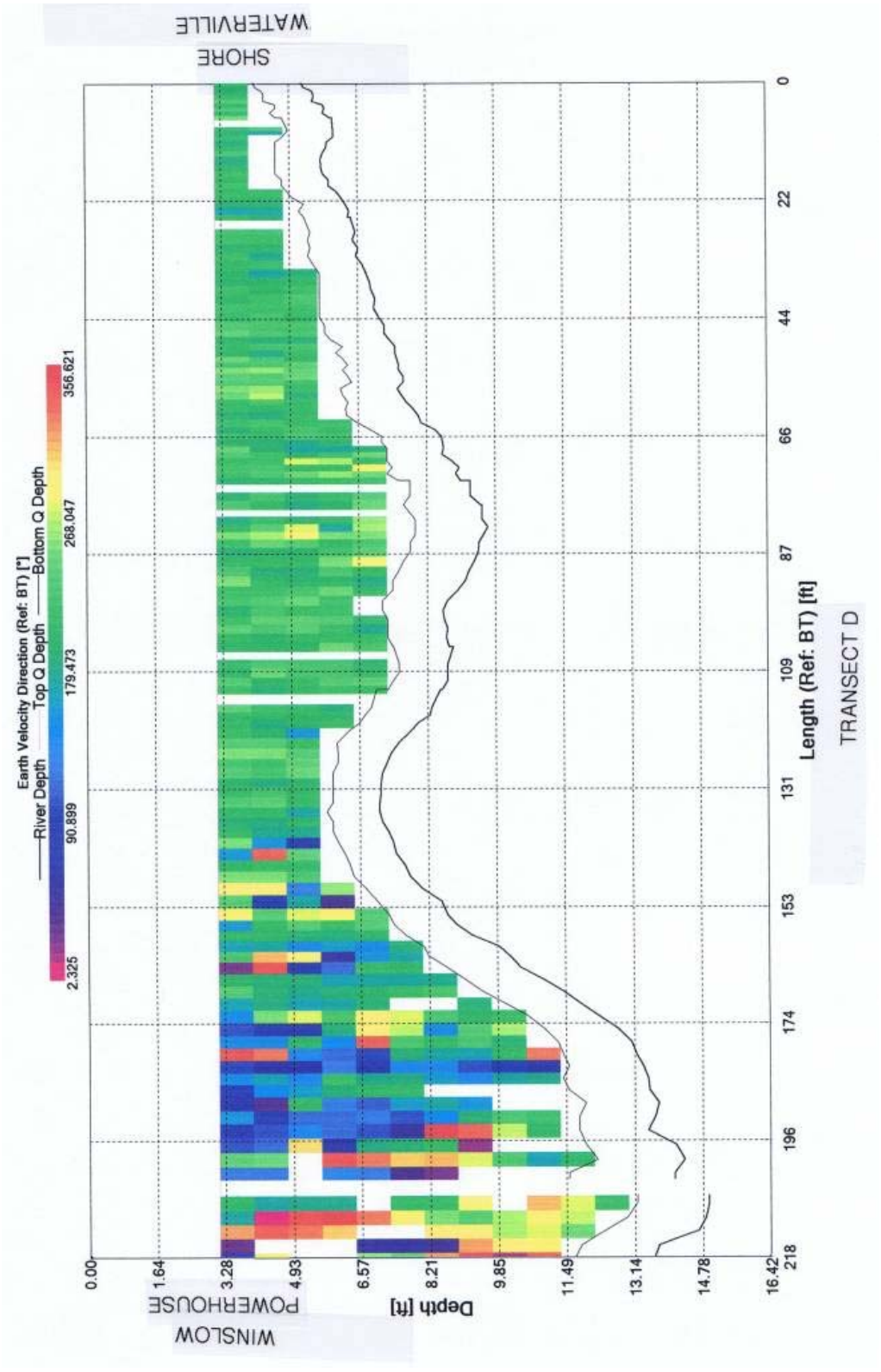


Figure 15: Transect D at tailrace illustrating direction

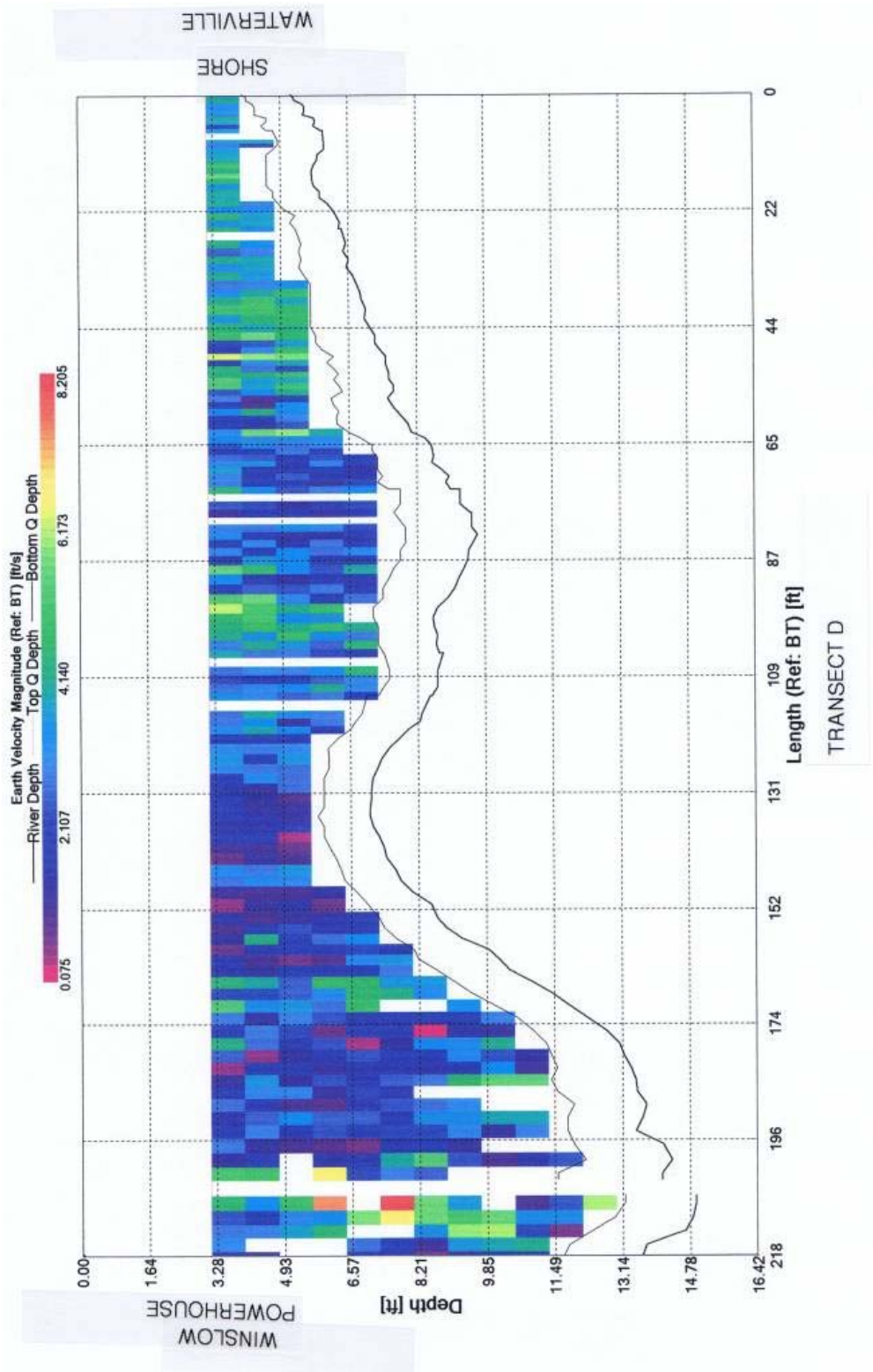


Figure 16: Transect D at tailrace illustrating magnitude

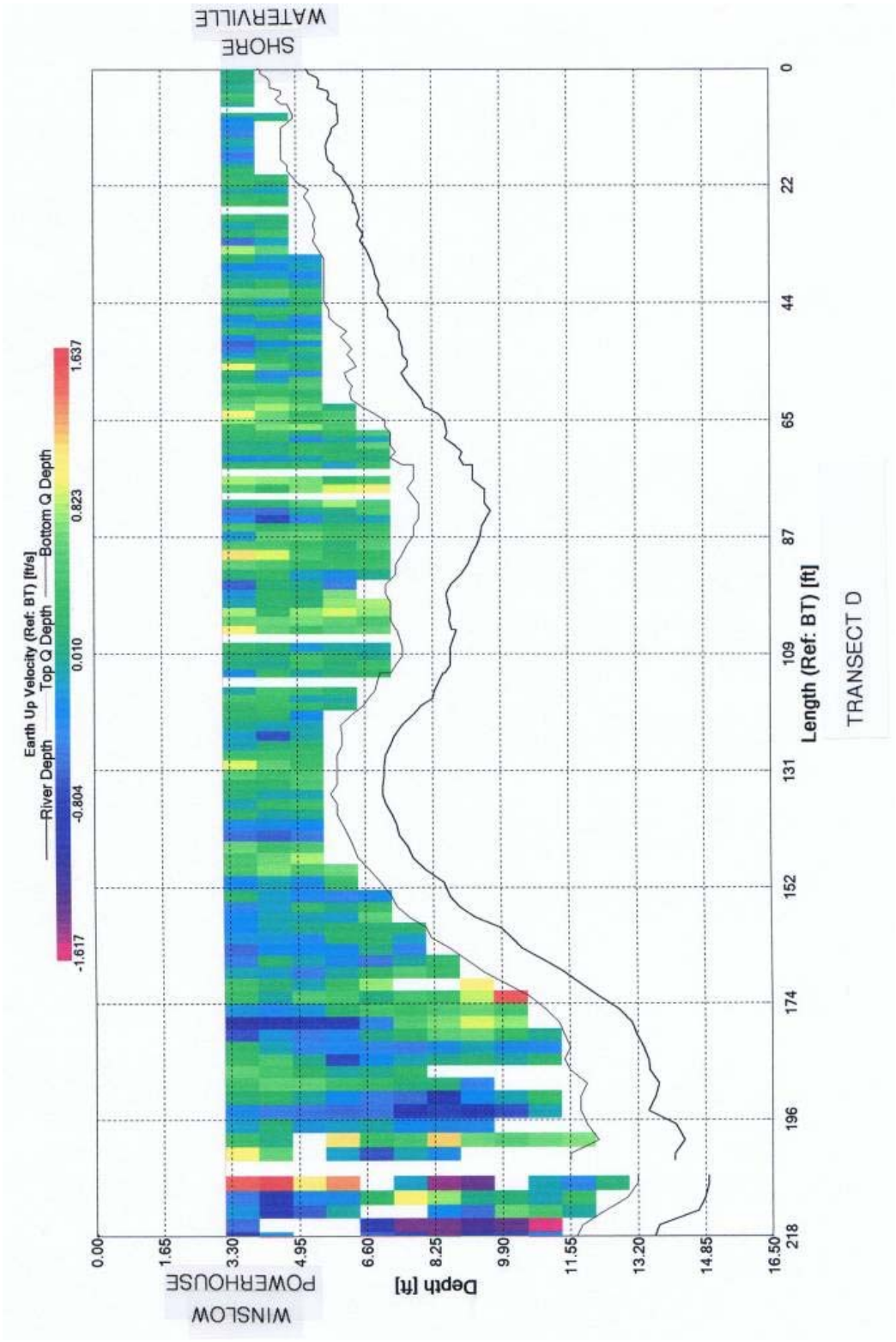


Figure 17: Transect D at tailrace illustrating vertical velocity

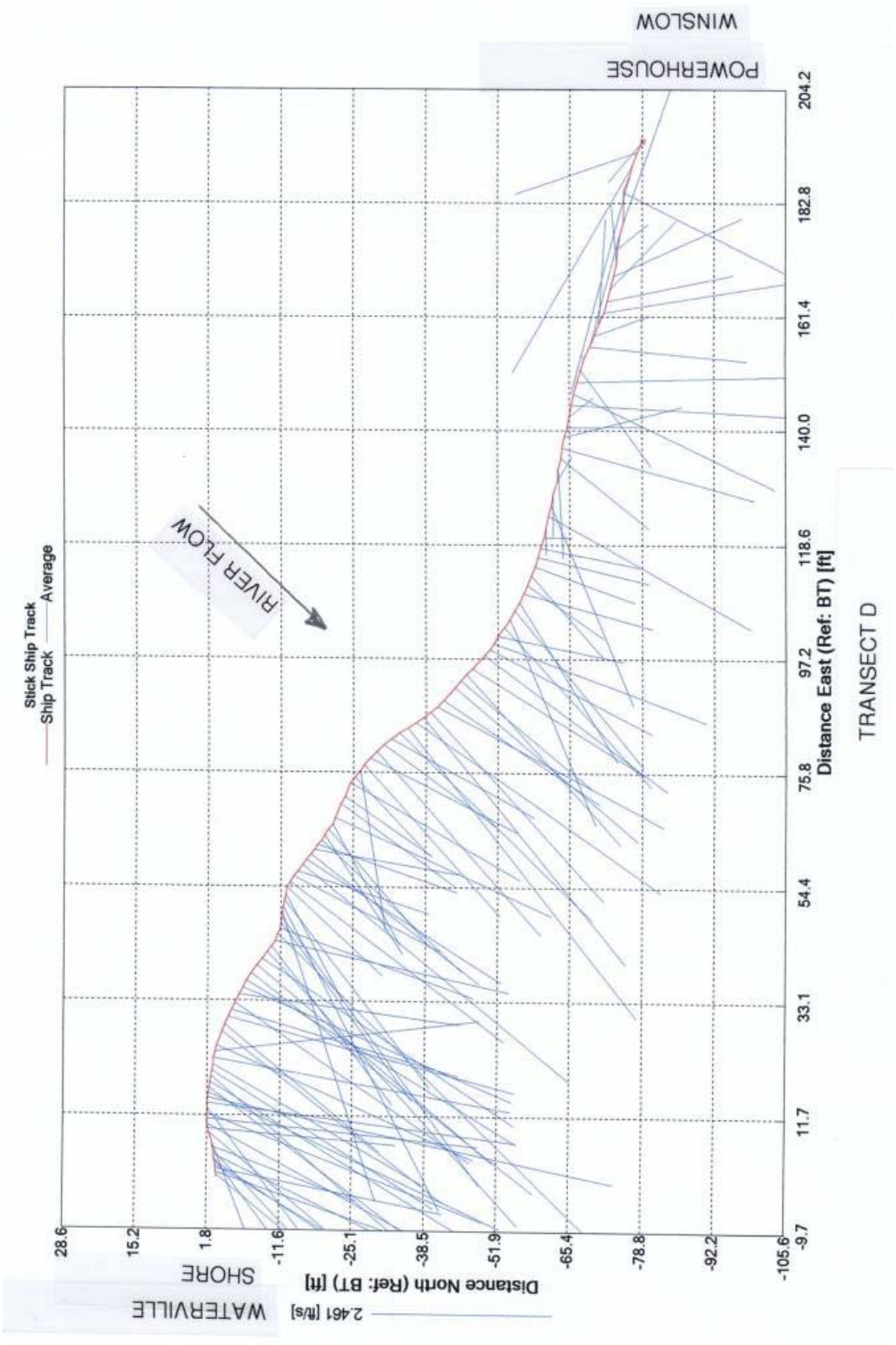


Figure 18: Transect D ship track plan-view vector sticks illustrating average direction

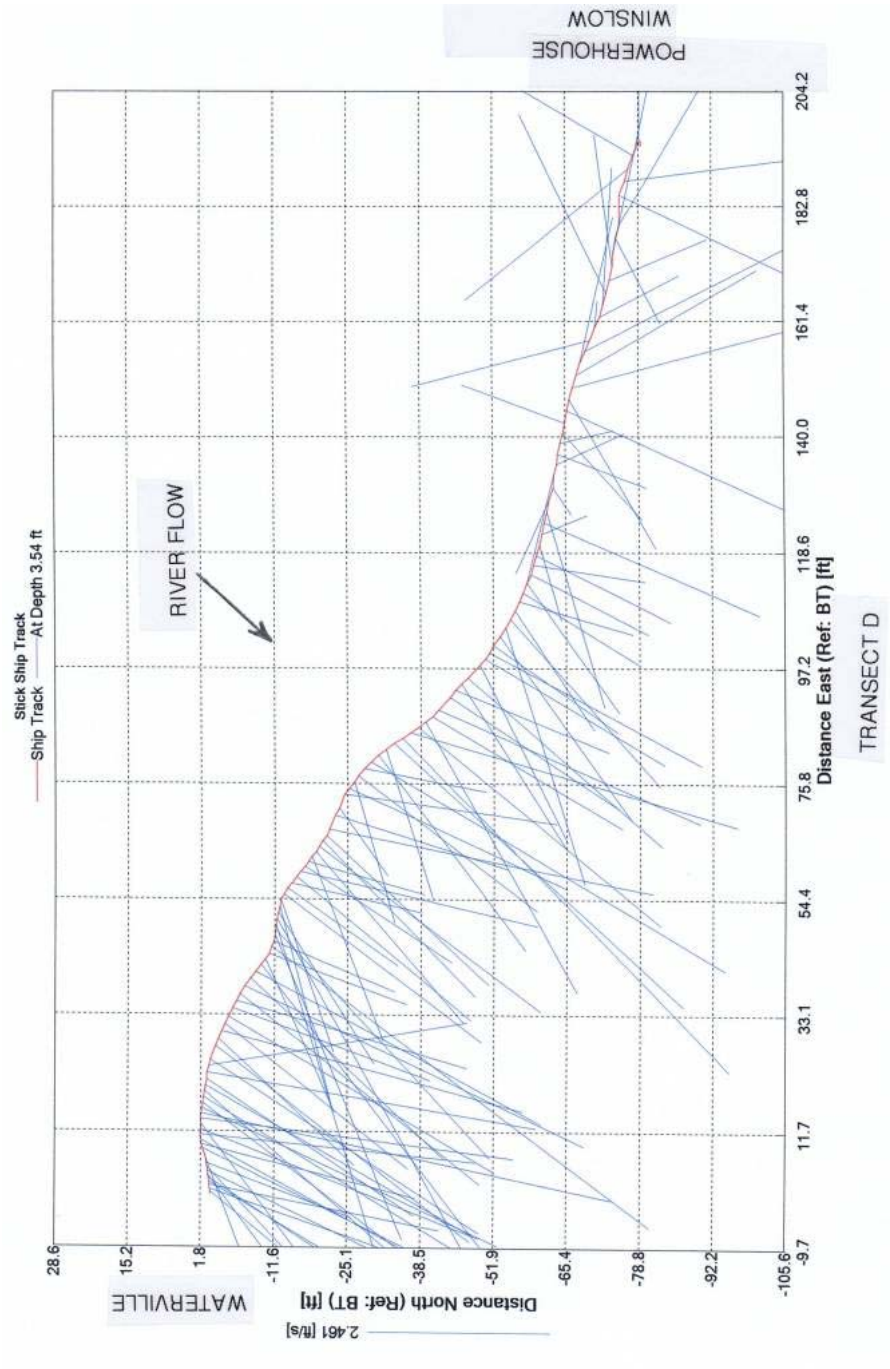


Figure 19: Transect D ship track plan-view vector sticks 3.5’ below water surface

Transect D Notes: Transect length about 225’, Max. depth 15.2’, Mean depth 9’, Max. vel. 10.3 ft/sec. Mean vel. about 2 ft/sec. Some cells have the vertical water velocity around 0.9 ft/sec. about 70’ from Waterville shore. As one would expect maximum vertical velocities are up against the powerhouse. There is a shoal about 130’ off the Waterville shore and about 1’ lower in elevation than Transect C.

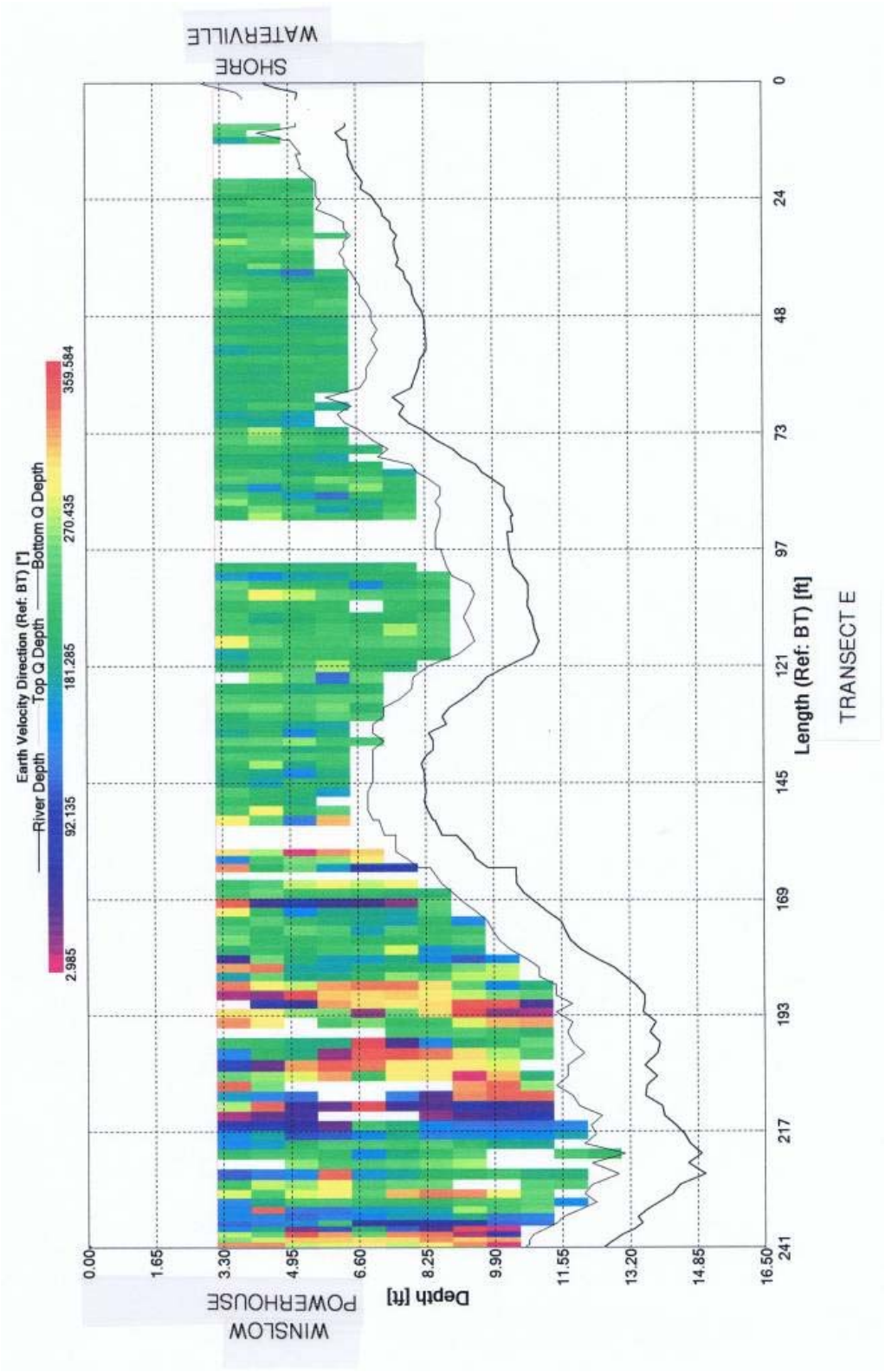


Figure 20: Transect E at tailrace illustrating direction

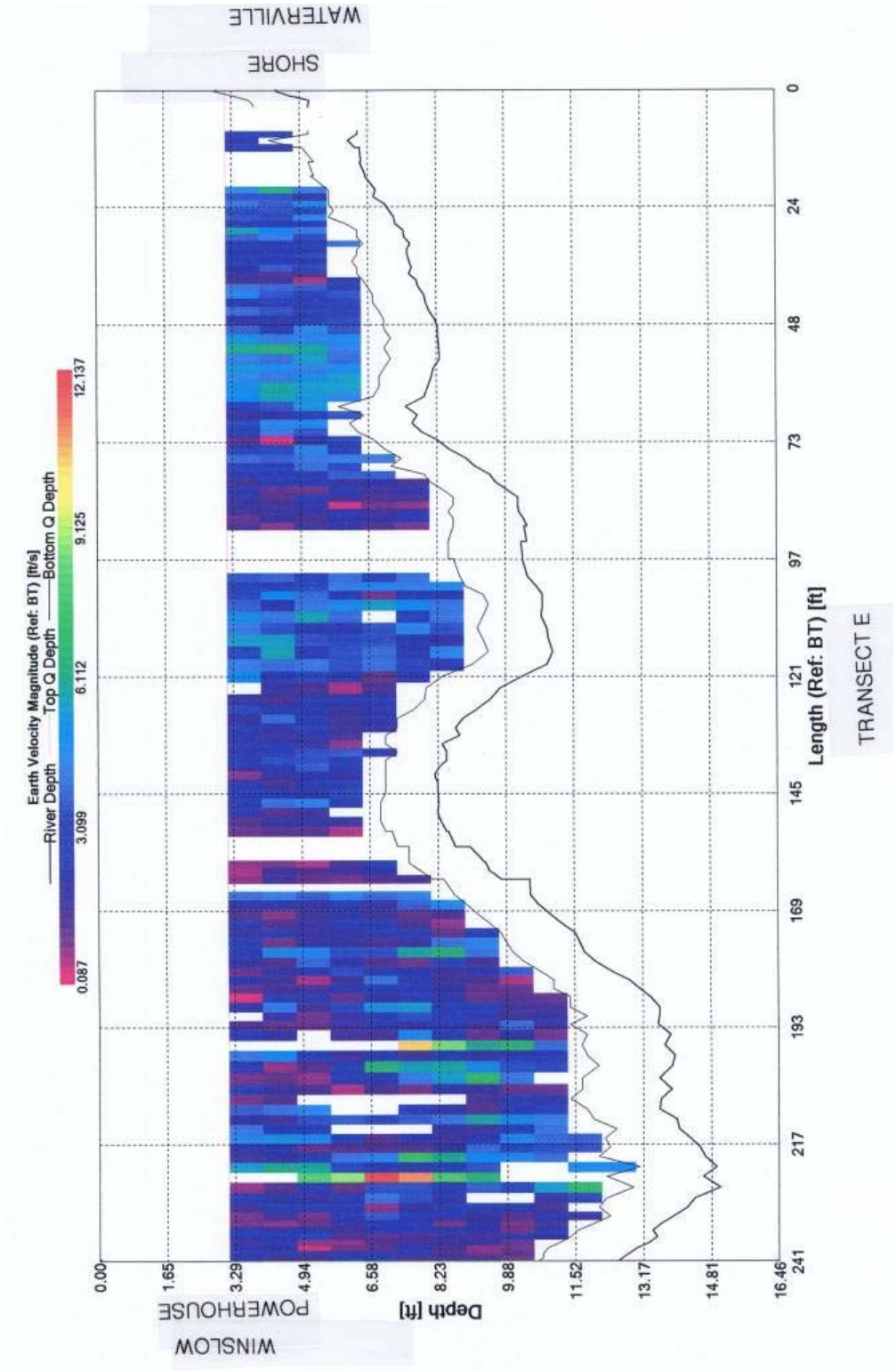


Figure 21: Transect E at tailrace illustrating magnitude

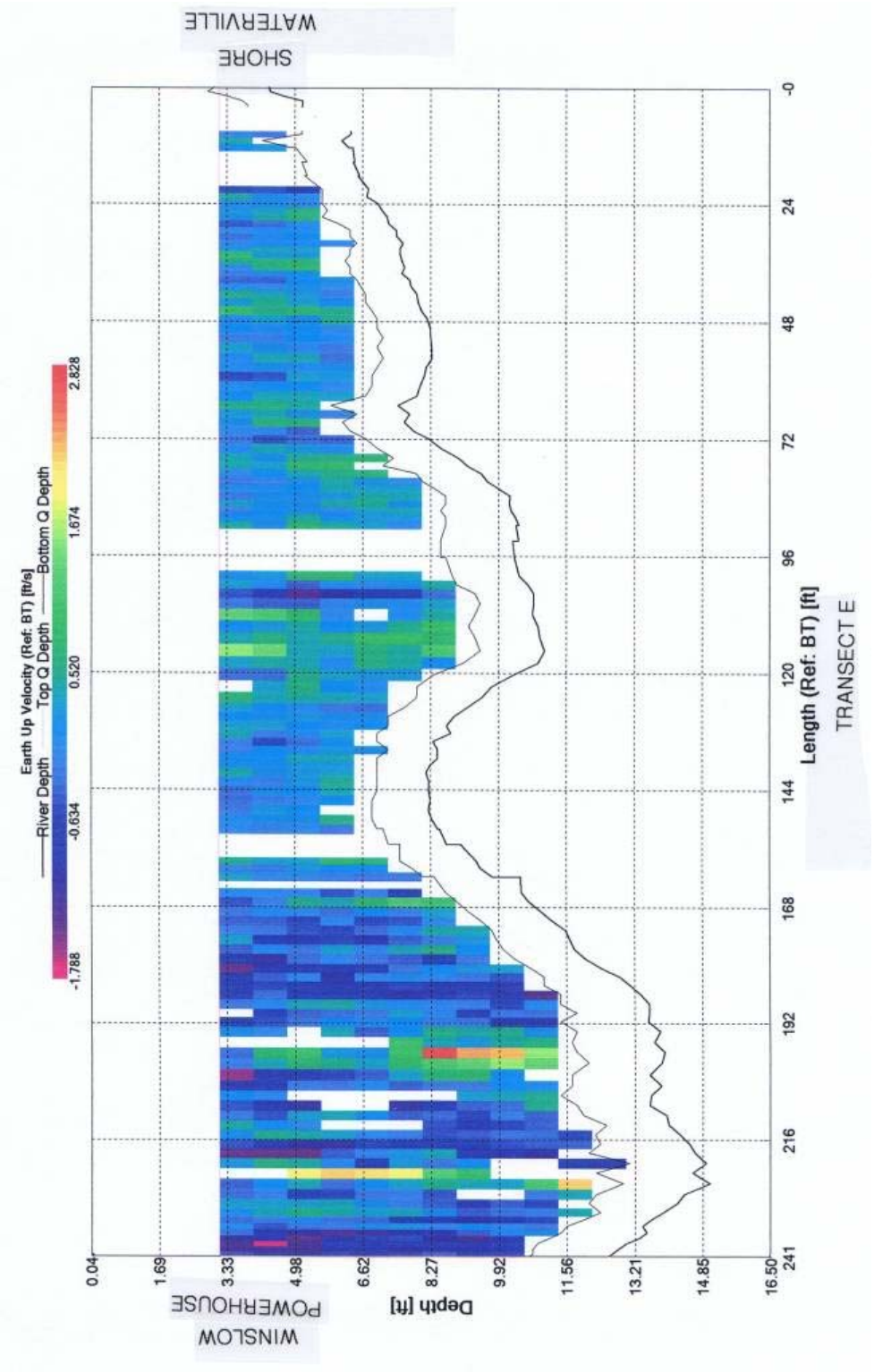


Figure 22: Transect E at tailrace illustrating vertical velocity

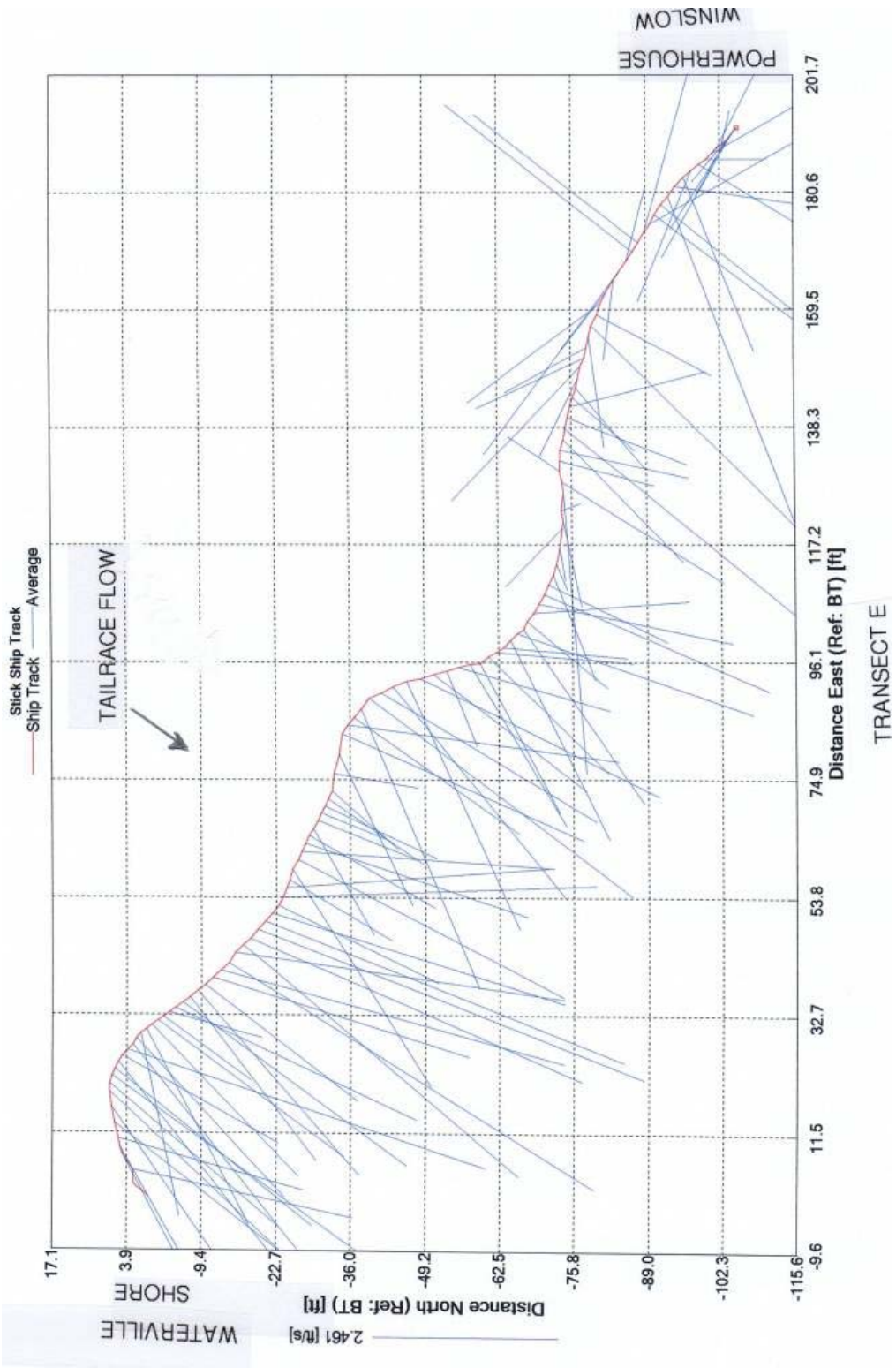


Figure 23: Transect E ship track plan-view with vector sticks illustrating average direction

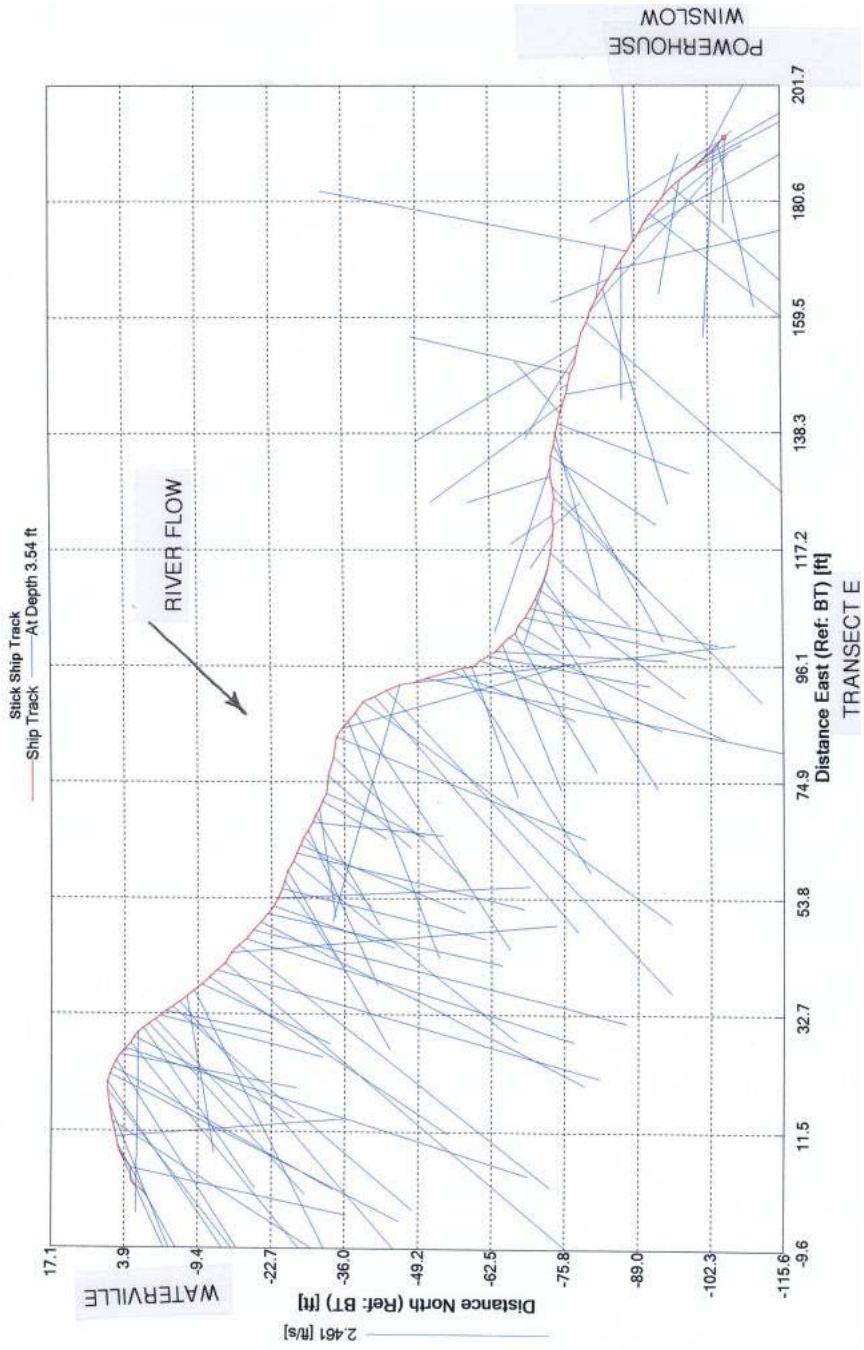


Figure 24: Transect E ship track plan-view vector sticks 3.5’ below water surface

Transect E Notes: Transect length about 230’, Max. depth 15.1’, Mean depth 10’, Max. vel. 12 ft/sec. Mean vel. about 1.9 ft/sec. The vertical water velocities go up and down by the powerhouse. There are two shoals, one at about 70’ and one at about 145’ off the Waterville shore and about 1’ lower in elevation than Transect C. Flow maintains shore lead on Waterville side of transect.

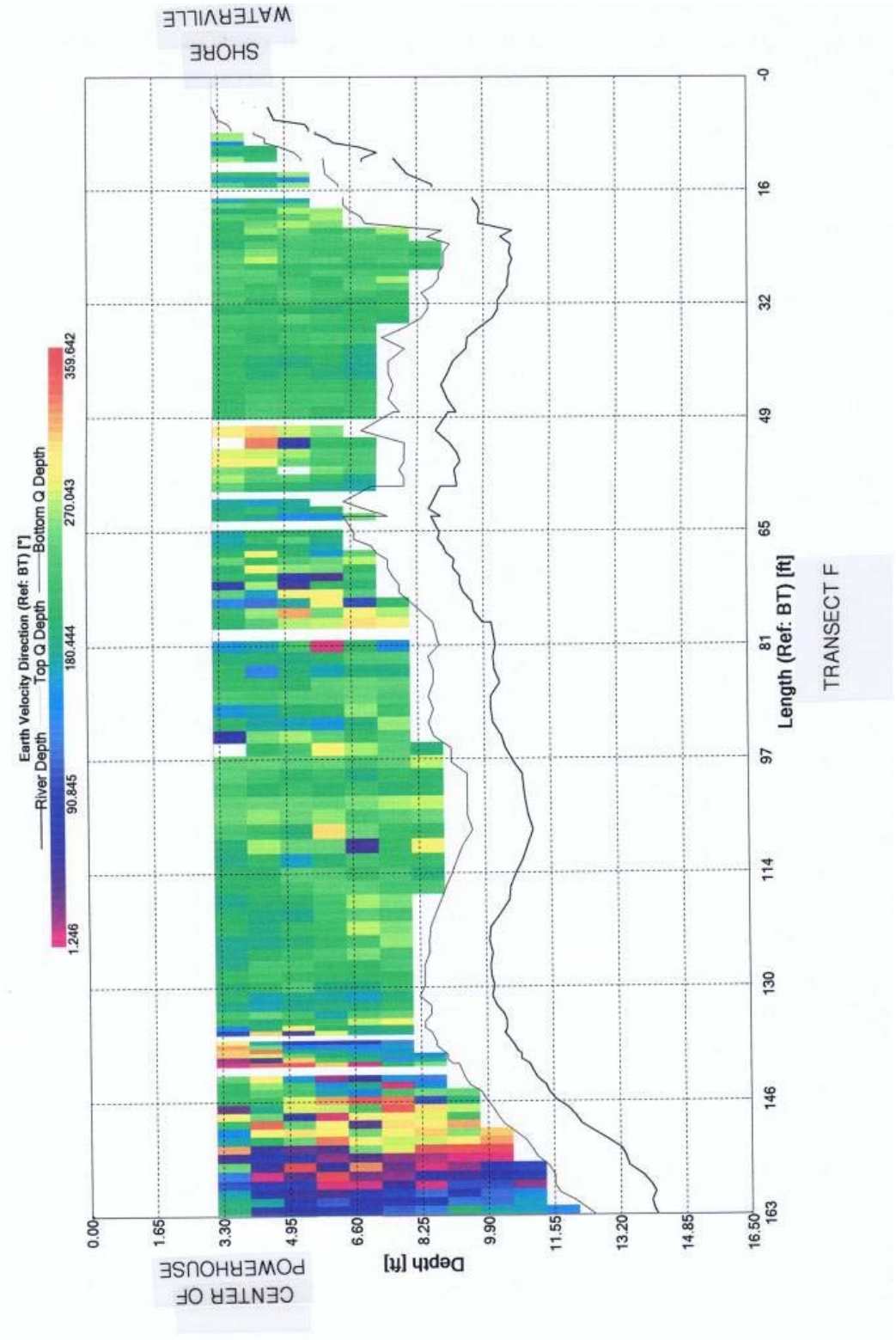


Figure 25: Transect F at tailrace illustrating direction

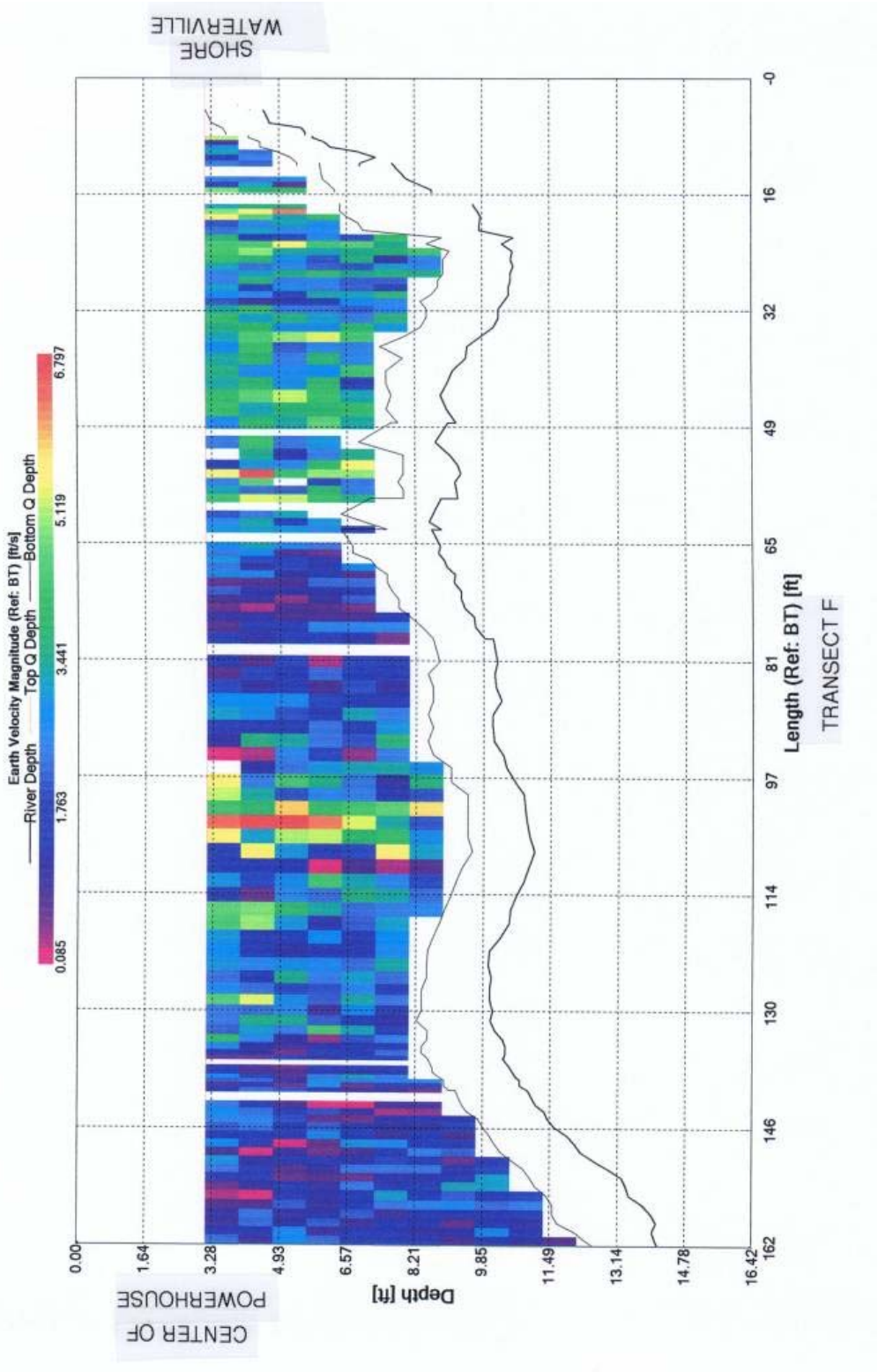


Figure 26: Transect F at tailrace illustrating magnitude

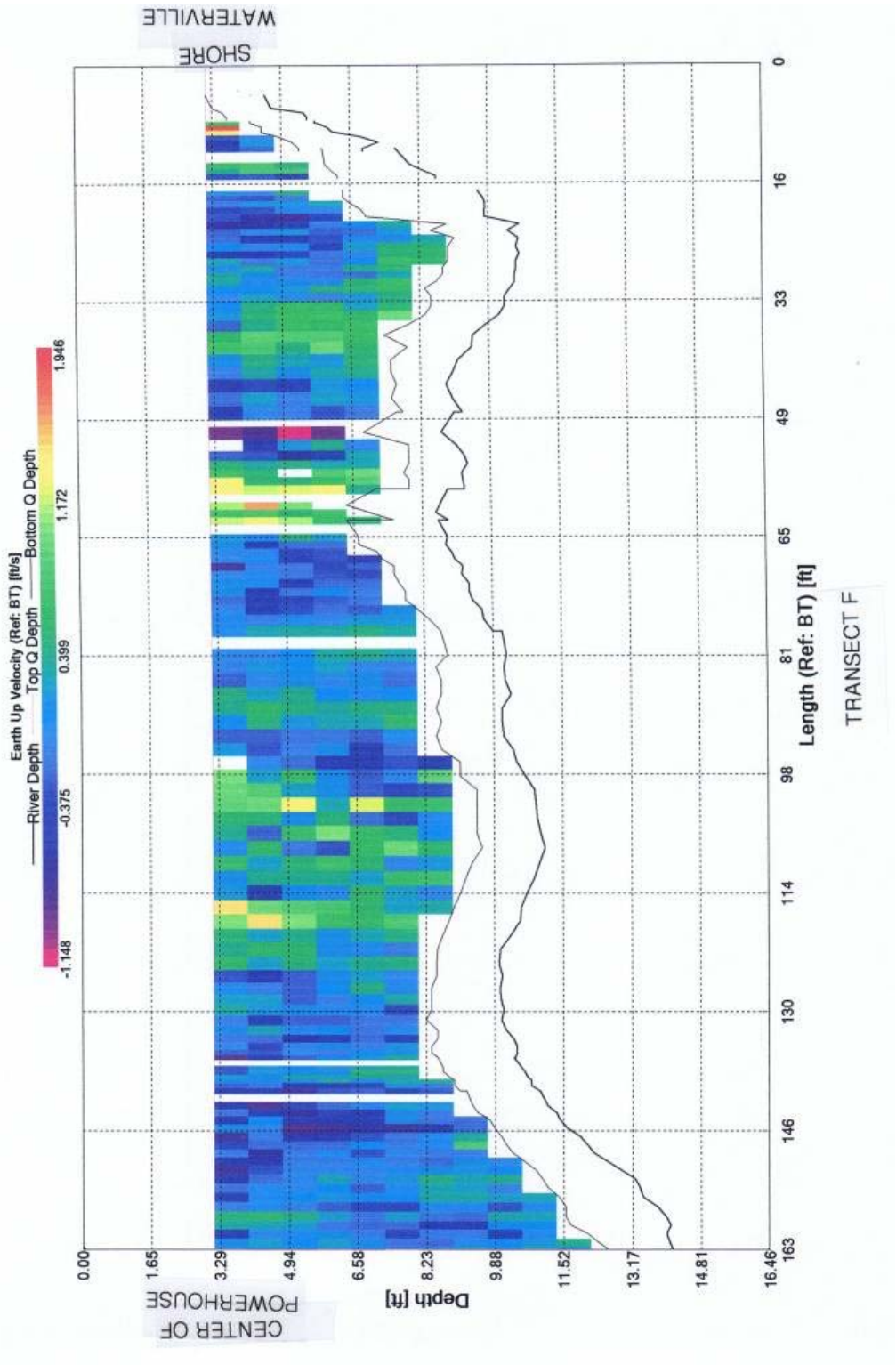


Figure 27: Transect F at tailrace illustrating vertical velocity

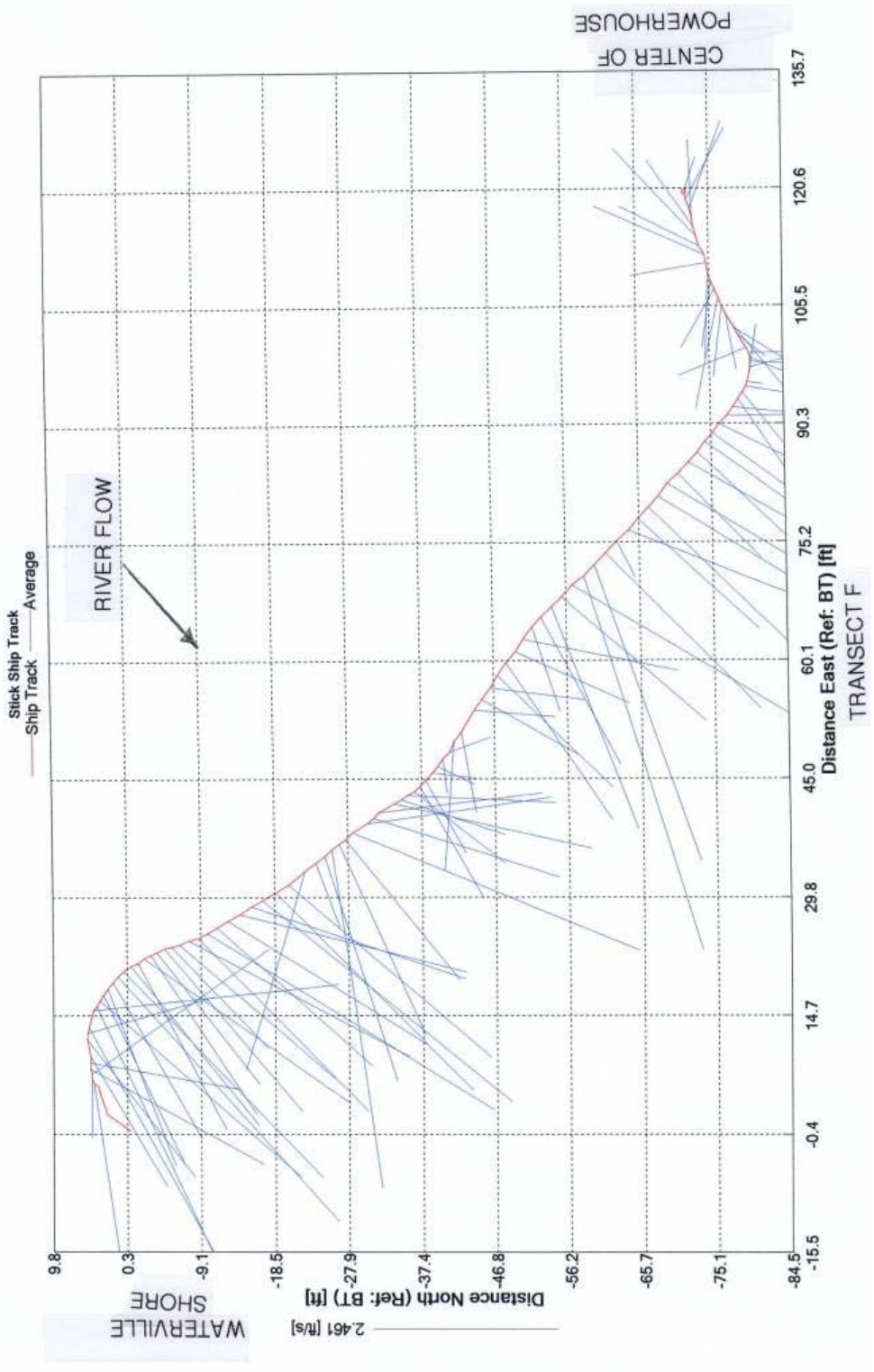


Figure 28: Transect F ship track plan-view vector sticks illustrating average direction

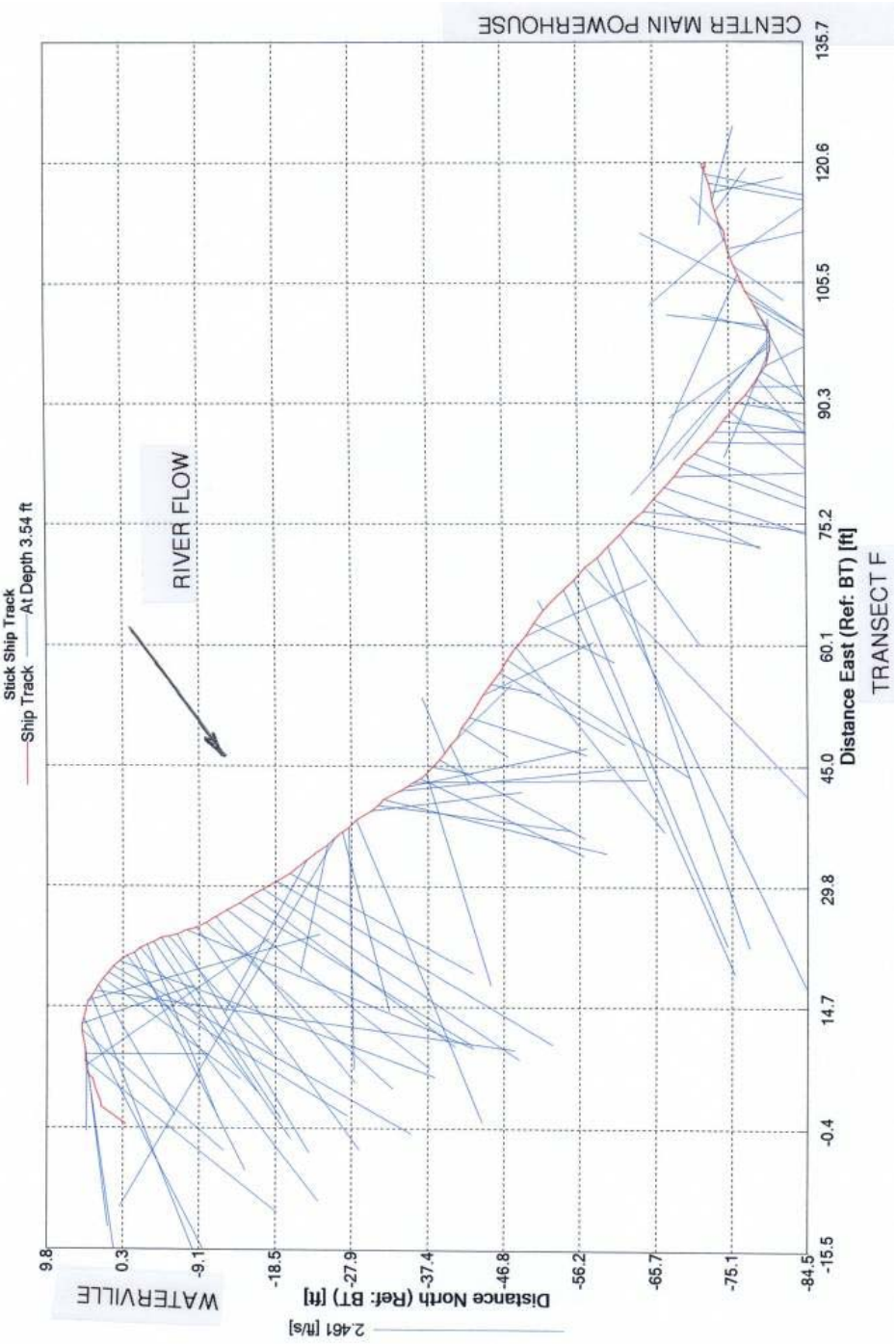


Figure 29: Transect F ship track plan-view vector sticks 3.5’ below water surface

Transect F Notes: Transect length about 150’, Max. depth 14.8’, Mean depth 9.5’, Max. vel. 10 ft/sec. Mean vel. about 1.8 ft/sec. Directional turbulence at powerhouse area. See upwelling at the rock outcrops. Flow maintains shore lead on Waterville side of transects.

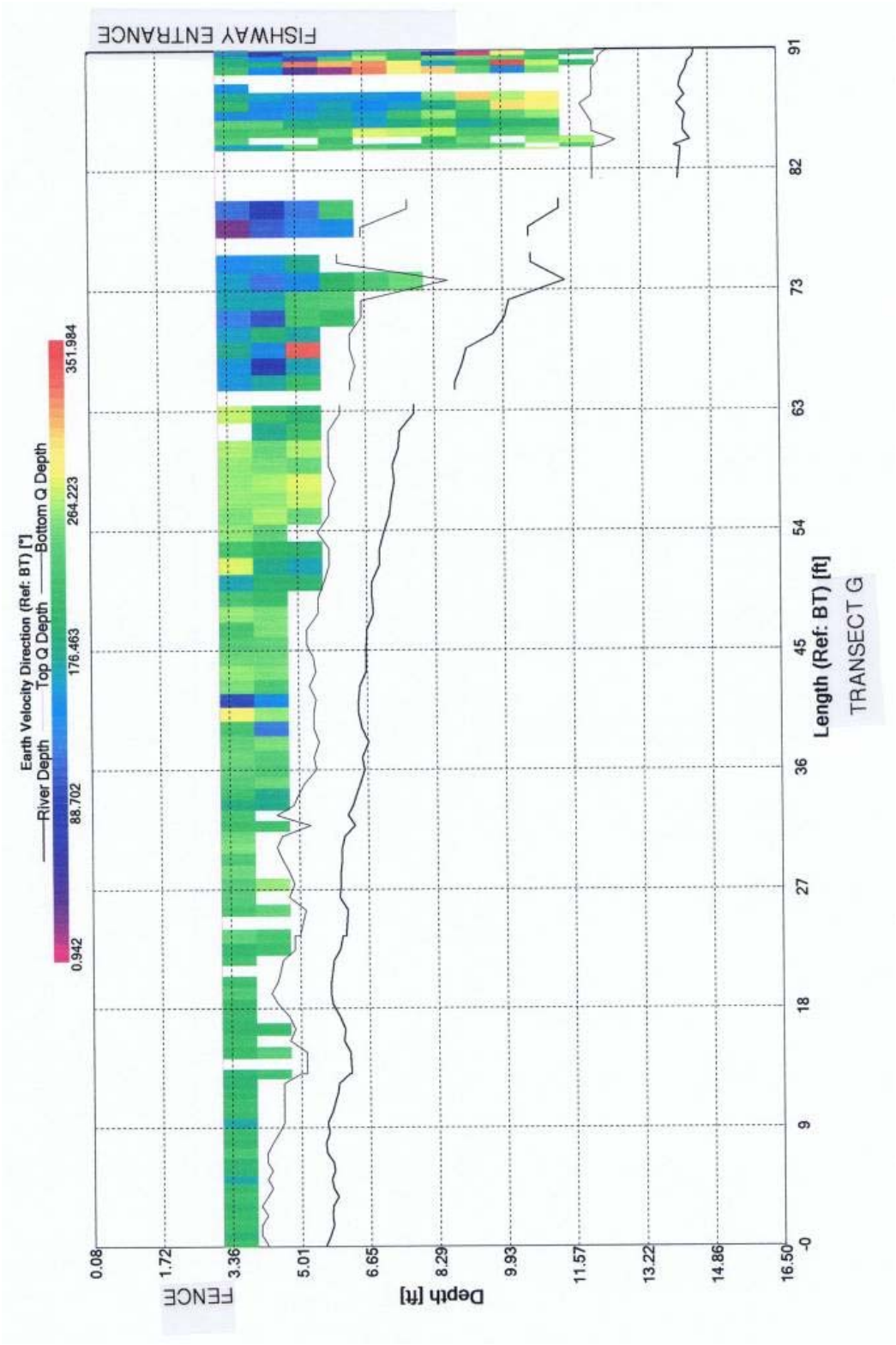


Figure 30: Transect G at tailrace illustrating direction

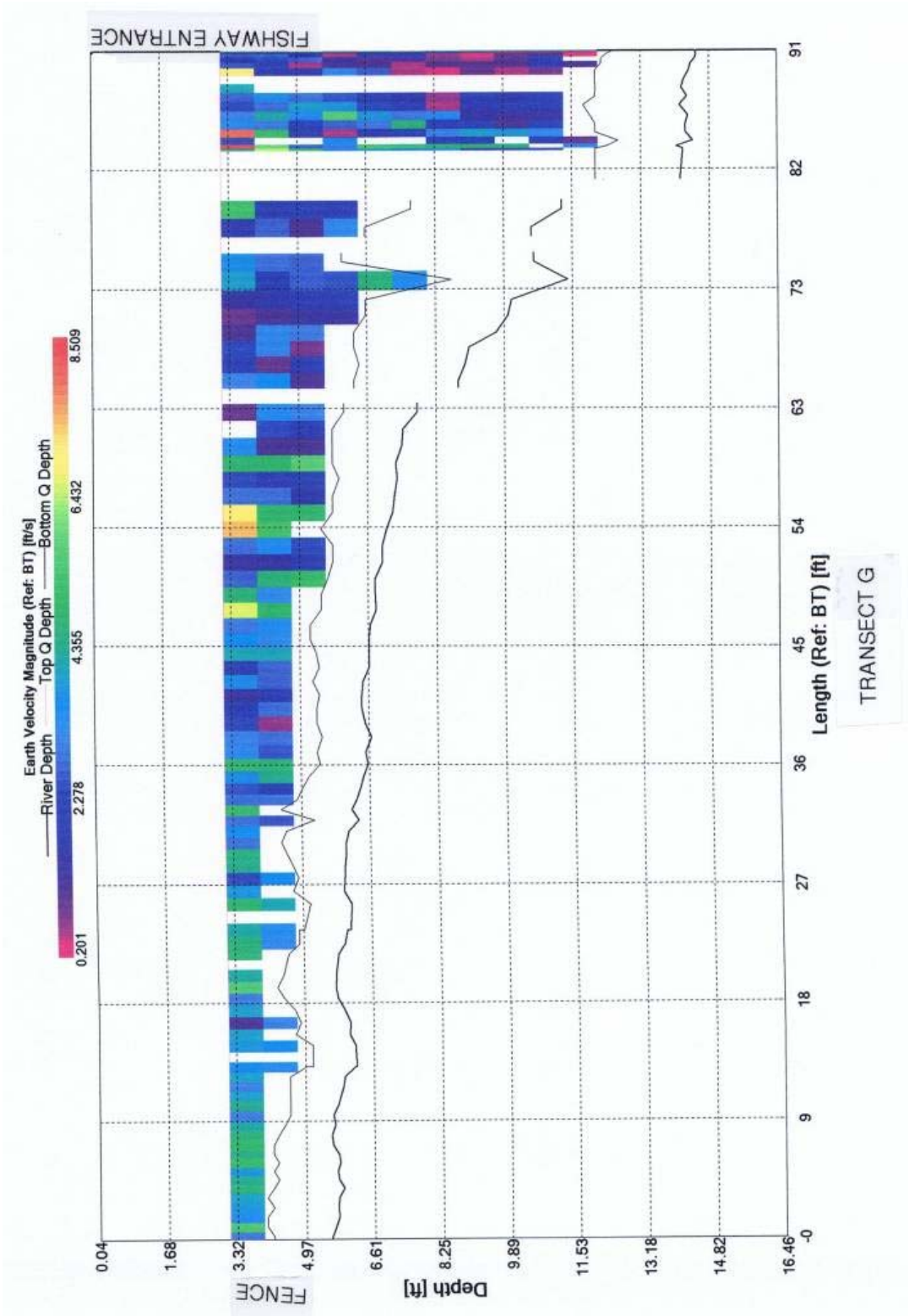


Figure 31: Transect G at tailrace illustrating magnitude

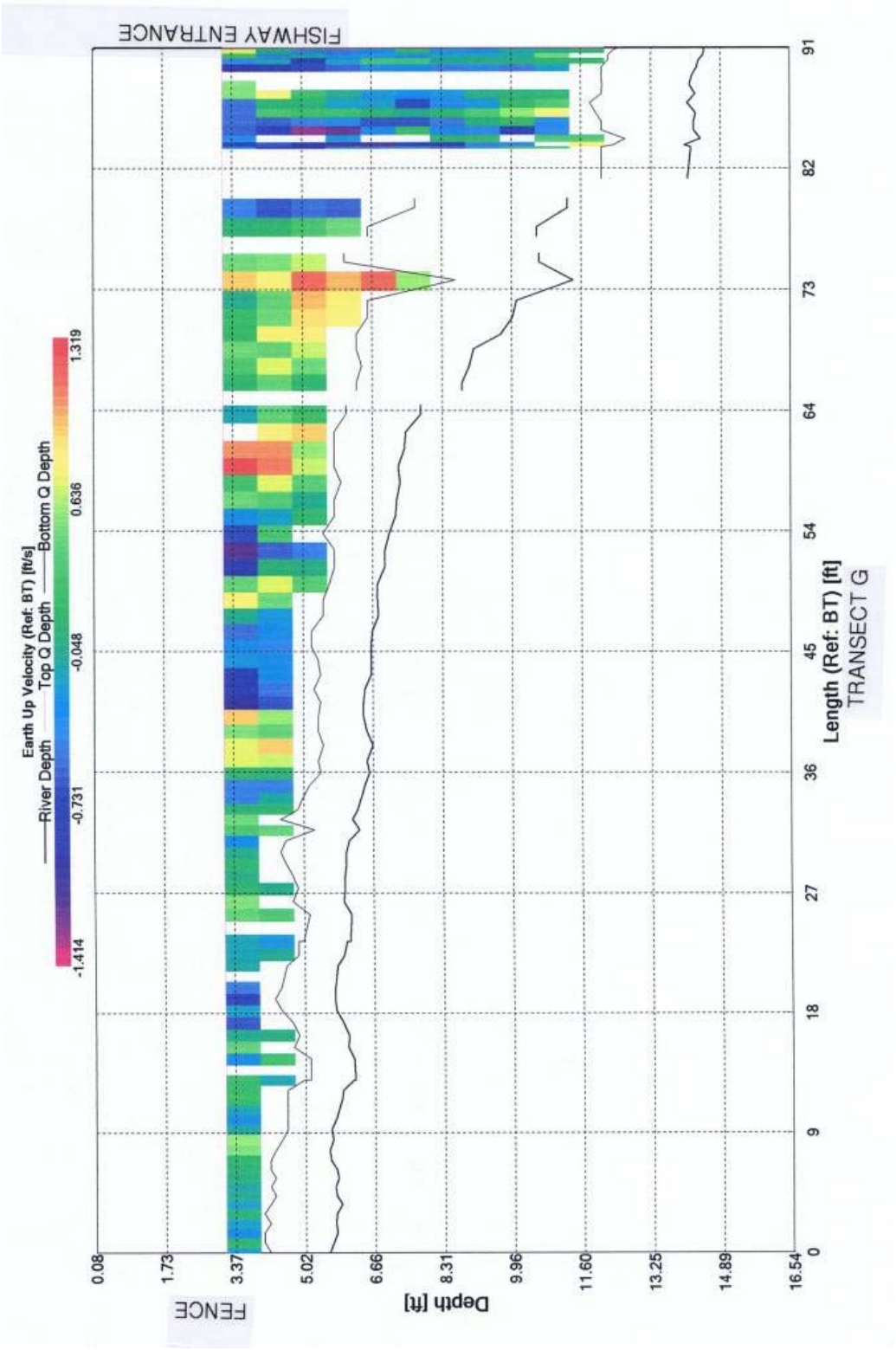


Figure 32: Transect G at tailrace illustrating vertical velocity

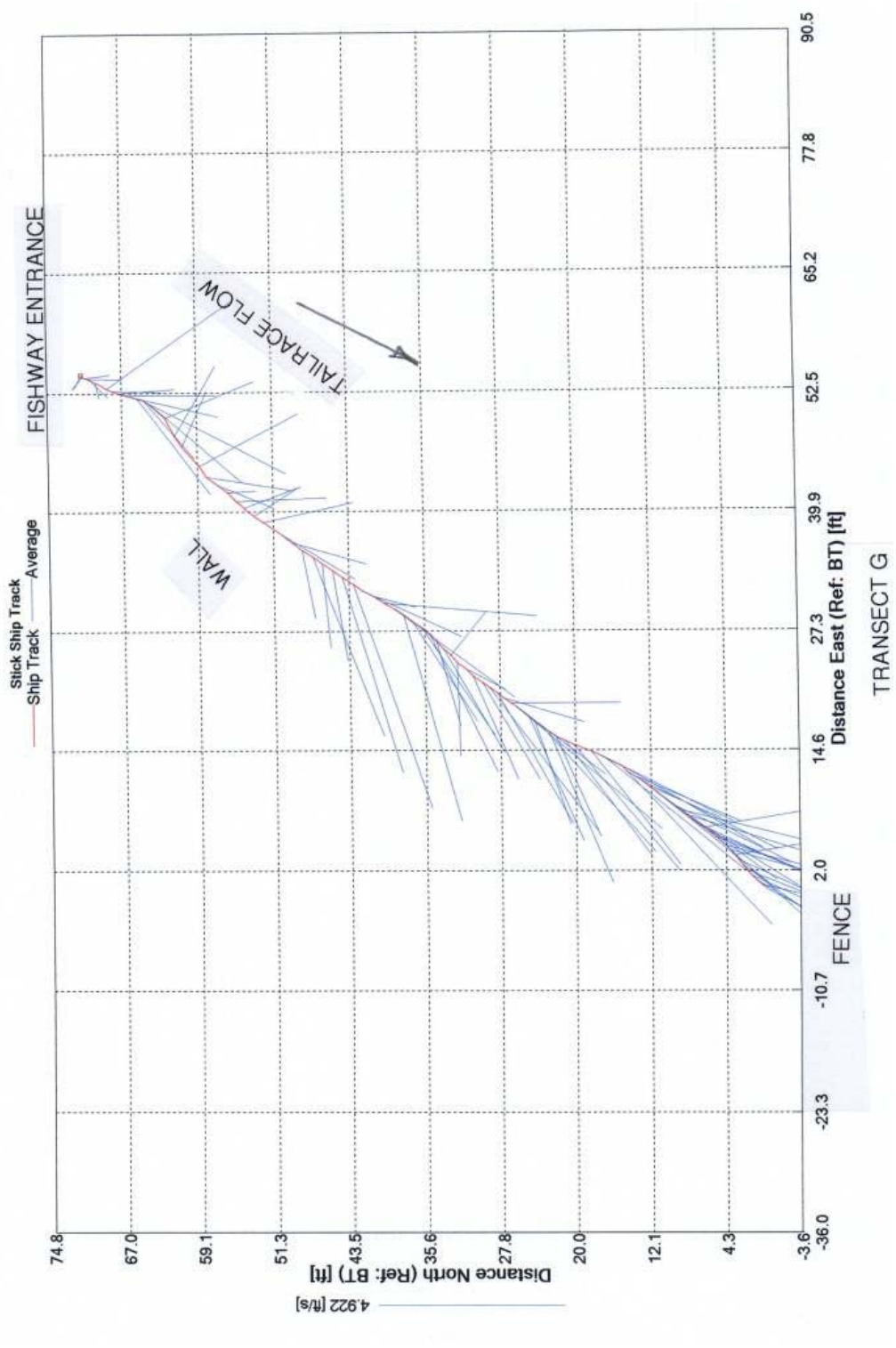


Figure 33: Transect G ship track plan-view vector sticks illustrating average direction and velocity

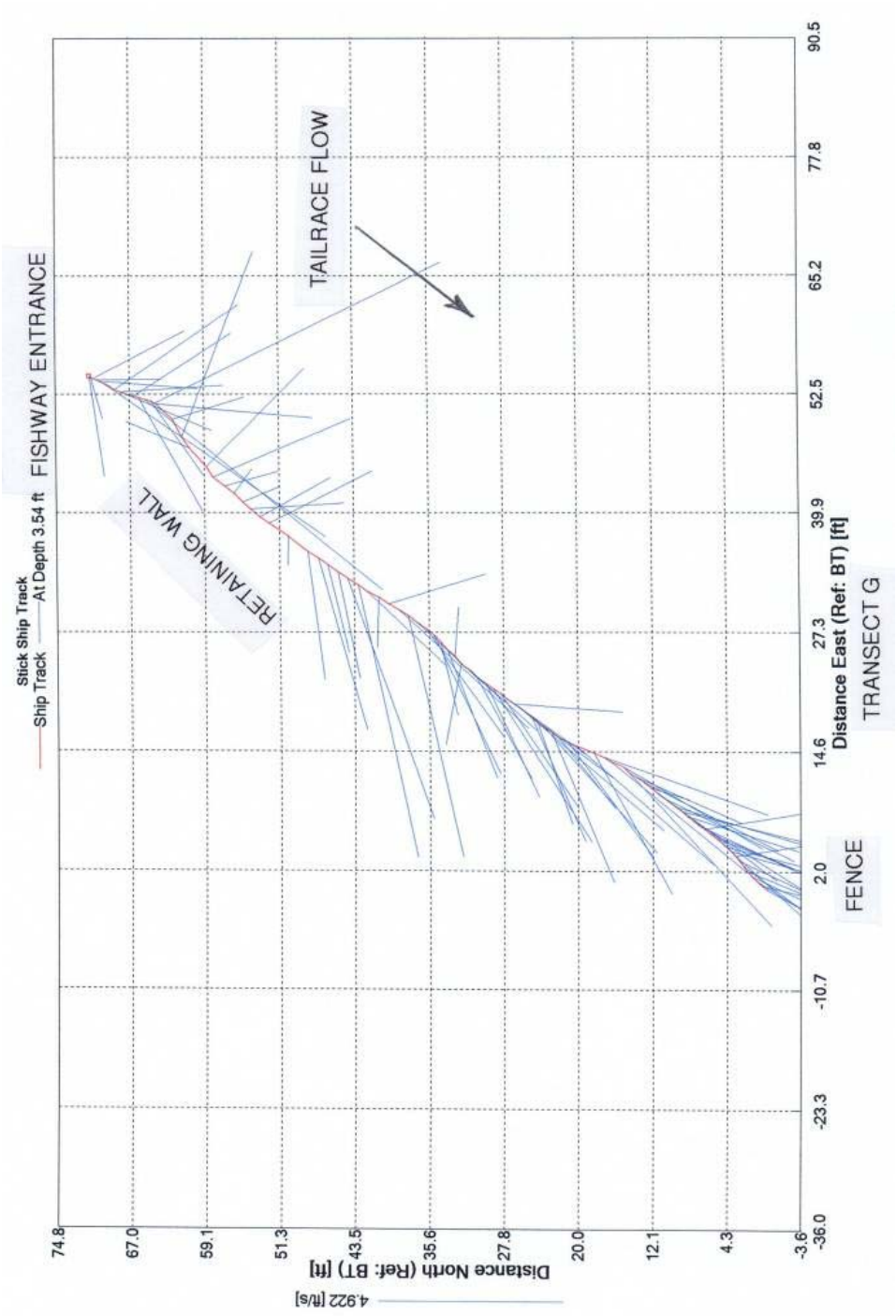


Figure 34: Transect G ship track plan-view vector sticks 3.5' below water surface

Transect G Notes: Figures 31, 32, and 33 show a bad data collection area at about the 82' location on the transect. There appears to be about a 2.5' grade change and the vector sticks show a vector toward the tailrace. There could be some influence on data collection of the side lobes hitting the retaining wall but the grade change appears to be pronounced.

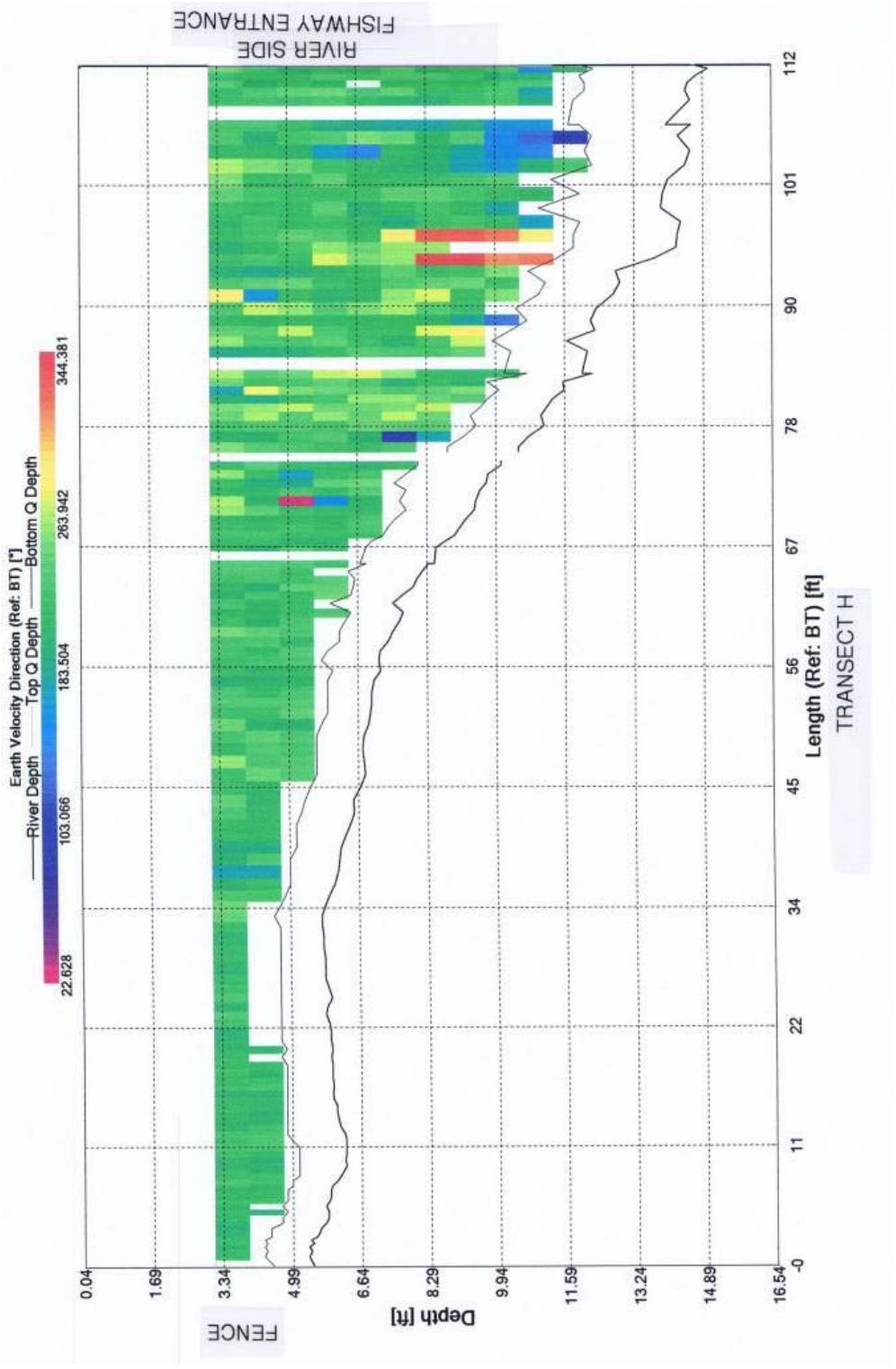


Figure 35: Transect H at tailrace illustrating direction

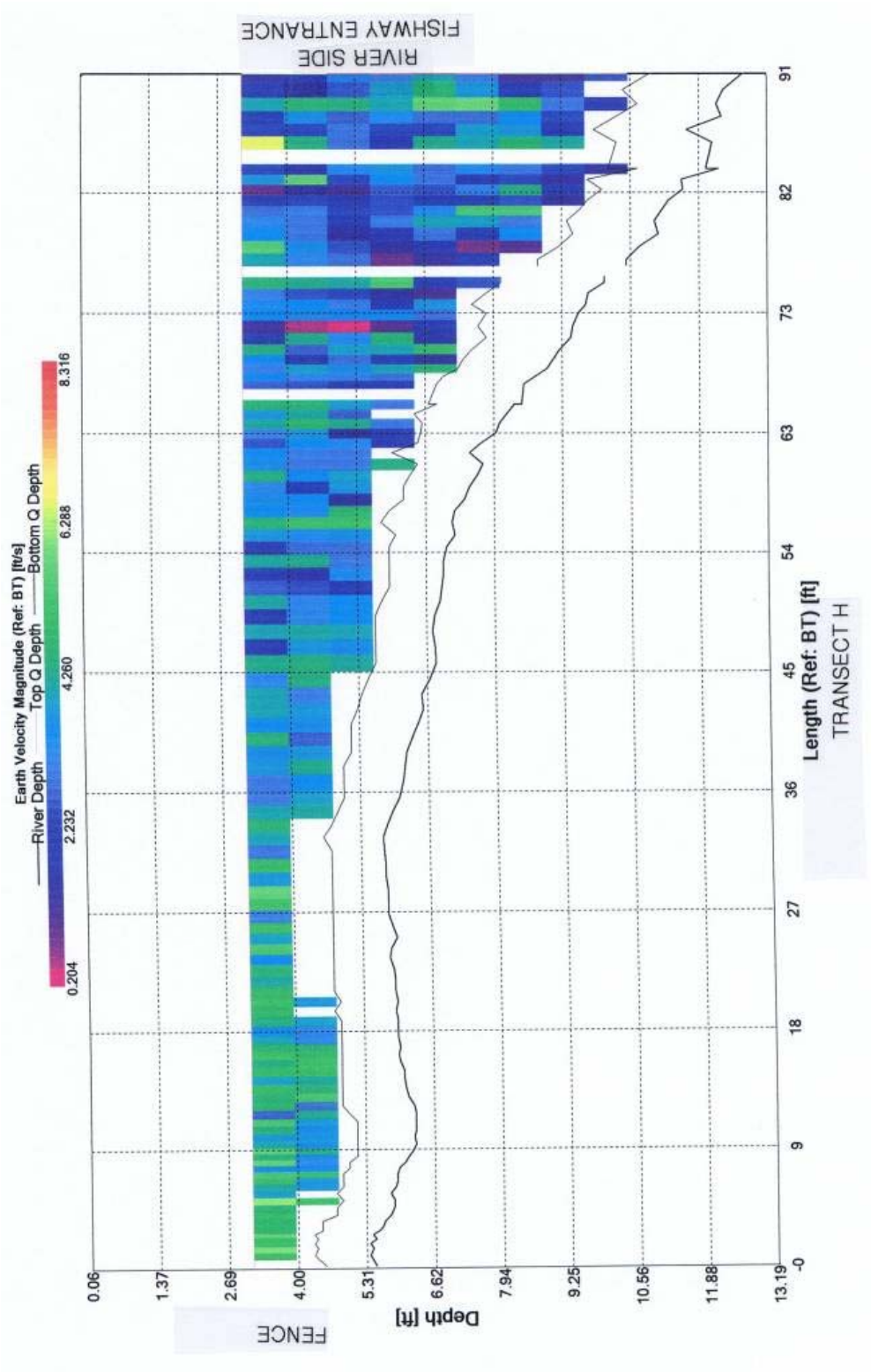


Figure 36: Transect H tailrace illustrating magnitude

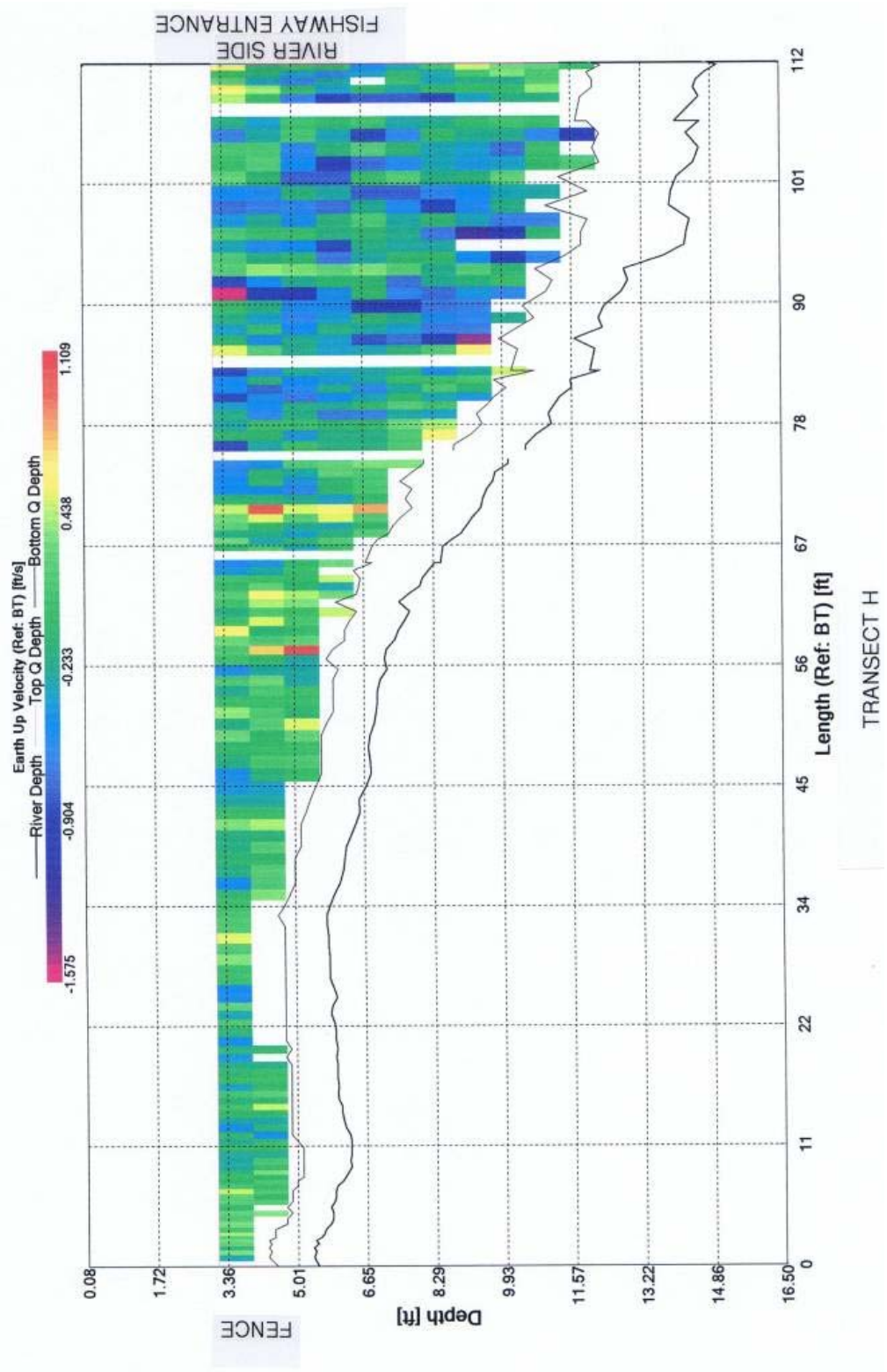


Figure 37: Transect H at tailrace illustrating vertical velocities

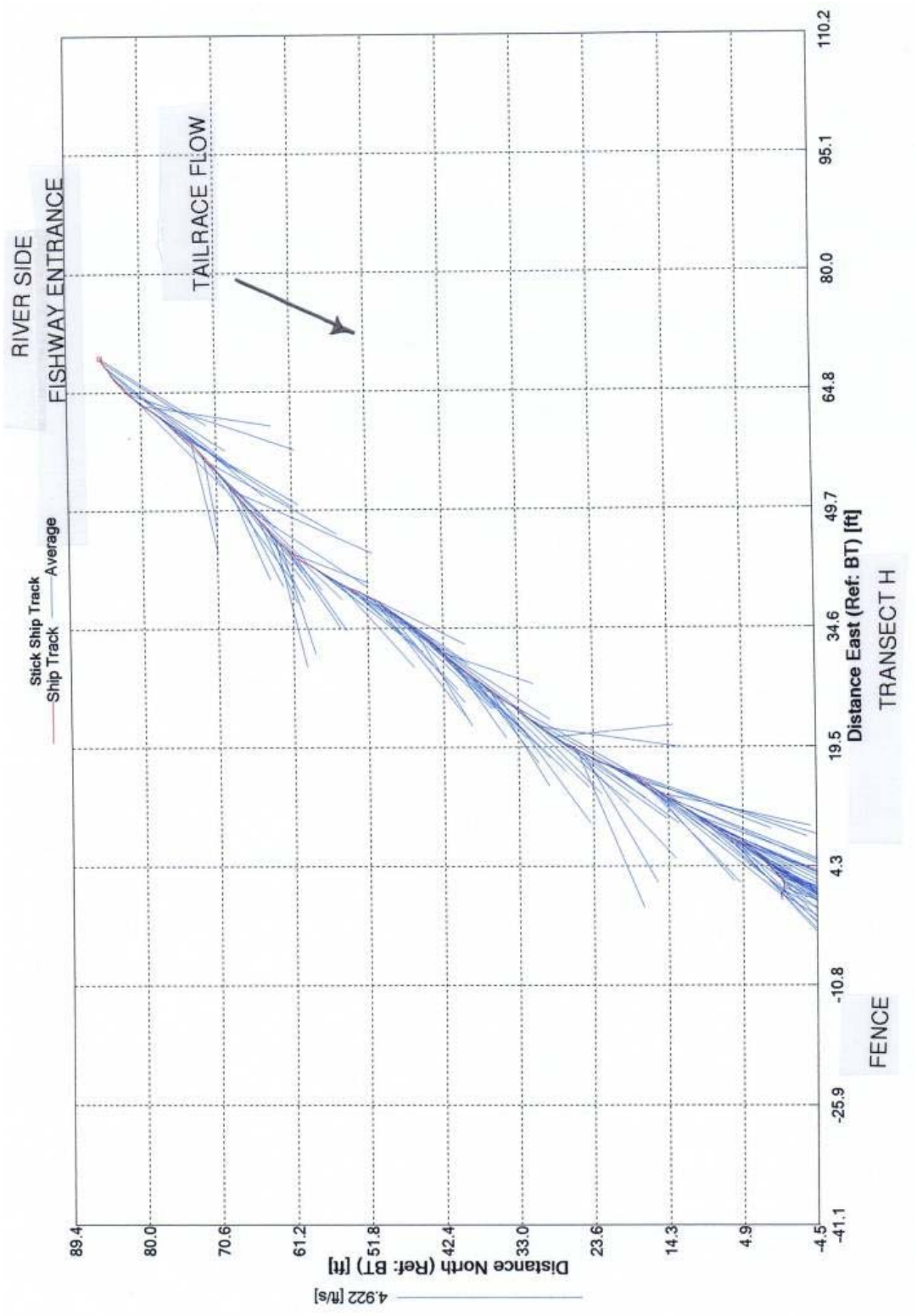


Figure 38: Transect H ship track plan-view vector sticks illustrating average direction

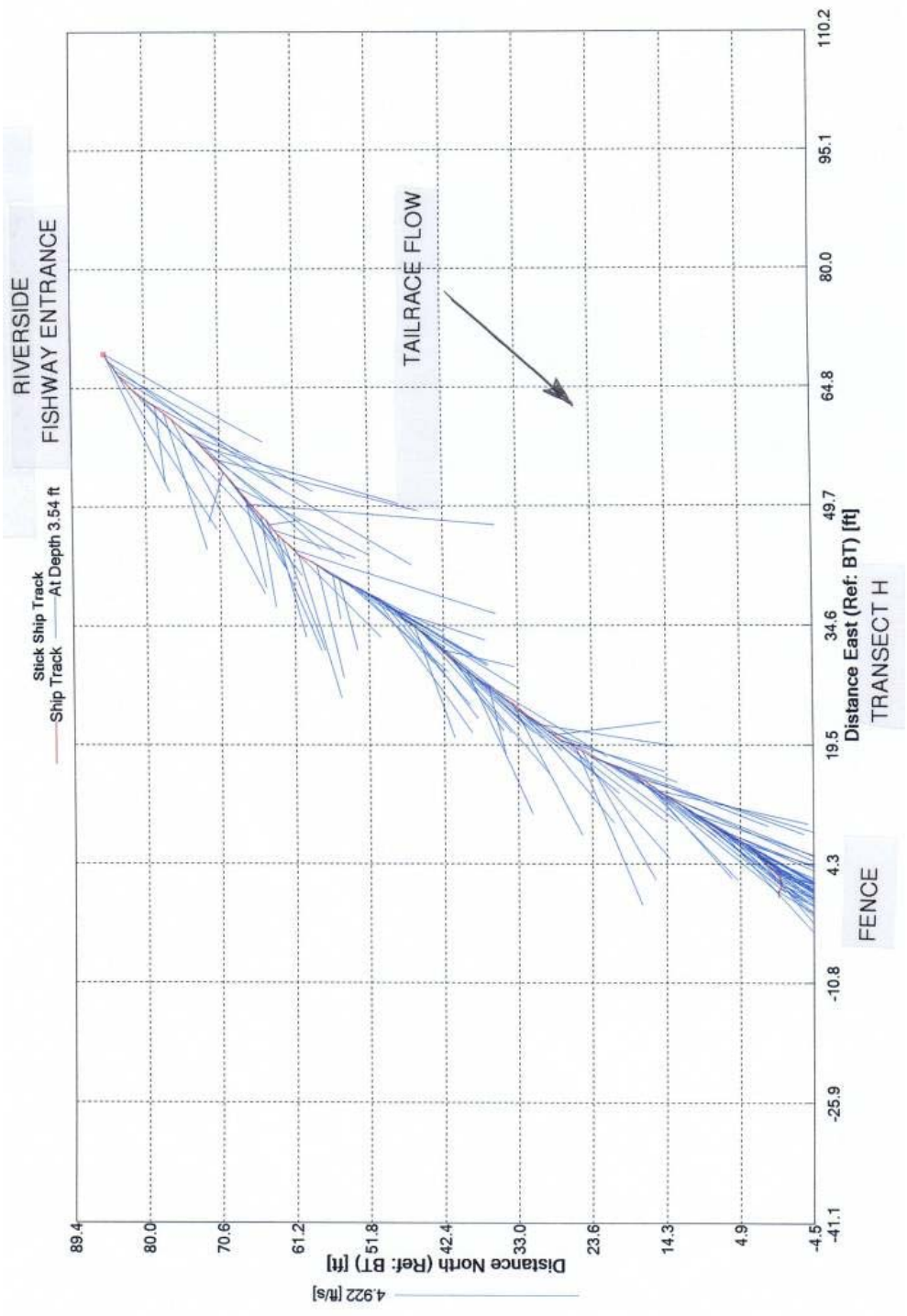


Figure 39: Transect H ship track plan-view vector sticks 3.5' below water surface

Transect H Notes: Figures 35, 36, and 37 do not show the abrupt grade change shown on Transect G. The vector sticks show vectors going downstream.

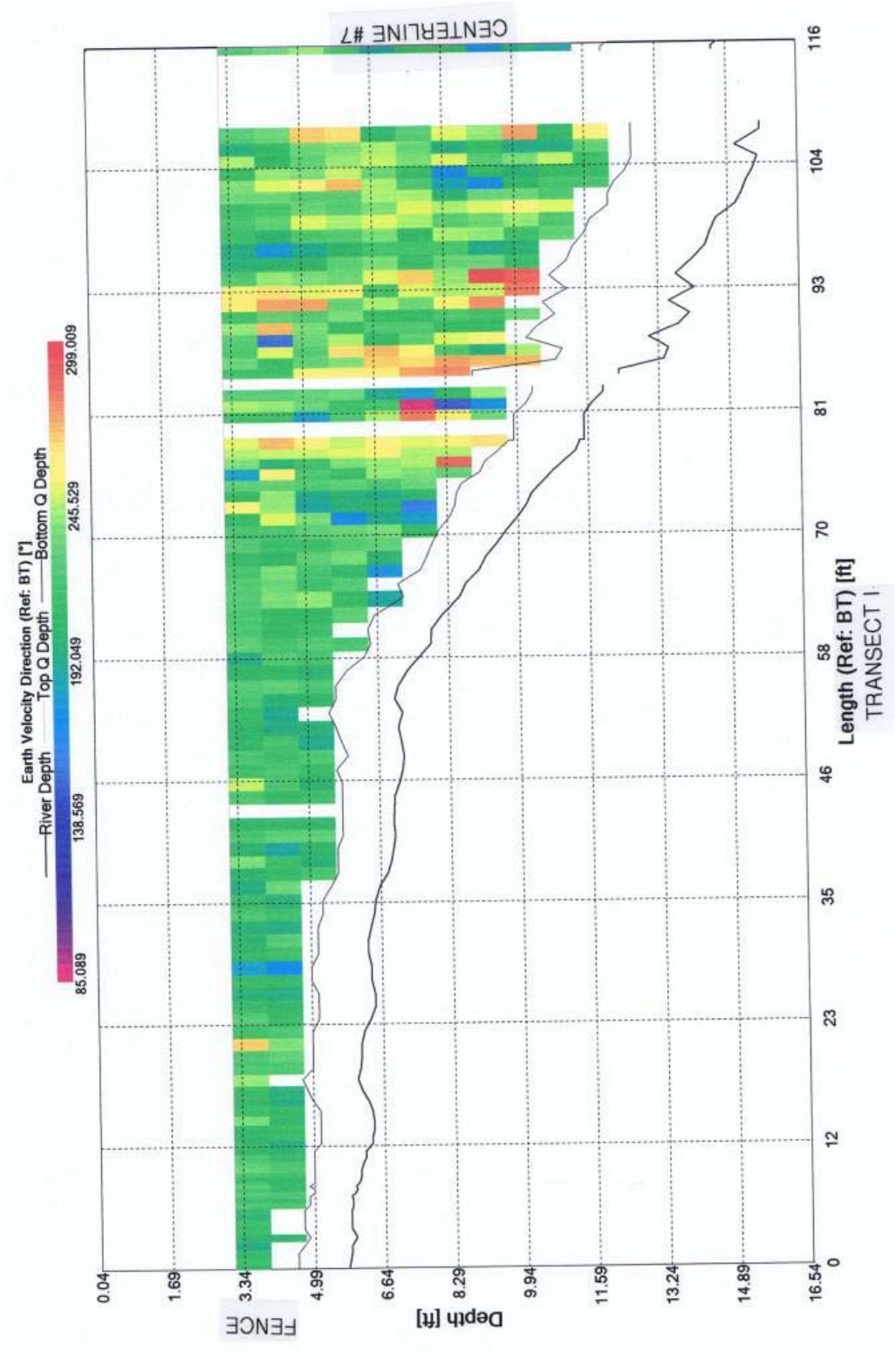


Figure 40: Transect I at tailrace illustrating direction

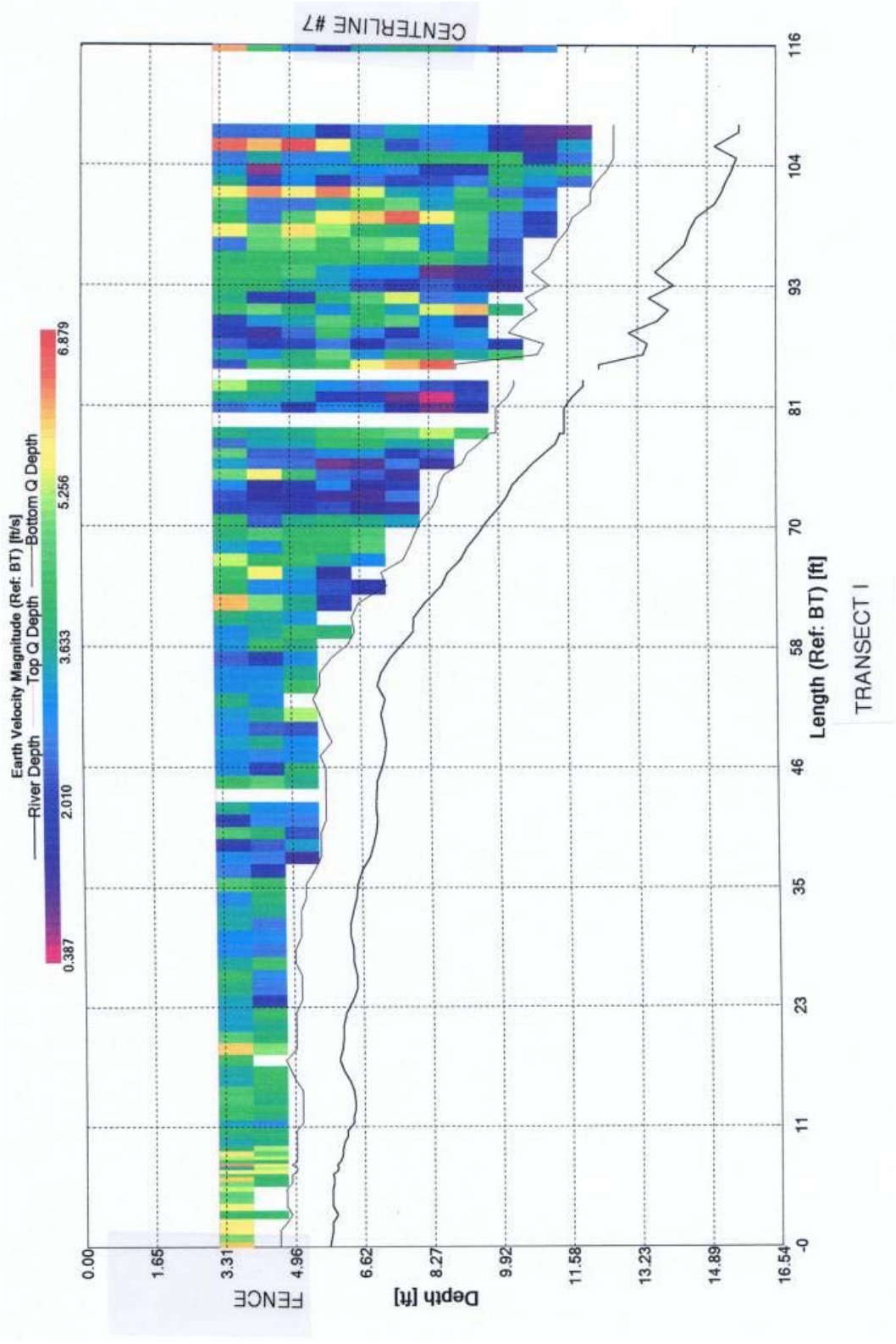


Figure 41: Transect I tailrace illustrating velocity magnitude

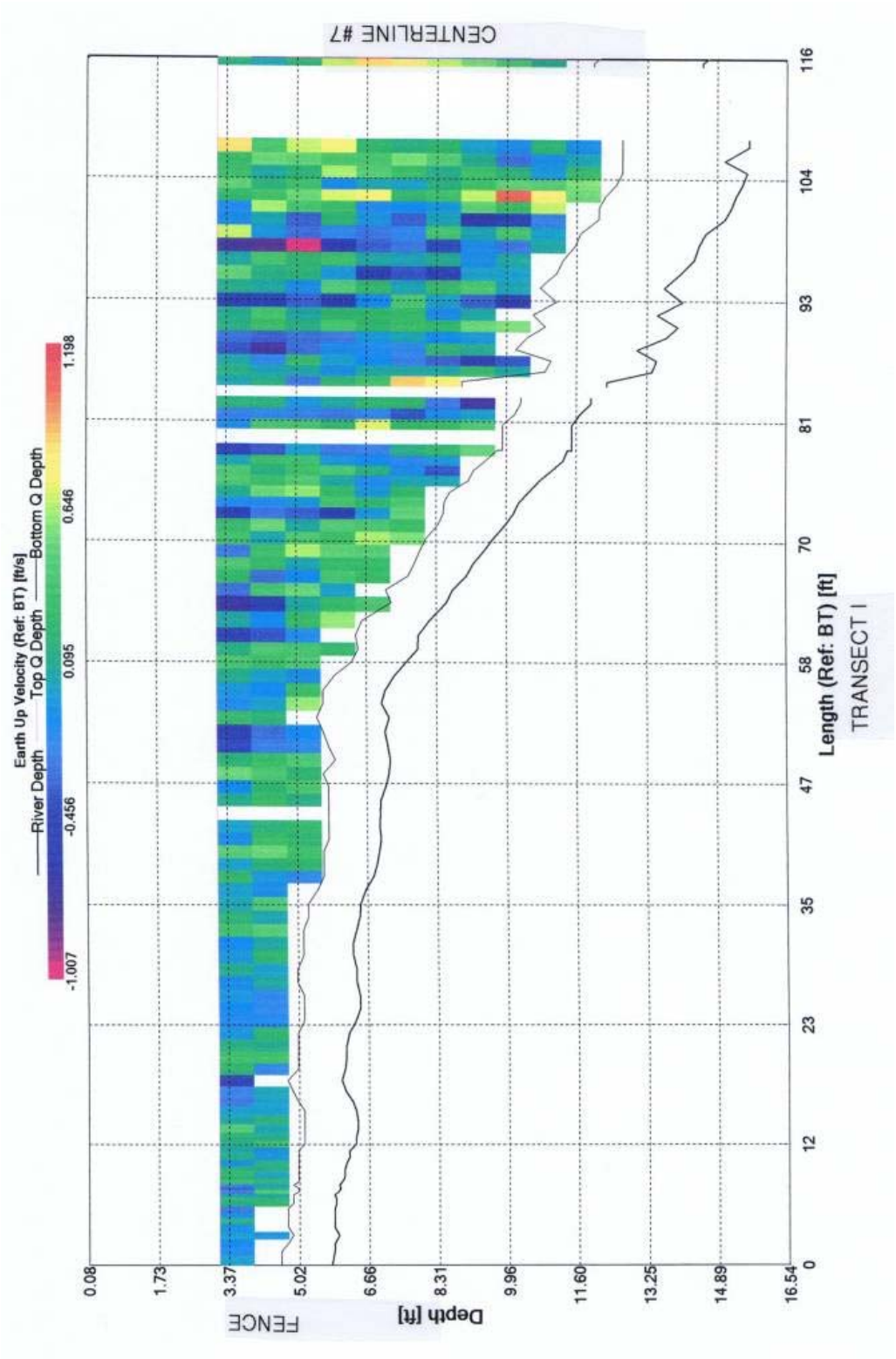


Figure 42: Transect I at tailrace illustrating vertical velocity

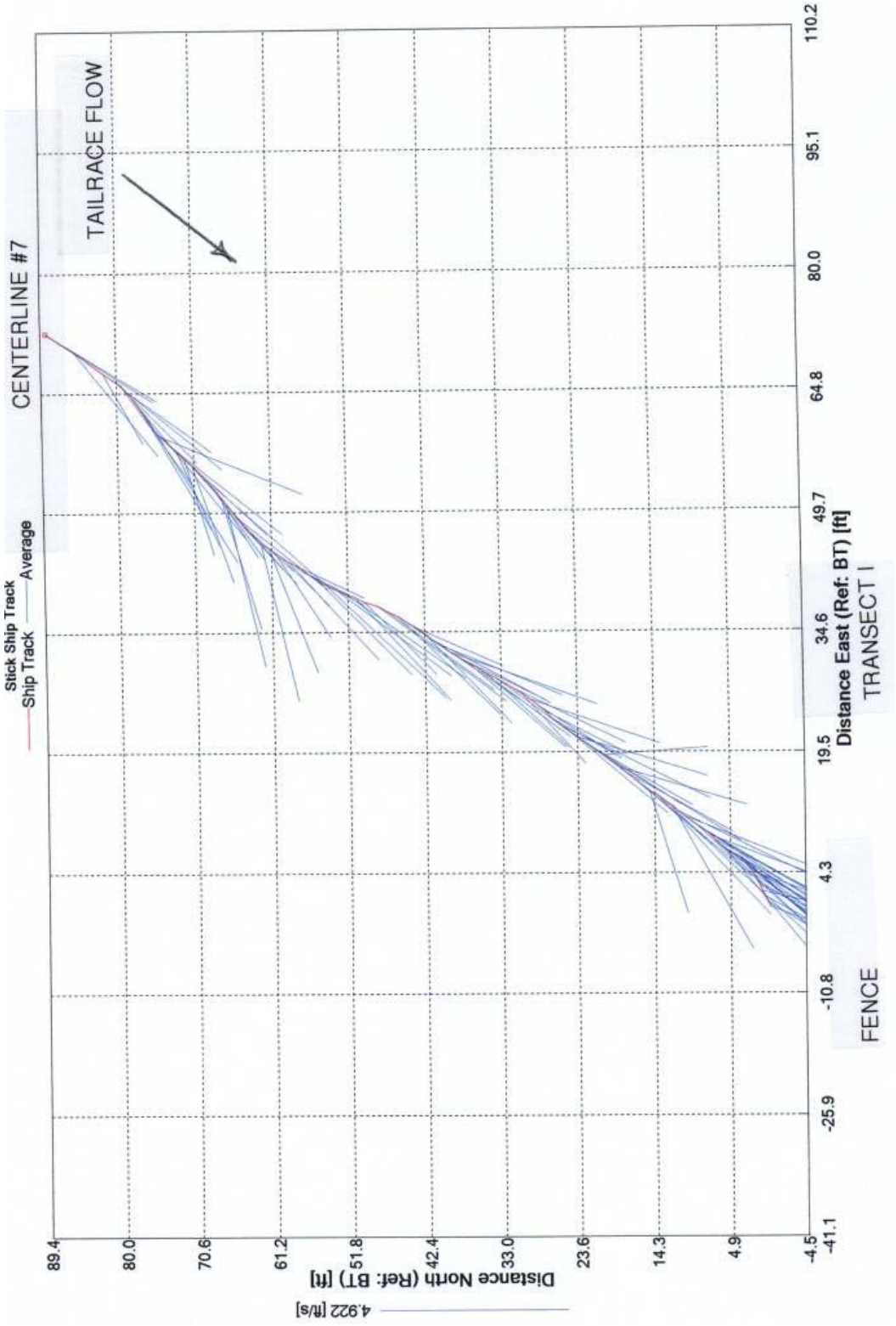


Figure 43: Transect I ship track plan-view vector sticks illustrating average direction

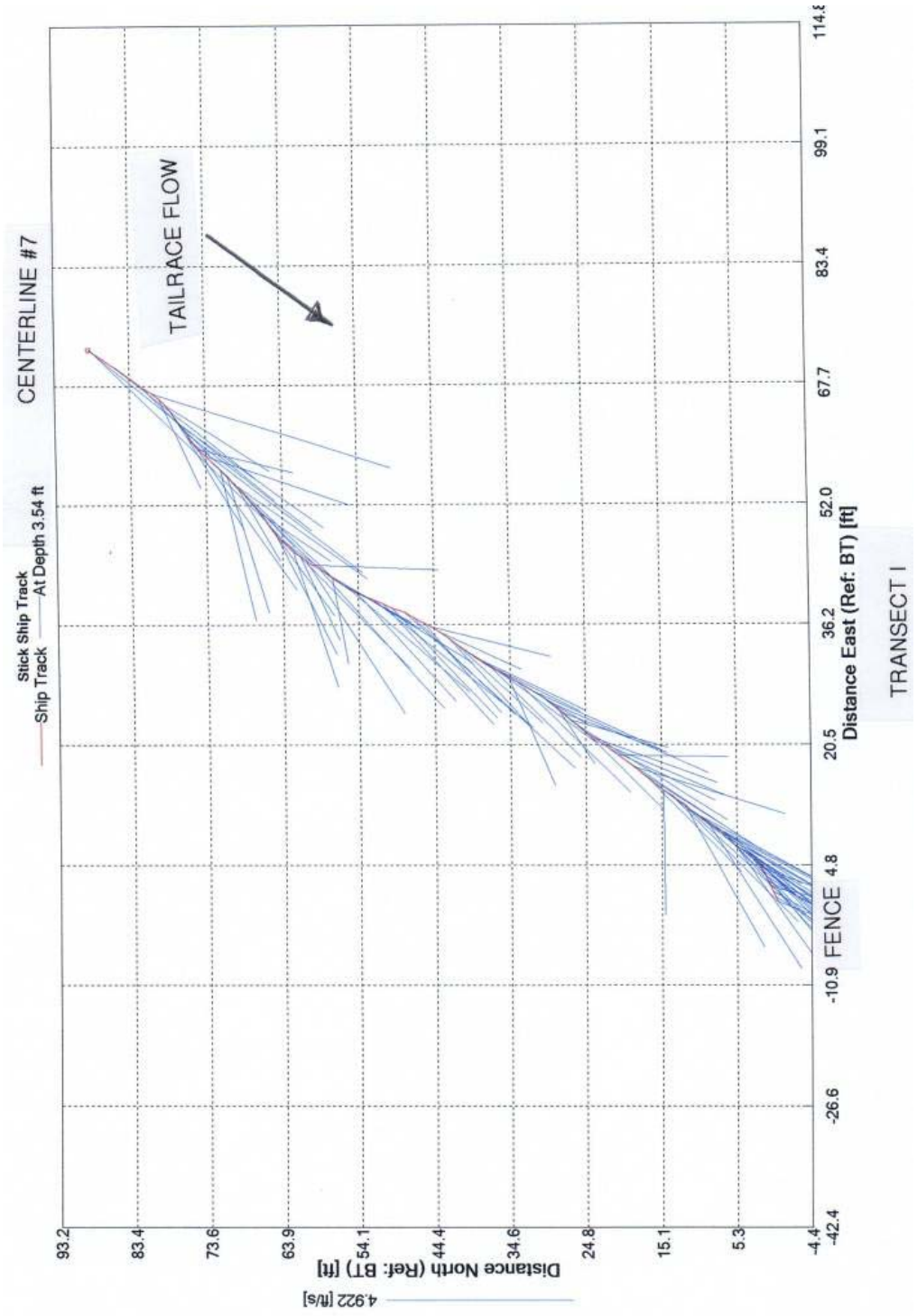


Figure 44: Transect I ship track plan-view vector sticks 3.5' below water surface

Transect I Notes: Transect I shows grades and vectors consistent with Transect G. There is lost data up against the draft tube wall due to side lobes hitting concrete.

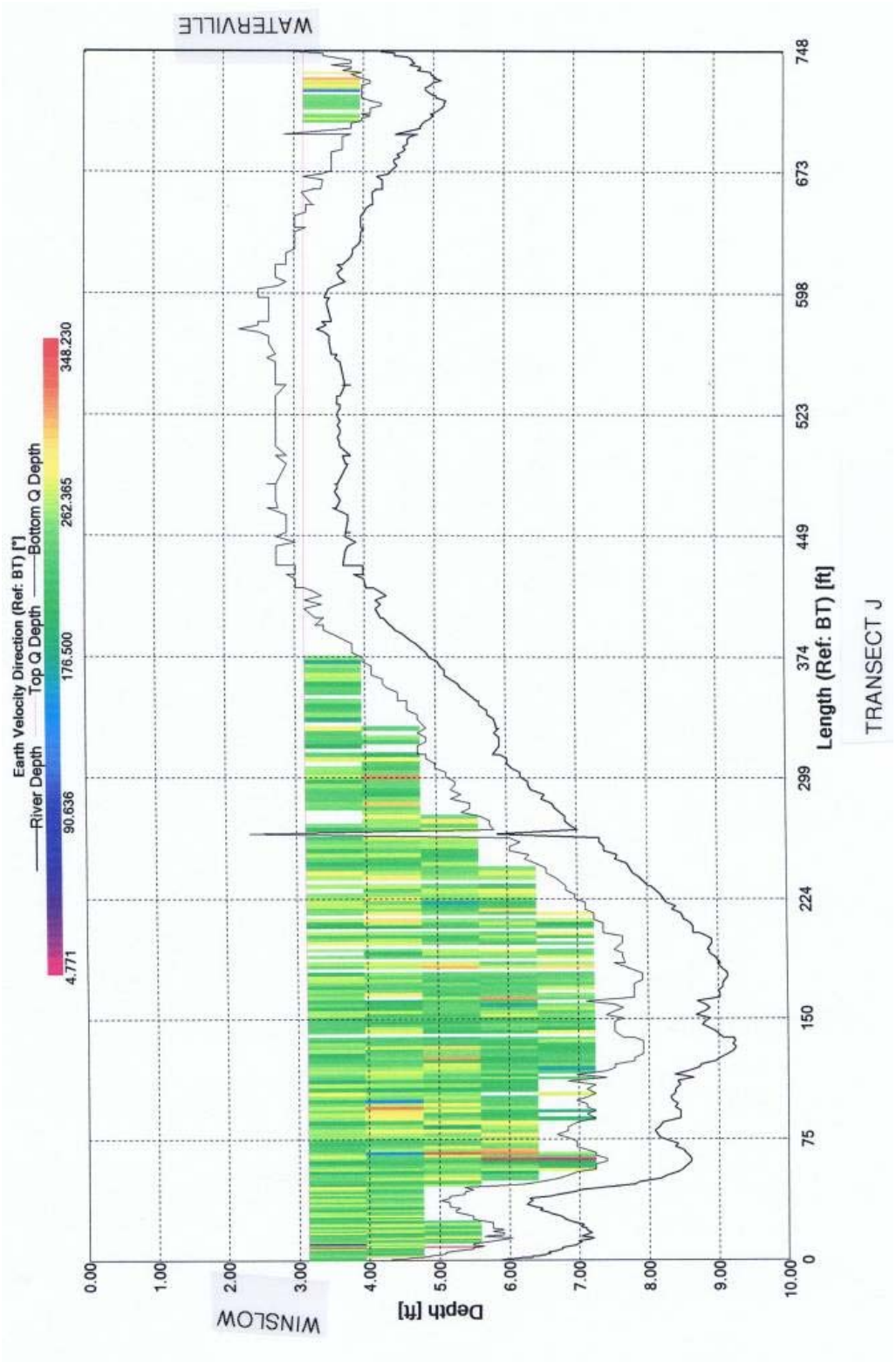


Figure 45: Transect J at tailrace illustrating direction

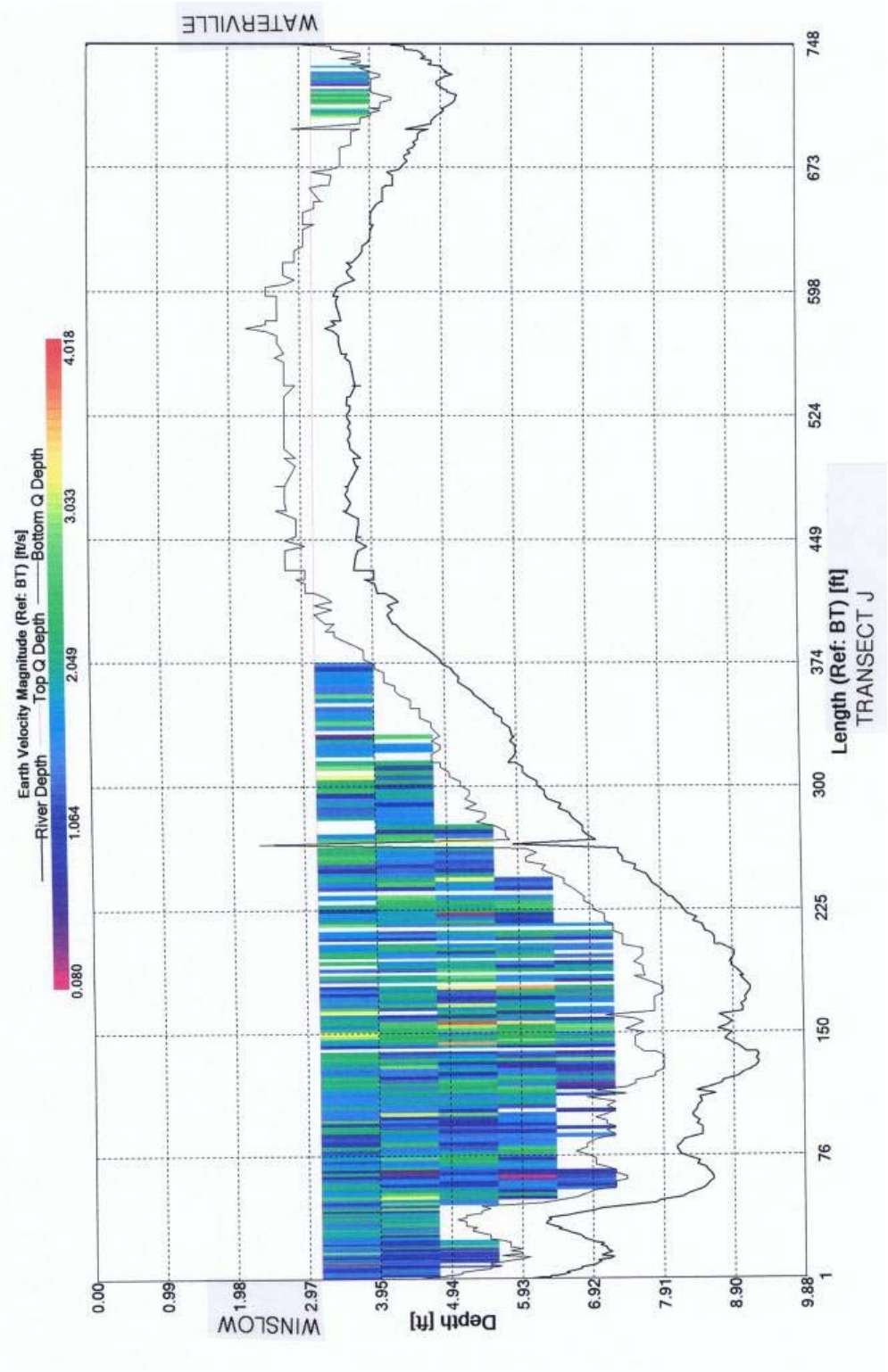


Figure 46: Transect J tailrace illustrating velocity magnitude

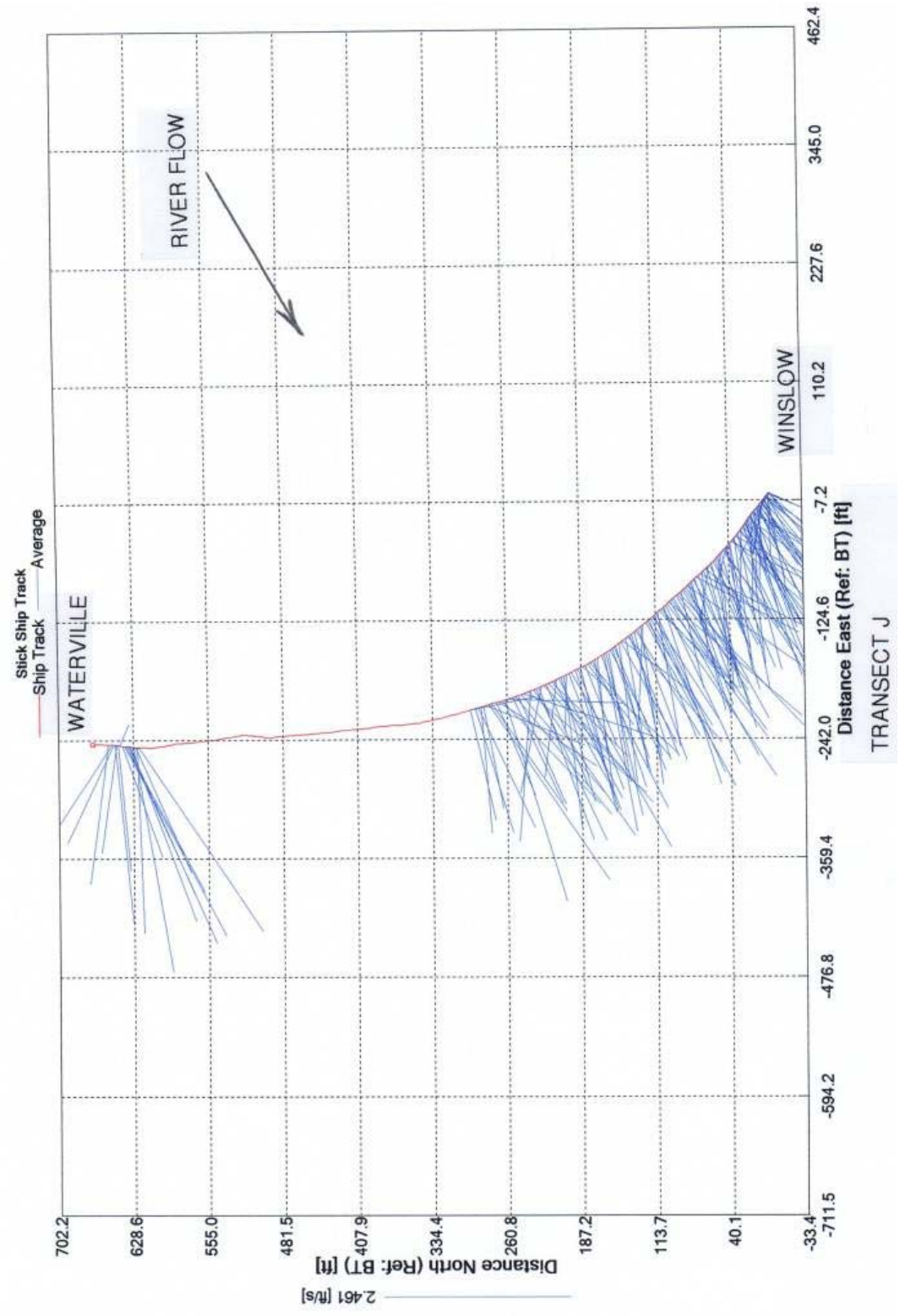


Figure 47: Transect J ship track plan-view vector sticks illustrating average direction

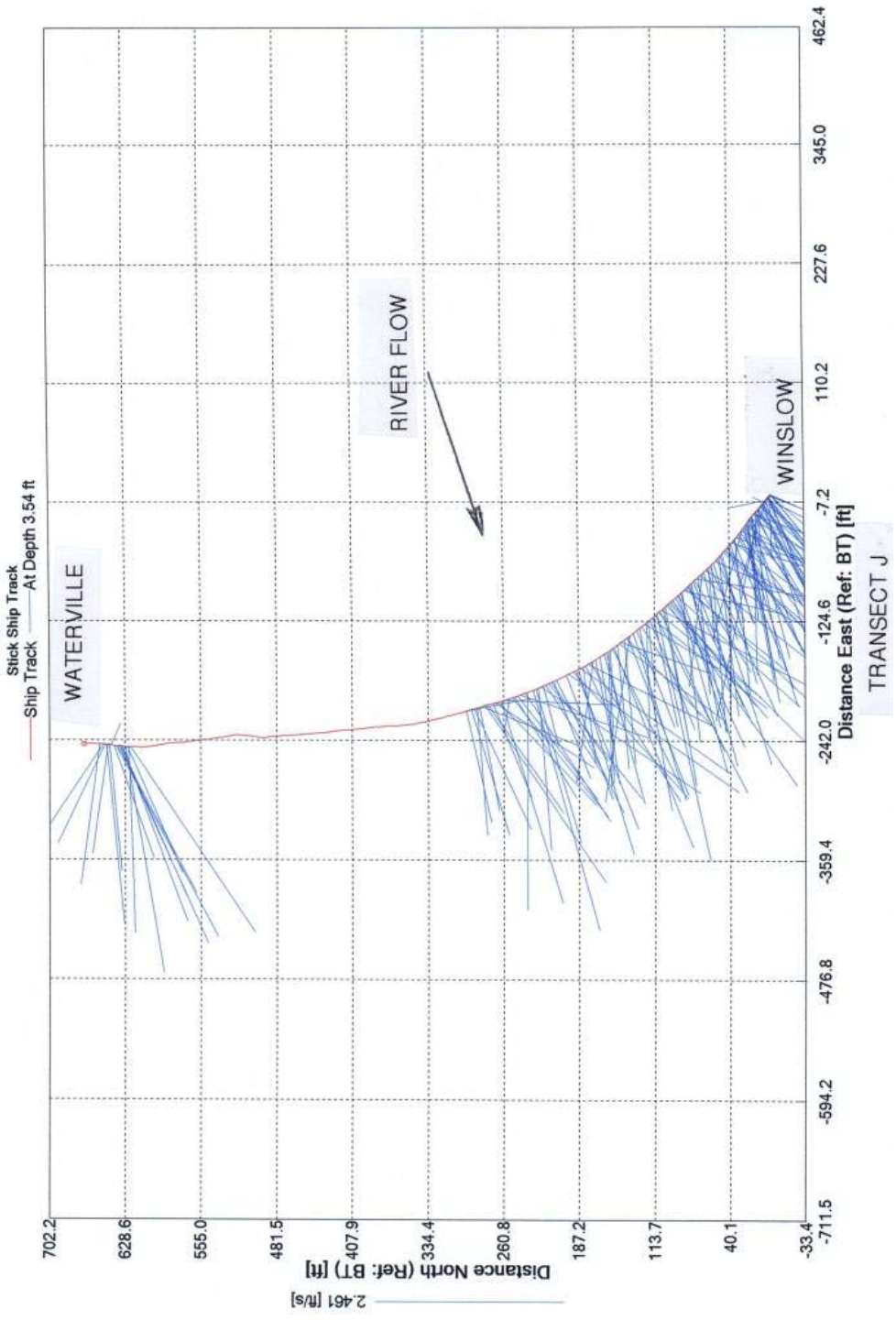
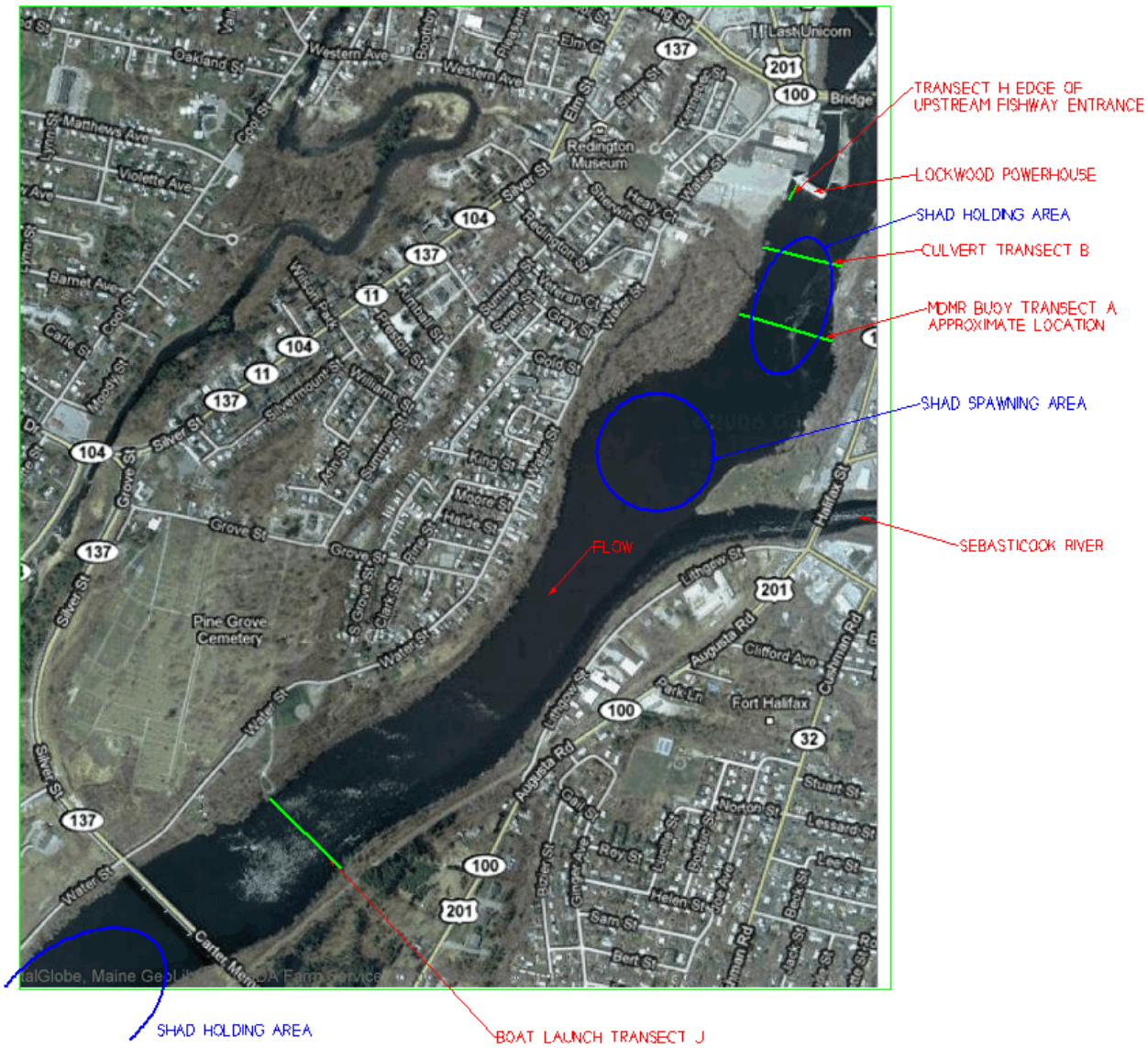


Figure 48: Transect J ship track plan-view vector sticks 3.5’ below water surface

Transect J Notes: This portion of the transect is in a water depth that is less than the equipment minimum. The maximum depth recorded was 9.6 ft and the mean depth was 6’. The majority of the flow appears to be on the Winslow side of the river.

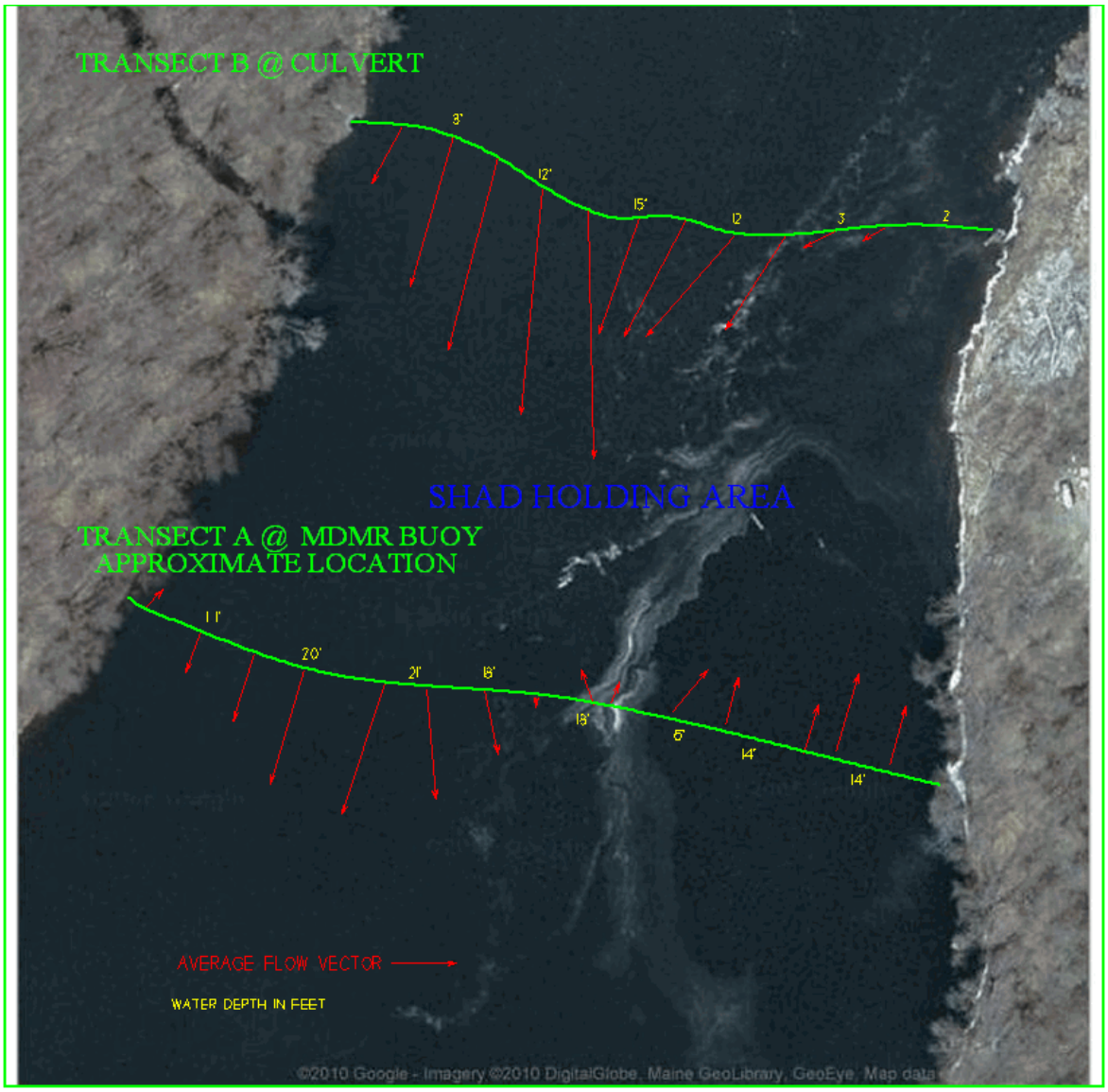
5.0 GENERALIZED OBSERVATIONS



SITE PLAN VIEW SHOWING APPROXIMATE RIVER TRANSECT LOCATIONS TAKEN OCT. 9, 2009

Figure 49

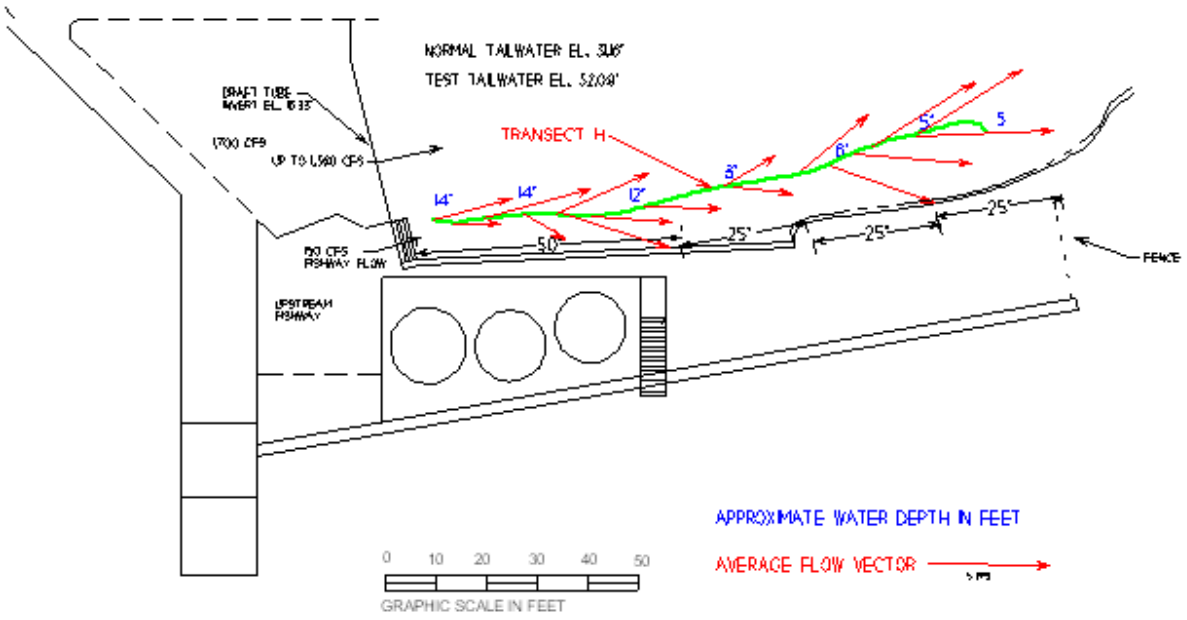
Figure 49 correlates some representative transects and 2009 shad observations presented in the "Lockwood Project Fish Lift Upstream Radio Telemetry Effectiveness Study For American Shad"



SITE PLAN VIEW SHOWING TRANSECTS A & B TAKEN OCT. 9. 2009

Figure 50

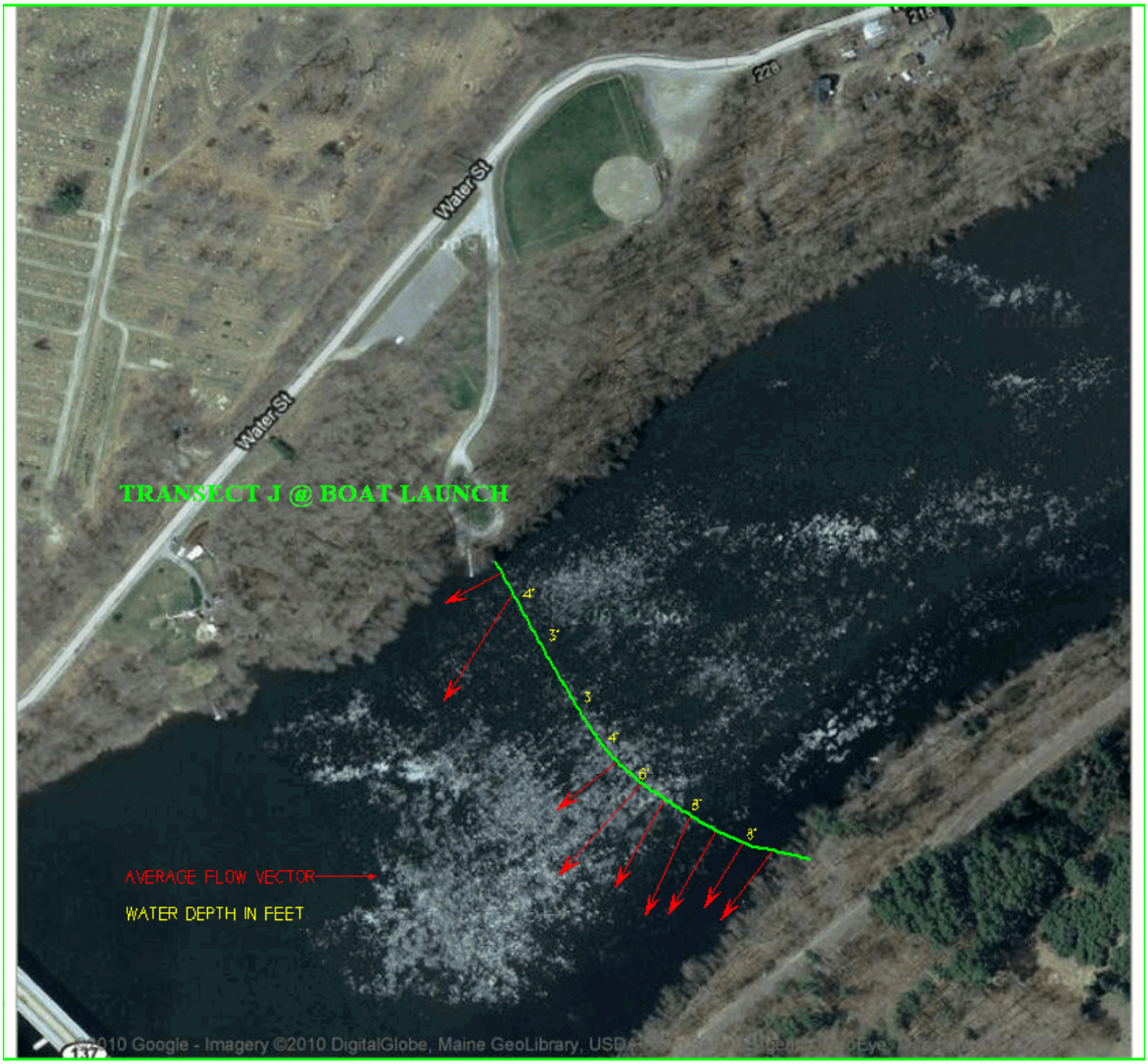
Figure 50 schematically overlays ADCP transect results on an air photo in the area where shad were known to hold. From the buoy upstream there appears to be a good leading flow along the Waterville side of the river. At the buoy transect there is a shoal about 5.5 feet below the water surface and an eddie that directs the flow upstream along the Winslow side of the river. This eddie could redirect shad downstream however; the extent or duration is unknown.



SITE PLAN VIEW SHOWING TRANSECT H LOCATION AND VECTORS

Figure 51

Figure 51 overlays the ADCP Transect H on a drawing of the fishway entrance area. The average vectors indicated good leading shore flows up to the fishway area. The dye flows indicated a good surface leading flow. There is an abrupt grade change just downstream of the entrance. This may be due to ADCP side lobe reaction with the concrete wall or maybe a river bottom feature.



SITE PLAN VIEW SHOWING TRANSECT J TAKEN OCT. 9, 2009

Figure 52

Figure 52 utilizes a vector schematic and water depth numbers to illustrate the ADCP data that found that the majority of flow was found on the Winslow side of the river.

6.0 FUTURE PLANS

NextEra Energy plans to continue consultation with resource agencies on the results of the ADCP hydraulic study, determine what conclusions can be drawn from the study, and then come to consensus regarding the implications of the results.

7.0 REFERENCES

Castro-Santos, T. 2004. "Optimal Swim Speeds For Traversing Velocity Barriers: An Analysis Of Volitional High-Speed Swimming Behavior Of Migratory Fishes," *The Journal of Experimental Biology*, 208, 421-432. The Company of Biologists 2005.

Haro, A., T. Castro-Santos, J. Noreika, and M. Odeh. 2004. "Swimming Performance of Upstream Migrant Fishes in Open-channel flow: A New Approach to Predicting Passage through Velocity Barriers," *Canadian Journal of Aquatic and Fisheries Sciences* 61:1590-1601.

APPENDIX D

Evaluation of Atlantic Salmon Smolt and Kelt Downstream Passage at the Lockwood Project (FERC No. 2574)

Evaluation of Atlantic Salmon Smolt and Kelt Downstream Passage

at the

Lockwood Project (FERC No. 2574)

March 15, 2010

NextEra Energy Maine Operating Services, LLC
26 Katherine Drive
Hallowell, Maine 04347

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LIST OF FIGURES

1.0 INTRODUCTION

1.1 Background

NextEra Energy installed a new downstream fish passage facility at the Lockwood Project in 2009. In NextEra's 2008 Kennebec River annual fish passage report, NextEra indicated that it would use 2009 as a shake-down period for the new facility and would evaluate its resistance to tearing, debris loading and other mechanical issues. NextEra also indicated that it would attempt to gather some general qualitative observations of fish passage at the facility as feasible. In addition, the 2008 annual report indicated that in 2010, NextEra Energy in consultation with resource agencies would conduct a pit tagging or other type of quantitative study to evaluate the effectiveness of the new facility.

1.2 Project Description

The Lockwood Project is located on the Kennebec River in the city of Waterville and town of Winslow, Maine (see Figures 1 and 1a). The Project's license is held by the Merimil Limited Partnership (Merimil), of which NextEra Energy Maine Hydro LLC (NextEra) is the Operator. There are two powerhouses at the Project; one contains six vertical Francis units (Units 1-6) and the other powerhouse contains Unit 7, a horizontal Kaplan unit. The total installed capacity of the Project is approximately 7.5 megawatts, and total unit flow is approximately 5,660 cfs. Trash racks are located in front of the intake sections to limit debris from passing through the turbines. Trash rack "clear" spacing is 2 inches for Units 1–5, 3.5 inches for the bottom two thirds and 2 inches for the top third for Unit 6, and 3.5 inches for Unit 7.

The Project includes an 875-foot-long spillway section with 15-inch-high flashboards. In 2007, three orifices, 3-feet-long by 8-inches-high were placed at three locations along the spillway. The purpose of the orifices is to pass a 50 cfs minimum flow for the protection of downstream fisheries. The spillway discharges to a series of bedrock terraces known as Ticonic Falls.

In the summer of 2009, NextEra installed a new downstream fish passage facility in the Lockwood power canal (see Figures 2 and 3). This facility consists of a new 10-foot-deep floating boom leading to a new 7-foot-wide by 7-foot-deep sluice and associated mechanical overflow gate. Maximum flow through the gate is 6% of station capacity or 340 cfs. The sluice is located on the river side of the power canal just upstream of Unit 1 trash rack and discharges directly into the river. The boom is 300-feet-long and is secured on the land side of the canal and angles downstream to the new sluice gate. The boom has floatation and is suspended in the water column. It is constructed of 4 feet of an impervious rubber material manufactured by Slickbar Incorporated, followed by 6 feet of 7/16-inch Dyneema netting.

NextEra used late summer and fall of 2009 as a shake-down period for the new facility and evaluated its resistance to tearing, debris loading and other structural issues. NextEra did observe some fish using the new facility in the fall and also identified some issues with the new facility. These issues included the need for additional floatation, the need for upstream facing tether lines securing the boom, and possibly removing some of the existing "belly" in the boom. Some of these modifications were completed in 2009 (installing additional flotation and installing tether

lines). In addition, some tearing of the boom fabric did occur; however, the boom generally stayed in place as seen in the aerial photo. NextEra is presently in discussions with the boom manufacturer to see if there are options to eliminate the tearing of the boom. In addition, NextEra is also evaluating other boom options and will consult with the resource agencies prior to spring deployment. NextEra's plan is to make any necessary modifications prior to the spring 2010 study.

1.3 Objective

The objective of the study is to determine if a floating guidance and associated new sluice gate will effectively pass Atlantic salmon smolts and kelts.

2.0 DOWNSTREAM PASSAGE EVALUATION

2.1 Methods and Materials

The floating guidance device and sluice gate will be evaluated through releasing and monitoring pit tagged smolts and kelts under various scenarios. During each smolt passage scenario, 50 smolts will be released with a maximum sample size of approximately 275 fish. This study will take place from mid April through the end of May 2010.

The resource agencies commented and NextEra agrees that the kelt study be delayed until we have an opportunity to understand downstream smolt behavior at the Project. Kelts are valuable to the population, and we want to make sure that the guidance device is demonstrated effective for smolts before testing it for kelts. The kelt study is tentatively scheduled to take place from mid April through the end of May 2011. During each kelt passage scenario, 15 kelts will be released with a maximum sample size of approximately 60 fish.

Generally, the releases will take place to assess sluice passage during times when all seven units are operating at or near full capacity. The study results will include a record of generation (units and capacity) during the study. The sluice will be opened at various flow rates to find the most effective rate. Having the units at or near full capacity is the preferred operational scenario so as to reduce variability in the resultant data. However, based on river flow conditions, this operational scenario may not always be available and some releases may occur with some units off or at reduced flows. If this situation does occur, NextEra will attempt to operate Units 1and 2 on a first-on last-off basis followed by Unit 7, then Units 3 to 6.

The first release of 50 smolts and 15 kelts is planned to occur with all units running at or near full capacity with the new surface gate set at 4% of station capacity or approximately 225 cfs. If this scenario demonstrates that smolts and kelts are migrating via the new sluice effectively, then this scenario will be tested again to see if it is repeatable. If the data does not demonstrate that smolts and kelts are effectively passing the new sluice, then the scenario in the next paragraph will be tested.

The second release of 50 smolts and 15 kelts is planned to occur with all units running at or near full capacity with the new surface gate set at 6% of station capacity or approximately 340 cfs. This is the maximum flow of the new gate. If this scenario demonstrates that smolts and kelts are

migrating via the new sluice effectively, then this scenario will be tested again to see if it is repeatable. If the data does not demonstrate that smolts and kelts are effectively passing the new sluice, then NextEra will further consult with resource agencies to discuss additional ways to possibly increase passage effectiveness.

In addition, if the data demonstrates that smolts and kelts are effectively passing the Project at 4% station flow, NextEra reserves the option to test this route at lesser flows to see if lower flows will pass fish effectively.

The release schedules and scenarios described above are the intended study template. However, as is typical with field studies, NextEra may need to, in consultation with the resource agencies, vary the template in determining the final schedules and scenarios to be tested based upon the availability of smolts and kelts, on river conditions and on previous test results.

2.1.1 Pit Tag Equipment

NextEra proposes to use pit tagging methods to complete the smolt and kelt study. The use of this method will allow for multiple releases with adequate sample sizes to evaluate the new facility under various flow rates. As described in section 2.1.2 below, the release location in the Lockwood canal downstream of the headgate structure should insure that most smolts and kelts will migrate downstream and not swim back upstream and pass via spill. This type of smolt behavior was observed during the 2007 smolt downstream passage radio telemetry study at Lockwood and during the 2000 smolt downstream passage pit tag study at NextEra's Bar Mills Project. The Bar Mills Project is similar to the Lockwood Project and has a power canal and head gate structure.

Half duplex RFID 3 mm pit tags and two readers will be used during this study. Each reader will be set to scan 21 times per second. The readers will be synchronized in a master/slave format to avoid interference. Connected to the readers will be two (2) closed loop antennas installed near the exit of the new sluice to detect smolts that pass via the sluice. Each antenna will be approximately 7-feet-high by 7-feet-wide and consist of two (2) loops of 12-gage. THHN stranded copper wire will be attached to the backside of individual wooden frames. Inductance for both antennas will be approximately 40 microhenries. Both antennas will be located far enough downstream of the sluice entrance to avoid detection of fish in the forebay so that passage is positively identified. Typically, antenna range is approximately 2-feet upstream and downstream of installed antennas.

Antennas will be tested under full station generation in a grid-like pattern with a pole-mounted or tethered tag to assess whether full coverage has been attained and to identify upstream detection range. If the testing on the two (2) proposed antennas indicates that reception range is less than desirable, then additional antennas will be used. NextEra will provide resource agencies with a sketch of the antenna locations once final antenna configuration is identified.

2.1.2 Fish Procurement, Tagging and Release

Smolts used for this study will be obtained in late winter/early spring of 2010 from one of the Federal Atlantic salmon hatcheries located in Maine. Kelts used for this study will be obtained

in the spring of 2011 (tentatively) from post-spawned fish previously captured at the Veazie fishway if available. Domestic brood stock fish will not be used due to behavioral issues; they may bias study results.

For each smolt and kelt release event, a number of fish will be transported from the hatchery to the Lockwood Project. The fish will be placed into 4-foot x 4-foot x 2-foot deep floating tanks located in a river location or in the Lockwood fishlift holding tanks.

The pit tagging will take place at the Lockwood fishlift facility. Tagging will be done by persons experienced in pit tagging techniques. Prior to tag insertion, fish will be anesthetized with clove oil for a period of approximately 2-3 minutes. Pit tags will be inserted in the ventral-abdominal region via use of a small surgical incision, approximately 3-mm in length. After tagging, the fish will be measured for total length (mm) and placed back into holding tanks for recovery. The fish will then be held for approximately 24 hours after tag insertion and prior to release. This holding period may be altered if observations indicate that more or less time is needed to recover. If adequate numbers of fish are available, up to 10 smolts and 5 kelts will be fitted with "dummy tags" and held for up to 72 hours to assess any handling/holding stress. The total target number of test smolts and kelts for the study will be approximately 275 and 60 respectively, assuming they are available.

The pit tagged smolts and kelts will be transported in water-filled containers and will be released into the upstream end Lockwood power canal just downstream of the power canal head gates. This should insure that all or most fish will migrate downstream thus staying within the study area.

2.1.3 Data Collection and Analysis

On a daily basis, NextEra will download and archive RFID tracking data at each antenna after release of tagged fish. The study period will continue until all fish are accounted for or a period of four weeks after the release of the last fish. After each release scenario, NextEra will calculate percent bypass effectiveness using the following assumptions and formula. Non detected fish are assumed to have migrated via the turbines and the effectiveness will be calculated by dividing the total number detected by the total number released.

3.0 Agency Consultation and Reporting

By December 31, 2010, NextEra will provide MDMR, NMFS, and USFWS with a copy of the draft study report for a 30-day review and comment period. The final study report, including the agency comments, will be filed with resource agencies and FERC by March 31, 2011.

Figure 1:
Lockwood Project Location Map

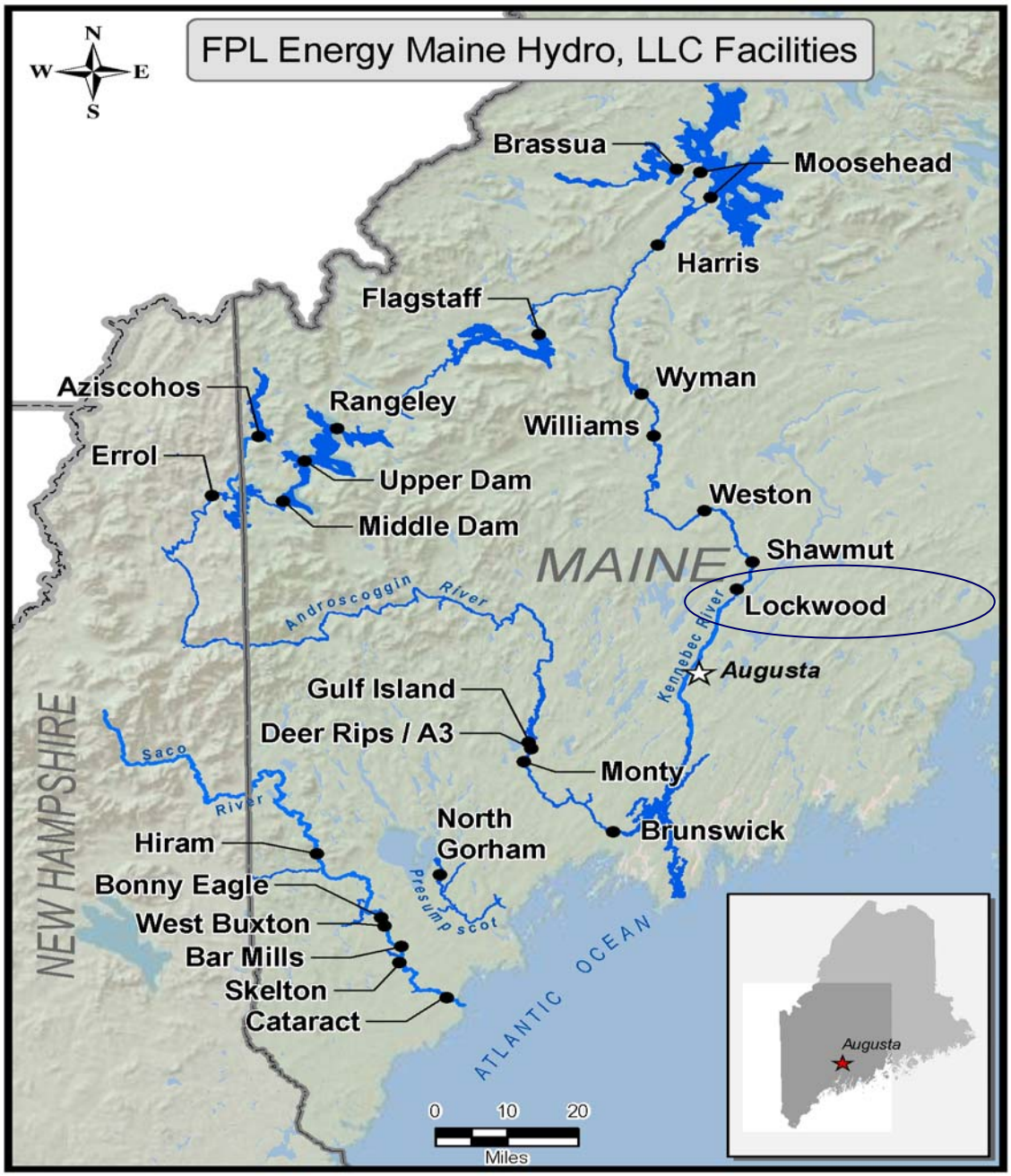

Figure 1a:
Lockwood Project Aerial View Details

Figure 2:
Lockwood Project Downstream Fish Passage Facility

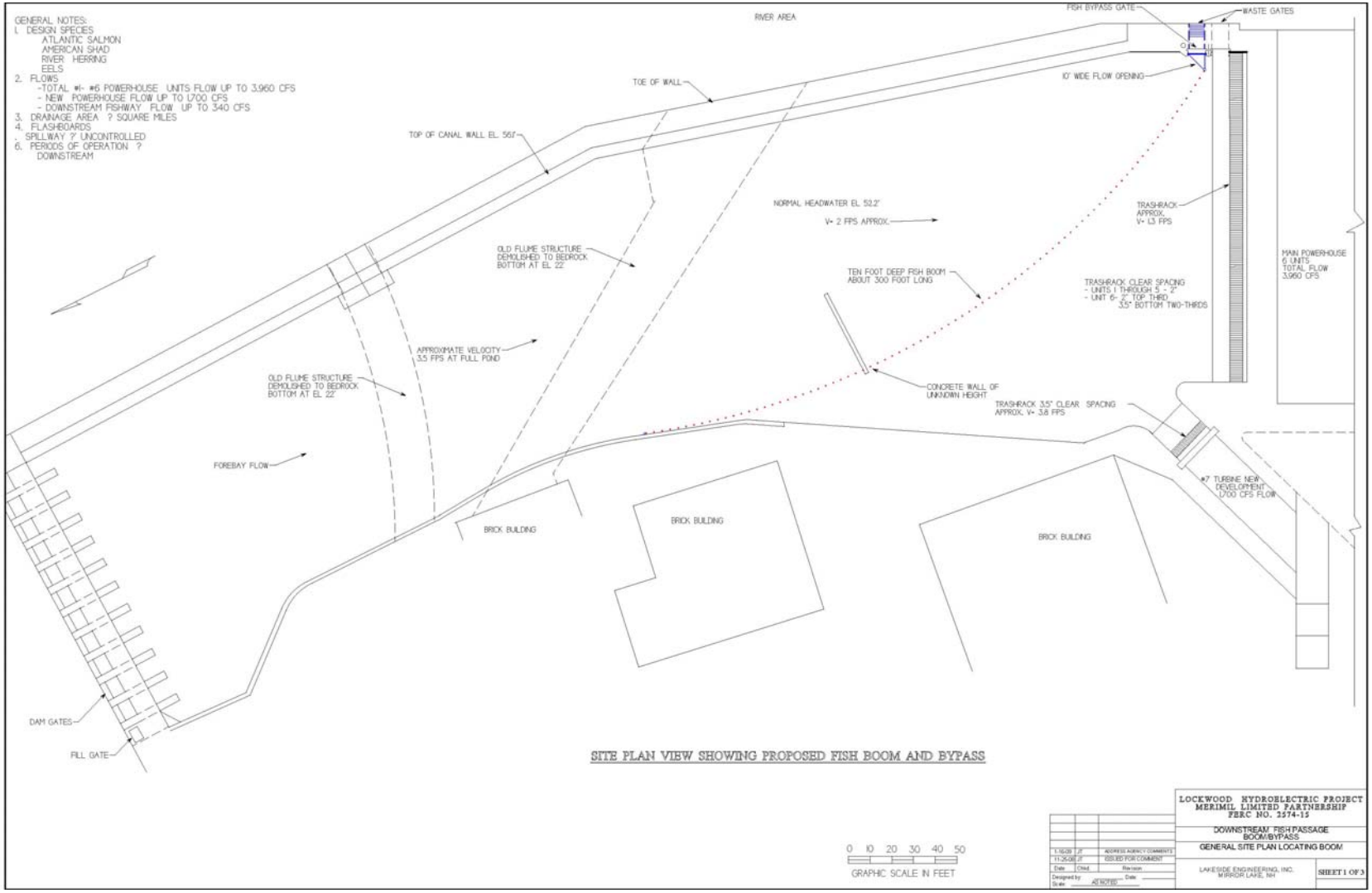

Figure 3:
Lockwood Project Aerial View of Floating Guidance Boom and Sluice Gate