FINAL REPORT
General Investigation

SOMERSET & SEARSBURG DAMS
(Deerfield River Watershed Study)
Greenfield, Massachusetts

US ARMY CORPS
OF ENGINEERS
New England District

December 2007

GREEN RIVER FISH PASSAGE
GREENFIELD, MASSACHUSETTS
CORPS OF ENGINEERS, NEW ENGLAND DISTRICT

EXECUTIVE SUMMARY

This restoration study focuses on four dams on the Green River in Greenfield, Massachusetts: the Wiley & Russell Dam, the Mill Street Dam, the Swimming Pool Dam, and the Pumping Station Dam. The dams block the migration of anadromous fish upstream to spawning areas and smolt movement to the ocean and prevent catadromous fish, which live in fresh water and spawn in the ocean, from accessing their primary habitat. The sectioning of the river has also impacted potamodromous fish, which are freshwater species that move to faster moving streams in the watershed to spawn. The Deerfield River watershed has its headwaters in south central Vermont and joins the Connecticut River in Greenfield, Massachusetts. The total drainage area is about 665 square miles with 350 square miles in Massachusetts and 315 in Vermont. The Somerset and Searsburg dams are located in Vermont, and by virtue of being mentioned in the authorizing legislation, loaned their names to the study. The total river length of the Deerfield River is 70.2 miles. Major tributaries to the Deerfield are the North River, Green River, Chickley River, and the Cold River. Up to 30 miles (15 in both Massachusetts and Vermont) of fish habitat can be restored by providing fish passage at the four locations along the Green River. Other than holding an impoundment, two of the dams, the Wiley & Russell Dam and the Mill Street Dam, no longer serve any practical purpose. Two of the dams, the Swimming Pool Dam and the Pumping Station Dam, maintain recreational and public water supply impoundments. The study area is shown on Plates 1 and 2.

The study considers the fish passage options of fish ladders, rock ramp fishways or bypass channels for the Swimming Pool and Pumping Station dams. The alternative list was expanded to include dam removal and partial breaching at Wiley & Russell and Mill Street dams. The study also considers instream aquatic habitat improvements along several channel reaches near Leyden Woods Apartments and a reach between Mill and Meridian Streets. A restored migratory corridor along the Green River will provide an increased quantity and quality of habitat for fish, leading to more abundant fish populations. Also, restoration of riparian buffer zones at the impoundments of the two lower dams will increase the productivity and ecological value of the area.

This report was prepared by the New England District, U.S. Army Corps of Engineers (USACE) in partnership with the Massachusetts Executive Office of Environmental Affairs and the Town of Greenfield, Massachusetts. The report includes an Environmental Assessment for the proposed project. Its preparation complies with the Council on Environmental Quality and USACE regulations for implementing the National Environmental Policy Act of 1969, which requires the Federal government to consider the environmental effects of a proposed action and to consult interested agencies, groups, and the public during the planning process.

An Incremental Analysis was prepared to quantify the habitat benefits that would accrue for each of the proposed restoration plans. The Incremental Analysis quantified the benefits of various options to identify the most effective restoration plan. It's purpose is to identify the alternative(s) which would cost effectively optimize the habitat for the target anadromous fish species to be restored, while minimizing any negative effects to existing habitat and species such as lacustrine and riverine fish, and wetland species. The recommended plan consists of the removal of both Wiley & Russell and Mill Street Dams and installation of fish passage structures at Swimming Pool Dam and Pumping Station Dam. This plan maximizes the environmental benefits and offers the greatest degree of habitat restoration for each dollar invested in a project. The restoration project would extend migratory habitat and spawning habitat for anadromous fish over a distance of 30 river miles. It is a cost-effective plan that reasonably optimizes environmental benefits that are in the national interest and consistent with Corps regulations. The estimated implementation cost for the recommended plan is $2,053,000, and the project would be cost shared 65 percent Federal and 35 percent non-Federal. Operations and maintenance of the project would be a non-Federal responsibility and are estimated to cost $12,000 per year for a 50-year life of the project.

Wiley & Russell Dam

Mill Street Dam

Swimming Pool Dam

Pumping Station Dam

SOMERSET & SEARSBURG DAMS
DEERFIELD RIVER WATERSHED STUDY
GENERAL INVESTIGATION

GREEN RIVER FISH PASSAGE
GREENFIELD, MASSACHUSETTS

US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT

December 2007

SOMERSET & SEARSBURG DAMS
DEERFIELD RIVER WATERSHED STUDY
GENERAL INVESTIGATION

GREEN RIVER FISH PASSAGE

GREENFIELD, MASSACHUSETTS
CORPS OF ENGINEERS, NEW ENGLAND DISTRICT

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SECTION 1: INTRODUCTION

This restoration study focuses on four dams along the Green River in Greenfield, Massachusetts that block the migration of anadromous fish upstream to spawning areas. These dams also prevent smolt movement to the ocean and prevent catadromous fish, which live in fresh water and spawn in the ocean, from accessing their primary habitat. Dam removal or fish passage facilities can restore up to 18 miles of fish habitat along the Green River.

1.1 STUDY AUTHORITY

Authority to conduct the Deerfield River Reconnaissance Study originated with the Senate's recommendation, in the 1998 Appropriations Bill, to "…initiate and complete a reconnaissance study of possible operational or other changes, including the conveyance of Somerset and Searsburg Dams to the Corps, to enhance ecosystem restoration." This authority of this Senate recommendation is based on an original Senate resolution of the Committee on Public Works, adopted on 11 May 1962.

1.2 STUDY PURPOSE AND SCOPE

As the Deerfield River Reconnaissance Study was initiated, it quickly became apparent that the two dams of interest in the authorization, and their associated lands located in Vermont, had been sold to other private interests as part of a deregulation plan. Both dams continue to generate hydroelectric power and the impoundments are used for recreation. Therefore, no further investigation of these two sites was necessary. However, both the State of Vermont and the Commonwealth of Massachusetts requested that the Corps expand the scope of study to include the remainder of the Deerfield River, a tributary of the Connecticut River.

The scope was then reduced when the Vermont interests opted out leaving only the Massachusetts segment. Through the involvement of the Commonwealth of Massachusetts Executive Office of Environmental Affairs and its watershed initiative, the reconnaissance study was completed with the focus becoming the four Green River dams located in Greenfield, Massachusetts. The study documented in this report describes alterative plans to restore fish passage and riverine habitat upstream of these four dams on the Greenfield River. A total of 30 river miles of fish habitat would be restored if fish passage at the four dams could be achieved.

1.3 STUDY AREA CHARACTERISTICS AND SETTING

The Green River originates on the south slopes of Mt. Olga in Marlboro, Vermont and flows approximately 30 miles to its confluence with the Deerfield River in Greenfield Massachusetts (Plate 1). That confluence is approximately 4 miles upstream from the confluence of the Deerfield River with the Connecticut River. The Green River watershed includes the Vermont towns of Marlboro, Brattelboro, and Halifax, and the Massachusetts towns of Leyden, Colrain, Shelburne, and Greenfield. The total length measured in river miles is approximately fifteen in Massachusetts and fifteen in Vermont.

As a tributary to the Connecticut River, the Green River historically provided migratory, spawning and nursery habitat for native anadromous fish, including Atlantic salmon, American shad, blueback herring and sea lamprey, as well as the catadromous American eel. During the last 200 years, the construction of dams for various industrial uses along many New England Rivers, including the Connecticut, Deerfield, and Green Rivers, has blocked the migration of pre-spawning adults of these

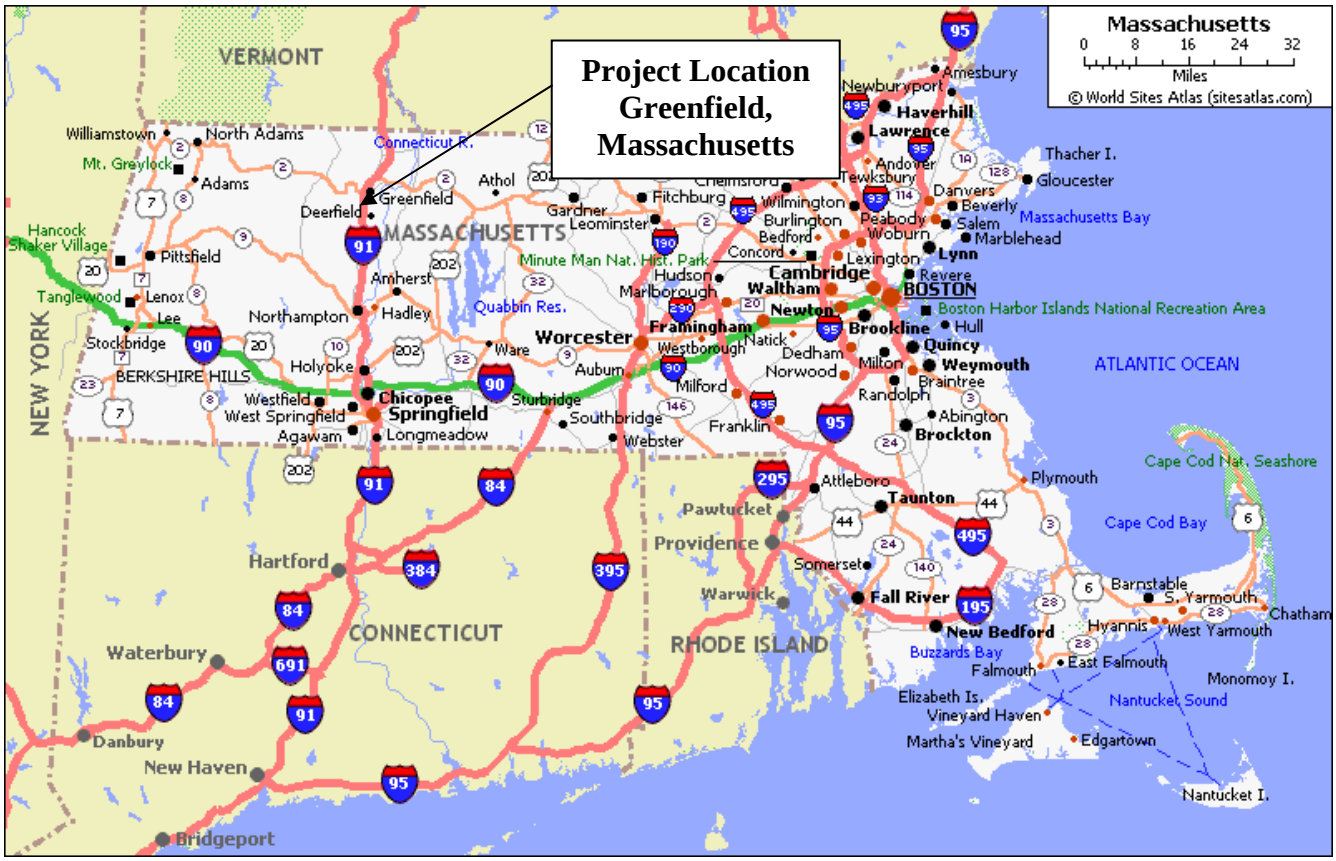


Plate 1 Project Location Map

species to their historic upstream spawning habitat. Consequently, their populations were either eliminated or significantly reduced.

During the last two decades, various state and federal government agencies have been working cooperatively to restore anadromous fish to their historic habitat in the Connecticut River and its tributaries, the Deerfield and Green Rivers included. Restoration efforts have included identification of specific restoration locations, stocking anadromous fish to historical upstream spawning and nursery habitats, and provision of fish passage beyond dams, by either dam removal, or creating by-pass structures such as fish ladders, lifts and/or partial dam breaching. In addition, studies of potential restoration areas have been conducted to identify anadromous fish habitat and the best methods to restore and/or access this habitat. Currently, many tributaries to the Deerfield River, including the Green River, are stocked with Atlantic salmon fry in order to reestablish anadromous populations in these rivers.

As a result of the restoration efforts, several fish passage facilities have been constructed on the Connecticut River, and many of the anadromous species noted above have been partially reestablished, and have access to its upstream regions as far north as Vermont. There is also unobstructed passage through the first several miles of the Deerfield River to its confluence with the Green River, and continuing through the Green River approximately 1.2 miles to the Wiley & Russell Dam in Greenfield. However, there is no fish passage beyond this dam in Massachusetts, preventing any further potential upstream migration of returning pre-spawning Atlantic salmon adults (as well as other migratory fish species). The Mill Street Dam, the Town Swimming Pool Dam, and the Pumping Station Dam, all located along an approximate 8.7-mile reach of the Green River in Greenfield,

continue to obstruct fish passage to upstream regions of the river as well. The proposed project would provide anadromous fish passage at each of these four dams on the Green River enabling fish migration to spawning and nursery habitat in upstream portions of the Green River and its tributaries. One other dam exists upstream in the village of Guilford, Vermont, which already has a fish ladder installed and will allow fish to pass further upstream of that point.

1.3.1 Physical Characteristics of the Watershed

Relatively steep rocky slopes and narrow valleys in the upper reaches and a narrow flat plain in the lower reaches characterize the Green River basin. Elevations in the basin vary from 140 +/- ft. National Geodetic Vertical Datum (NGVD) at the most downstream dam to 2,400 +/- ft. NGVD at the headwaters (an average drop of 75 feet per mile). The Green River floodplain in Greenfield mainly is narrow, flat, deforested, and development is mostly commercial and residential. In the upper reaches, the floodplain is mostly wooded or agricultural with sparse residential development.

1.3.2 Water Quality

The Green River has been designated as Class B, Cold Water Fishery according the Massachusetts Surface Water Quality Standards (314 CMR 4.00) set by the Massachusetts Department of Environmental Protection (DEP). This is defined as waters in which the maximum mean monthly temperature generally does not exceed 68°F (20°C) and, when other ecological factors are favorable, is capable of supporting a year-round population of cold-water stenothermal aquatic life such as trout. Proposed draft Water Quality Standards revisions have designated the Green River above the water supply dam as “Class A, Cold Water, Public Water Supply, High Quality Water”.

The 2000 water quality assessment performed by the DEP (2004) reported that the water quality in the segment of the river between the Pumping Station Dam and the Town Swimming Pool Dam was supporting its designated uses for aquatic life, primary and secondary contact recreation, and aesthetics. The water quality in the segment of the Green River from the Swimming Pool dam down to the confluence with the Deerfield River was also assessed as supporting these same uses, however an alert status was assigned to the assessments for all of these uses based on concerns about degraded habitat quality conditions, occasional elevated bacteria counts in the main stem and several tributaries, and in stream turbidity, trash and debris. The Department of Public Health has also reported that the Green River Swimming pool on the Green River has experienced occasional elevated bacteria counts that exceeded the swimming standards and resulted in beach closures. (DPH Marine and Freshwater Beach Testing Annual Reports for.2002, 2003, and 2004)

1.3.3 Environmental Resources

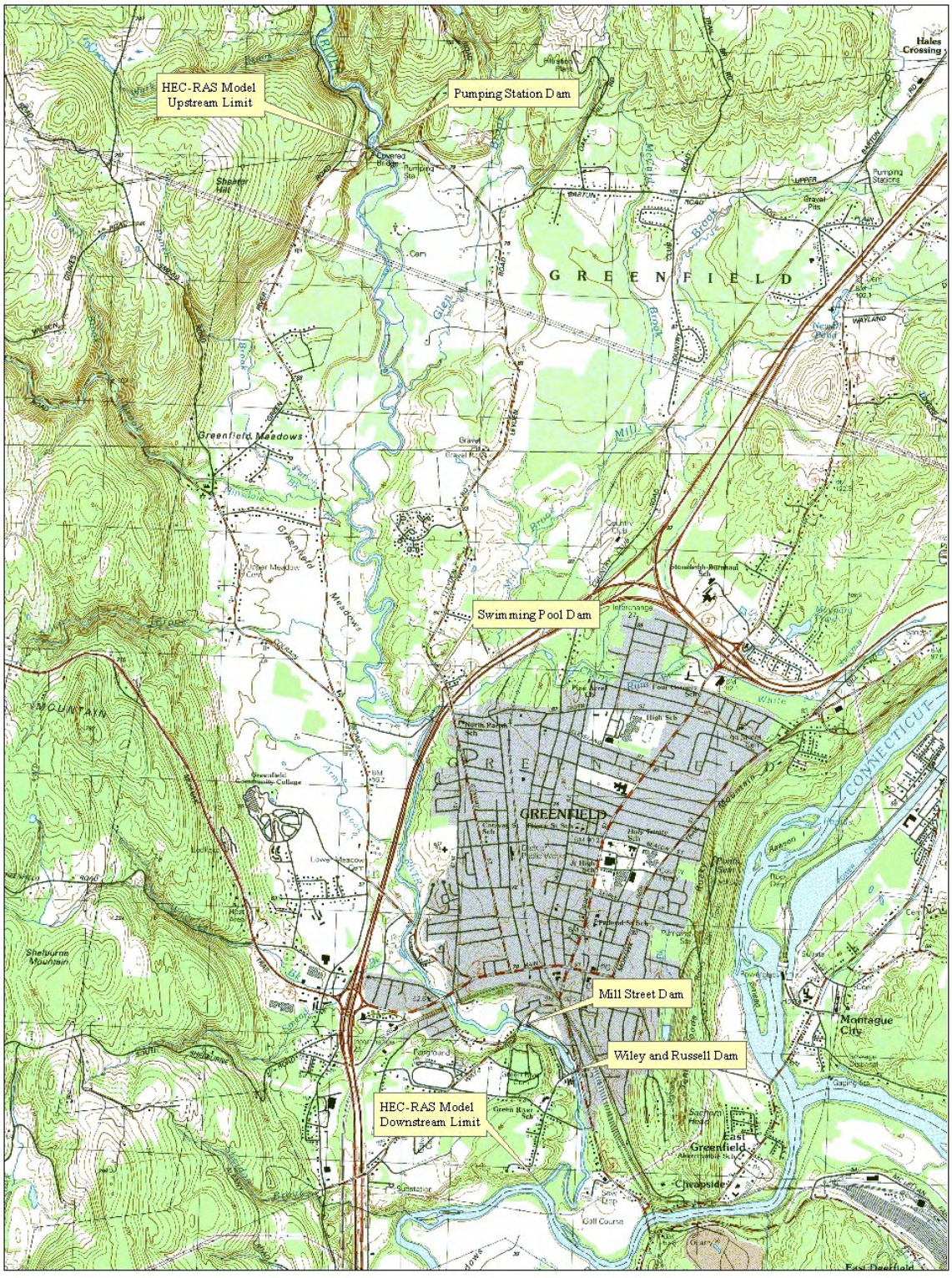
The proposed restoration of fish passage and riverine habitat on the Green River represents an opportunity to enhance locally, regional, and nationally important environmental resources. Anadromous fish and other aquatic life and the wildlife that depend on the river’s resources would benefit from implementation of a restoration project. If no measures are taken to restore fish passage and riverine habitat on the Green River, fish passage will continue to be impeded and the benefits to regionally and nationally recognized resources would not accrue. The improvements in fish and wildlife resource value that would be generated with the project would not be achieved.

The improvements listed above would contribute to the regional efforts to restore anadromous fisheries in the Connecticut River where they have important ecological, economic and cultural importance. Anadromous and catadromous fisheries are by definition (Corps of Engineers Engineering Regulation

ER 1105-2-100) are federally significant. Removing the impoundments would re-expose the riparian banks allowing vegetation to be reestablished providing overhang shade and additional fish habitat along the river. The latter would improve the habitat niches, moderate temperatures, and reduce direct solar radiation onto demersal eggs (attached to the substrate). The removal of dams and adjacent structures would restore a natural river ecosystem with important fishery and recreational values and would enhance water quality in the Green River.

1.3.3 (a) Historic and Archeological Resources

The Green River is considered archaeologically sensitive for the presence of prehistoric archaeological sites dating from the Middle Archaic (5500 – 3000 B.C.) to the Contact Periods (1500 – 1620 A.D.). The Green River was used for hydropower for a number of industries during Greenfield's history. The Wiley and Russell Dam was determined to be a contributing element to the Greenfield Tap & Die Plant No. 1, a district eligible for the National Register of Historic Places. The former Greenfield Tap & Die Company, an important tool making concern, operated from 1912 to 1992 at the site of an older, similar industry. It is anticipated that removal of the Wiley and Russell Dam will require prior documentation through the Historic American Engineering Record (HAER). The proposed removal of the Mill Street Dam, and the construction of fish ladders at the Swimming Pool and Pump Station dams, should have no effect on historic properties provided that all staging and project features are situated in previously disturbed areas. Consultation has been initiated with the Massachusetts State Historic Preservation Office and the Stockbridge-Munsee Tribal Historic Preservation Officer. Coordination with these parties and the Greenfield Historical Commission should continue throughout the project implementation process. Execution of a Memorandum of Agreement (MOA) with the Massachusetts State Historic Preservation Office is recommended as a means of documenting the tasks required to meet preservation goals.



STUDY AREA MAP

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1 inch equals 2,500 feet

U.S. Army Corps of Engineers
Section 206: Environmental Restoration
Green River
Greenfield, MA

PLATE 2

1.4 EVALUATION METHOD

The primary goals of the project are restoration of anadromous fisheries, aquatic habitat, and improvement of water quality. Every habitat is made up of physical, chemical, and biological components each of which can be defined through various criteria. For purposes of this evaluation, habitat criteria (water quality, aquatic habitat, and anadromous fish habitat) were broken down into basic requisites for aquatic life. Three requisites related to water quality were identified: dissolved oxygen, temperature, and flow. Aquatic habitat was broken down into four component requisites: spawning substrate, in-stream cover, forage, and benthic invertebrates. Habitat requisites for anadromous fisheries were identified as upstream passage, downstream passage and spawning habitat.

The Corps prepared an Incremental Analysis to quantify the habitat benefits that would accrue for each of the proposed restoration alternatives. A quantification of benefits is necessary to determine the cost effectiveness of various restoration plans. The recommended alternative is selected using information showing the changes in costs among alternatives.

The method used for evaluating the Green River involves the examination of three primary habitat types that define the existing ecosystem of the study area. These include:

- Riverine habitat, which exists in the reaches of the river between each of the dams, upstream and downstream of their impoundments.

- Lacustrine habitat; which consists of the impoundments upstream of each dam; and

- Wetland habitat, which is located at various locations along the edges of the river or adjacent to the river, and may be hydraulically dependent upon the water levels of the river and/or the impoundments. (The primary wetland examined in this study is located in the oxbow area adjacent to the impoundment upstream of the Mill Street Dam).

In conducting the Incremental Analysis, these habitat types are evaluated in terms of positive or negative changes that might be expected with each of the possible restoration alternatives. In evaluating the changes that would occur, it is possible that implementation of some of the restoration alternatives will decrease one habitat type while increasing another (e.g., by the removal of dams, the amount of lacustrine habitat formed by the impoundment will be reduced, however the riverine habitat will improve). The method used evaluates changes in the area and quality of each habitat type for each alternative and considers how costs change when increments of habitat improvement are added.

1.5 STUDY COORDINATION

The Commonwealth of Massachusetts Executive Office of Environmental Affairs (EOEA) and the Town of Greenfield, Massachusetts partnered with the Corps to fund and support the study. EOEA provided local coordination by organizing public information meetings, hosted meetings for involved agencies, and, with assistance from the Natural Resources Conservation Service, conducted a public education and outreach session. The Corps also sent letters to various Federal and state resource agencies as well as various public interest groups.

SECTION 2 – PROBLEM IDENTIFICATION

2.1 EXISTING CONDITIONS

This section of the report will provide details on each of the four dams being evaluated on the Green River as well as highlight the plan formulation constraints affecting the analysis.

2.1.1 WILEY & RUSSELL DAM

This is the first dam in the series of four dams along the Green River, located 1.2 miles above the confluence with the Deerfield River. It is a run of the river timber crib dam and concrete spillway 10 to 14 feet in height and about 185 feet in length. The dam is founded on bedrock and consists of an open timber crib with a vertical downstream face. The crib is covered on the top with a thin concrete cap and has a thin inclined concrete upstream face extending into the sediments impounded behind the dam. The structure has concrete and stone masonry abutments with abandoned outlet structures on both abutments. The two low-level outlet structures have deteriorated significantly and are inoperable, and the entire dam has fallen into considerable disrepair. The dam was constructed in 1936 for water supply for the Greenfield Tap & Die Company adjacent to the site. The Town of Greenfield currently owns the dam and was issued orders by the Massachusetts Department of Environmental Management (DEM, now known as the Department of Conservation and Recreation, DCR) that required the dam to be repaired by October 1999. The required repairs have not been performed to date. The Town has plans to revitalize the neighboring community and may have reservations about removal of the dam as it provides an aesthetically pleasing reflecting pool and has historical significance to some people. Removal or passage would provide access to 0.3 miles of habitat within the Green River.

The DEM Office of Dam Safety Inspection and Evaluation Report, dated June 18, 1998, lists the dam (ID no. 2-6-114-3) as “Small Size”, having a “Significant Hazard” classification, and being in generally poor condition. The report documents significant deficiencies in the condition of the dam and recommends detailed engineering investigations into the stability and adequacy of the dam as well as extensive remedial work. Specific deficiencies included: no corrective actions taken on previously identified deficiencies from a 1993 inspection; major cracking in the abutments; extensive tree and brush growth; spalling and severely decayed concrete; stones missing from masonry abutment walls; sinkholes along right abutment wall; trash racks and sluice gates no longer intact; and controls inoperable. Recommended investigations included: detailed hydraulic/hydrologic assessment to determine adequacy of the spillway; structural stability analysis of the masonry abutments and the timber crib and concrete spillway structures; investigation into the outlet structures integrity and seepage potential; and development of a written operations and maintenance plan.

The Corps performed an initial visual inspection on September 5, 2001 with regard to the possible installation of a fish passage. This confirmed the reported deficiencies and recommendations of the 1998 DEM report. The dam’s spillway, abutment walls, and outlet structures have not undergone any visible maintenance activities and have continued to deteriorate. The dam is considered to be in a very poor to unsafe condition. Extensive remedial, replacement, or removal actions are required to bring the dam and associated structures into a safe operating condition. Considerable deterioration and decay has occurred to the concrete weir, timber crib members, masonry abutment walls, and adjacent outlet structures. There is currently no means to regulate the pool level behind the dam. The right abutment diversion conduits that ran to the old mill building are full of silt and sand deposits and the old timber gates have rotted away. The left abutment low-level outlet discharge is also blocked with debris and the old cast iron gate is inoperable. Most of the historical storage behind the dam is silted in with sediments, which block the intake to the old low-level outlet gate. Potential contamination of these

upstream sediments is under investigation by others at this time and is not addressed herein. Significant damages have occurred to the downstream right abutment masonry wall (looking downstream) since the last inspection, several large portions of the wall have collapsed due to seepage and repeated freeze/thaw action. The remaining portions of the masonry wall are unstable and ready to collapse. The dam is currently susceptible to a potential piping failure due to ongoing seepage through and around the right masonry abutment, as well as possible collapse of the deteriorated spillway structure.

The Corps performed a second site inspection on August 7, 2002 of the left abutment area to obtain more detailed information and to select subsurface boring locations for the proposed fish ladder. An old masonry and concrete foundation is located adjacent to this end of the timber crib spillway where the proposed fish ladder would be built. This old foundation appears to be the remnant of a flow diversion structure used for industrial purposes when the dam was functioning. The dam's inoperable low-level outlet used to discharge through the foundation of this structure. There is also an abandoned underground masonry channel running upstream under the north foundation wall. The foundation is currently filled with concrete and masonry rubble materials.

The Town would have to satisfactorily address all of the identified dam safety deficiencies prior to the construction of any viable fish passage structure under the Corps program. Due to the severity of the deterioration, conventional remedial repairs are probably no longer economically viable. The Town should consider the construction of a new dam immediately downstream of the existing dam or construction of the alternative rock ramp fishway if an impoundment structure is still part of the local neighborhood revitalization plans, otherwise the dam should be removed.

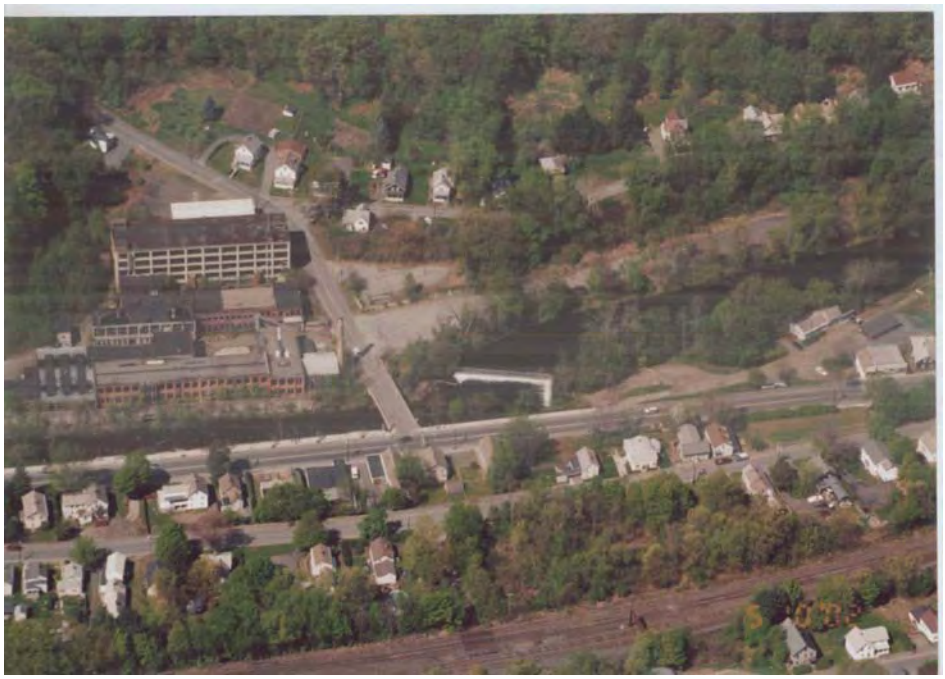


Photo 1: The Wiley & Russell Dam is located just upstream of the Meridian Street Bridge.

2.1.2 MILL STREET DAM

This is the second dam on the Green River, located about 1.5 miles above the confluence with the Deerfield River. It is a run of the river concrete gravity dam about 12 feet in height and about 170 feet in length. The dam was originally owned and used by Greenfield Electric Light and Power, but is

currently owned by the town of Greenfield. The adjacent Mill Street Bridge was reconstructed in 1981 and spans directly over the dam. The bridge's new left abutment was constructed directly over the original dam abutment, and the new right bridge abutment is located just upstream of the old dam. The Corps performed an initial site inspection on September 5, 2001 with regard to the possible installation of a fish passage. The dam appears to be founded on bedrock, as several outcrops are located at the dam's right abutment and also partially visible in the river bottom below the dam. It is not known whether the reconstructed bridge abutments are founded on bedrock. The dam has a single low-level outlet, of which the operating condition is unknown. Considerable deterioration of the concrete pier supporting the gate controls has occurred. Overall the concrete spillway section appears to be in fair condition, with the outlet works area being in poor condition. The Town would have to undertake repairs to the outlet gate structure if the dam is to remain and a fish ladder installed there. Removal or passage would provide access to 2.2 miles of additional habitat along the Green River.

Photo 2: The Mill Street Dam is partly beneath the Mill Street Bridge.

2.1.3 SWIMMING POOL DAM

This is the third dam on the Green River, located about 3.7 miles above the confluence with the Deerfield River. It is a run of the river concrete dam about 2 feet in height and about 75 feet in length, located adjacent to a public beach. The dam is currently owned and used currently by Greenfield for recreation purposes. An initial site inspection was performed on September 5, 2001 with regard to the possible installation of a fish passage. The dam is founded directly on bedrock and appears to be in very good condition. The dam consists of a low concrete sill extending across the river with concrete piers extending above the river bottom. During summer months, slide gates are placed between the piers to impound a small pool for recreation and swimming. Modifications for fish passage would provide access to 4.6 miles of additional habitat along the Green River.

Photo 3: The Swimming Pool Dam is located at the town park off Nash's Mill Road.

2.1.4 PUMPING STATION DAM

This is the fourth dam on the Green River, located about 8.3 miles above the confluence with the Deerfield River. It is a run of the river concrete gravity dam about 17 feet in height and about 95 feet in length. The dam is owned and currently used by Greenfield for water supply. The Corps performed an initial site inspection on September 5, 2001 with regard to the possible installation of a fish passage. The dam is founded directly on bedrock and appears to be in very good condition. It consists of a concrete overflow spillway across the main river channel, a concrete outlet works structure at the left edge of the river, and a low embankment and concrete wall extending to the left abutment. A modification to provide fish passage would open 12 miles of additional habitat along the Green River.

Photo 4: The Pumping Station Dam is located just upstream of the covered bridge on Eunice Williams Drive.

2.2 FUTURE CONDITIONS WITHOUT PROJECT

If no project is implemented to provide fish passage on the Green River, the status quo will prevail. The river will continue to be used for stocking juvenile anadromous species but the four dams in Greenfield will continue to block upstream passage of anadromous fish and segment the river and its native fish population. A possible exception to that forecast is the potential failure of the Wiley & Russell Dam if remedial work is not performed in a timely manner.

2.3 PLANNING CONSTRAINTS

As a tributary to the Connecticut River, the Green River historically provided migratory, spawning and nursery habitat for native anadromous fish, including Atlantic salmon, American shad, blueback herring and sea lamprey, as well as the catadromous American eel and the potadromous smallmouth bass, white sucker, and brook trout.

This investigation identified and examined practical methods to achieve fish passage at each dam accounting for physical or operational constraints that exist to limit the range of alternatives. Two of the four dams are beneficially serving the community. The Pumping Station Dam provides storage for public water supply. Its removal is not an option. The town of Greenfield operates the Swimming Pool Dam off Nash's Mill Road to create a pool behind it for seasonal public recreation. The Town does not support its removal to provide fish passage. Therefore, the study considers dam removal only at Wiley & Russell Dam and Mill Street Dam. The study team initially considered an alternative fish passage measure of a by-pass channel around the Wiley & Russell and Mill Street dams. However, there is no good path for such a channel to follow with the upstream and downstream areas separated by the roadway embankment and both industrial and residential development. The cost of acquiring land itself was found to be more expensive than other fish passage alternatives. Also, the trap and truck method of fish passage was eliminated from further study because of the logistical constraints and seasonal variability associated with restoring passage for such a wide variety of aquatic species.

SECTION 3 – CONSIDERATION OF ALTERNATIVES

3.1 SITE SPECIFIC ALTERNATIVES

The following site-specific fish passage measures were identified for further study after considering planning constraints, including prevailing site conditions. It should be noted that different alternatives can be applied to each site but something has to be done at every site in order to achieve all the project benefits.

3.1.1 Site 1 – Wiley and Russell Dam

Alternatives:

a) no action (maintain existing condition)
b) remove dam or partial breach of dam
c) construct fish ladder
d) construct rock ramp fishway

3.1.1 (a) Maintain Existing Condition

If no project is implemented, the Wiley & Russell Dam will remain as an impediment to upstream fish passage. The dam is in poor condition, especially its right abutment. It is anticipated that the State Office of Dam Safety will require the town of Greenfield to perform repairs. Major structural repairs as well as repairs to its gate structure and controls should be performed. It is also possible that the dam could fail as a consequence of the cumulative effects of high water events and deferred maintenance. In 2005, the sluiceway on the right bank of the river blew out downstream of the dam, creating a condition of greater uncertainty (see Photo 6).

Photo 5: Water pours through a failed sluiceway fed by the Wiley & Russell Dam impoundment. This location is immediately upstream of the Meridian Street Bridge.

3.1.1 (b) Dam Removal or Partial Breach of Dam

Removing Wiley & Russell Dam would create unimpeded access for fish to travel upstream. If means for fish passage were also provided at the Mill Street, Swimming Pool and Pumping Station Dams, a fish ladder at Wiley & Russell Dam would provide access to excellent spawning habitat upstream.

Criteria for partial or complete dam removal to allow migrating fish upstream was provided by the U.S. Fish & Wildlife Service (USFWS). These included removal parameters, allowable flow conditions, and the maximum allowable change in water surface elevations at the dams for natural fish passage. A partial breach of the Wiley & Russell Dam called for removal of one-third of the spillway length in the middle channel section of the dam (60'long x 3'high). The removal height was determined knowing the maximum allowable difference between the upstream and downstream water surfaces at the dams cannot be greater than a 3-foot difference for a flow of 360 cfs. A 3-foot difference or less would allow migrating fish to access areas upstream naturally without need for a fish passage facility. The same elevation and flow criteria were applied to the complete dam removal alternative, which would return this section of the river to a nearly natural (pre-dam) state.

The hydraulic analysis of the Green River used the Corps of Engineers HEC-RAS computer model to compute water surface profiles. It is a standard step method for calculating water surface elevations for steady gradually varied flows, based on river geometry and structures crossing the channel. Input for the model consists of channel geometry, hydraulic roughness coefficients, bridge and dam elevation data and structural geometry, and flow data.

Dimensions of the dam, bridges, and river channel cross sections through the study reach were obtained from the HEC-2 files for the Greenfield, MA Flood Insurance Study. Supplemental survey was conducted in November 2001 to better define existing conditions of the structure, channel, and surrounding topography. This new survey data was incorporated into the model to better define the existing conditions. The new survey provided accurate elevation data for possible sediment loads just upstream of the dam.

Results of the HEC-RAS analysis computed elevations and velocities at each cross section for flows ranging from four times the annual average daily flow ("fish flow"), 360 cfs, to the 500-year flood event of 16,350 cfs. The results from this range of flows defined the local flow characteristics needed to identify whether the alternatives would meet the natural fish passage criteria, and define possible areas that are susceptible to scour and erosion due to velocity increases. The fish flow was used to model the maximum allowable flow that a migratory fish could overcome with an upstream/downstream water surface elevation difference of less than 3 feet at the site of the removed or partially breached dam. The HEC-RAS model results for this flow determined that for the dam removal alternative the water surface elevation difference was 6 feet at Wiley & Russell dam. This is due to the model's inability to predict the new river bottom elevation after dam removal. This study did not identify the thickness of accumulated sediment behind the dam. However, topographic surveys determined that ledge outcrops exists along the river bottom just below Wiley & Russell Dam at a low enough elevation to permit natural fish passage. It is highly probable that this ledge outcrop exists under the dam structure at the same elevation and when the dam is removed, sediments will erode (or possibly removed) sufficiently to create a new river bottom at this ledge surface. A notch could be cut to ensure the target species can overcome the ledge if it is found to be a barrier to fish passage. In any event, if the HEC-RAS model were run with this adjusted river profile in place, the water surface elevation difference from upstream to downstream would be less than 3 feet for the dam removal option. Model results of the partial breaching of the dam (8 foot difference from upstream to downstream) indicate that this method of fish passage is not a viable solution. Further investigation on

depth (sediment probes or cores) and particle size of the sediments behind the dam will need to be done during the final design phase to confirm the actual elevation difference between the upstream and downstream inverts when the dam is removed.

Calculated velocity increases, upstream of Wiley &Russell Dam for the more frequent flows analyzed, ranged from 3.5-5.7 feet per second for the proposed dam removal. These increased velocities may cause some localized erosion above the dam and redistribution of sediments downstream. However, predicting the amount and location of any sediment redistribution was beyond the scope of this effort.

During the study process, the Corps became aware of remedial work in progress by the Berkshire Gas Company along the reach between the Mill Street Dam and the Wiley & Russell Dam. Coal tar, a polynuclear aromatic hydrocarbon (PAH), is present in the area as a result of an historic coal-gas plant that used to operate in the area south of Mill Street. Berkshire Gas Company, working with the Massachusetts Department of Environmental Protection (DEP), has completed two phases of their remedial plan for the site, including some work in the Green River channel in 2001.

USACE collected samples of sediments from ten locations within the Green River (and Deerfield River) on September 5th and 6th, 2001. "Grab" samples were gathered using push cores and shallow dredges. Nine of the ten samples were collected from within the Green River. The one remaining sample was collected in the Deerfield River immediately downstream of the confluence with the Green River. Three sediment samples were taken in the immediate vicinity of each target location, and then composited into a single representative sample for the location. Samples were submitted to the analytical laboratory and analyzed for:

- Grain size
- Total organic carbon
- Metals (15)
- Polychlorinated biphenyls (PCBs; 22 congeners)
- PAHs

Grain size and total organic carbon results are used to characterize physical properties of the sediments, whereas the chemistry results are used to characterize potential anthropogenic contamination. Any such contamination may be considered residual, given that coal gas operations ceased in 1958 and discovered between 1971 and 1984.

Concentrations of chemicals detected in sediments may be compared to the *Threshold Effects Criteria* (TEC) provided by DEP as an indication of potential toxicity to aquatic organisms. Such comparisons indicate a general lack of toxicity for PCBs and metals, with the exception of chromium, which slightly exceeded its TEC. Concentrations of PAHs generally exceeded their respective TEC. However, there is uncertainty in the magnitude of these exceedances since they were similar in magnitude to the overstated bias in the reported concentrations of PAHs, as noted above. In light of this uncertainty, it appears that the reported exceedances of TEC are no worse and may be less problematic than indicated by the sample data.

As an additional point of comparison in assessing the health of the Green River environment, a macroinvertebrate study was conducted by the Deerfield Watershed Association in 2004. The findings of that study indicate that conditions in the Green River currently resemble conditions at ecological

health reference locations. It should be noted that this study did not sample directly in the areas of highest PAH contamination, so those results may understate actual effects. In addition, a DEP 2000 Water Quality Assessment report included results of macroinvertebrate surveys conducted in 2000 below the Pumping Station Dam and below the Wiley & Russell dam near Green River Park. The benthic community was not impacted at either of these sites and, in fact, improvement was noted in the macroinvertebrate community at the downstream station from 1995 data.

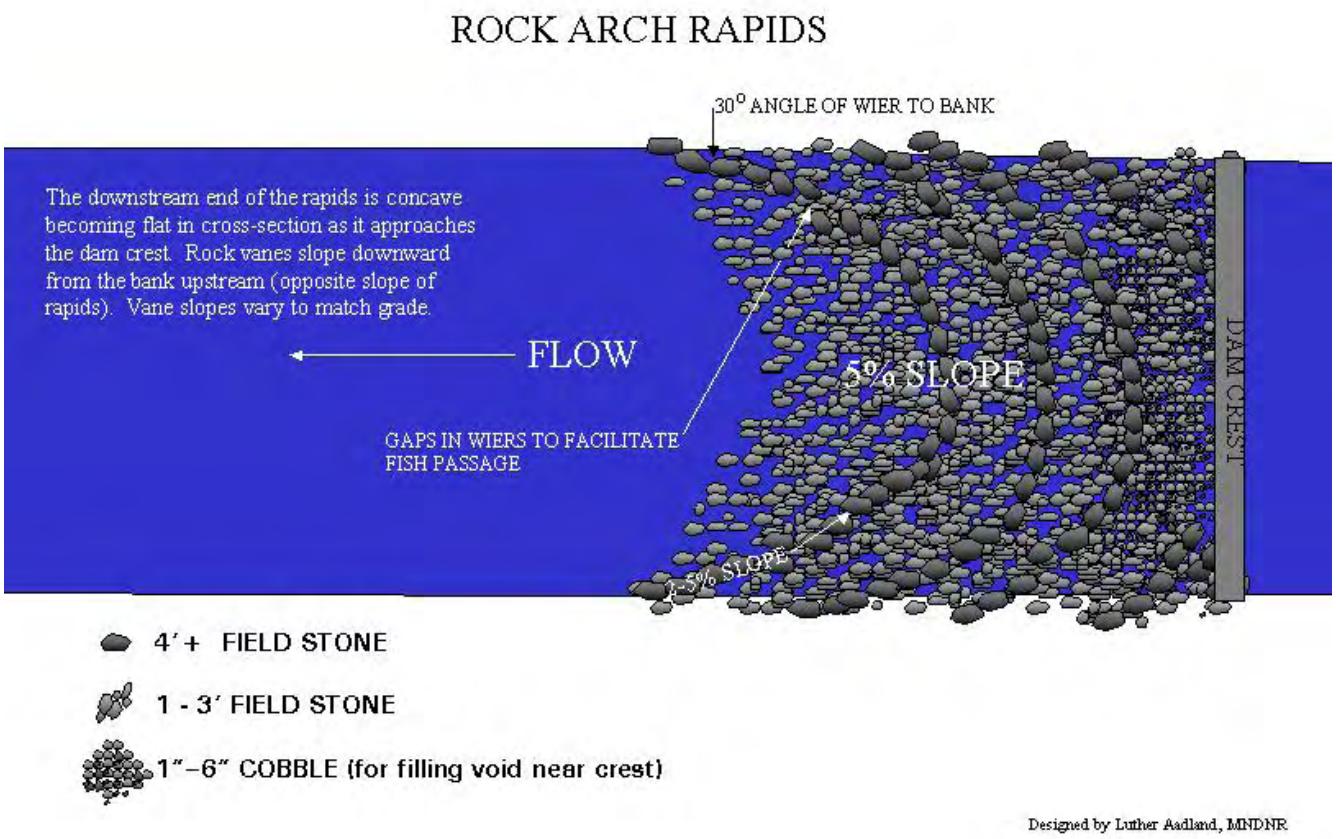
If the Wiley & Russell Dam were removed, the impoundment would be drawn down prior to any demolition activity. At that time, the opportunity would exist for Berkshire Gas Company to remove coal tar contaminated sediment in the "dry" with only a low flow channel flowing through this reach. This could be a much more economical process than if the impoundment remained. The need for further remediation, and the method and timing of that remediation, if any, should be explored through continued coordination with Berkshire Gas Company and DEP.

3.1.1 (c) Fish Ladder

A fish ladder would allow fish to pass upstream of the dam. The USFWS prepared a conceptual fish ladder and fish passage facility design for the Wiley & Russell Dam (Plates 19 and 21). The fish ladder design would optimize the passage of some, but not all species. If means for fish passage were also provided at the Mill Street, Swimming Pool and Pumping Station Dams, a fish ladder at Wiley & Russell Dam would provide access to excellent spawning habitat upstream. The dam is, however, in poor condition as noted in Section 3.1.1 (a) above. The town of Greenfield would have to perform repairs to the dam as a prerequisite for fish ladder construction.

3.1.1 (d) Rock Ramp Fishway

A rock ramp fishway is a specially engineered arrangement of boulders and cobbles that creates step pools with flow patterns sized to allow fish to climb gradually upwards from its toe to its crest and over a dam or other obstacle fronted by the rock ramp (see Figure 1 and Plates 20 and 22). In general, a concrete substructure of stepped cells with gravel fill are constructed in front of the dam at a 20 to 1 slope decreasing from the dam crest to the river invert. The substructure serves to buttress the dam and support the rocks that comprise the face of the ramp. Rows of boulders are arranged in a chevron pattern, angled downstream, where the largest boulders are placed near the river's banks and the remaining boulders in each row become progressively smaller until the river channel centerline is reached. This focuses the low flows to the center of the channel as they go down the rock ramp and gradually spreads higher flows so that there is always a location on the rock ramp where fish can climb successfully.



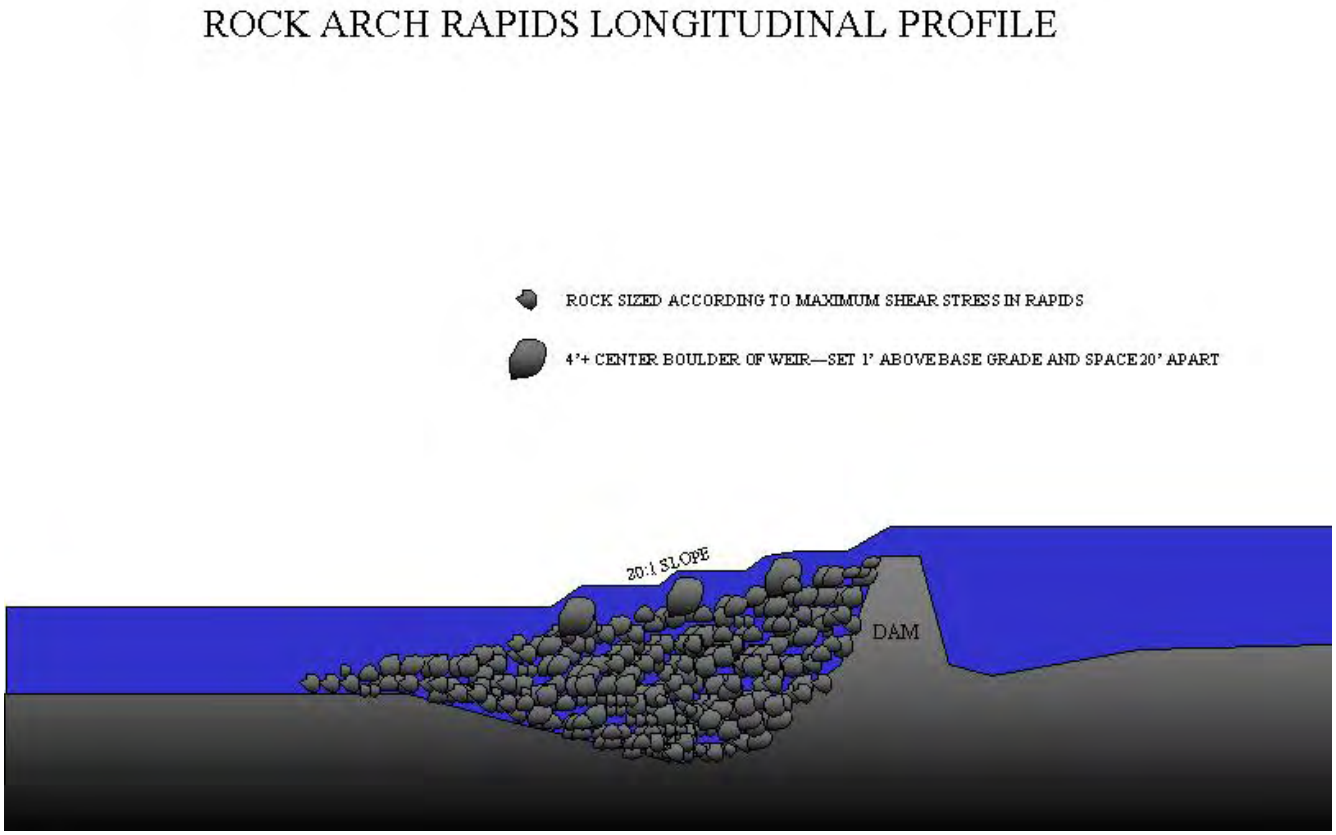


Figure 1 : Plan & Profile of typical Rock Ramp Fishway design; Substructure cell walls not shown

3.1.2 Site 2 – Mill Street Dam

Alternatives:

a) no action (maintain existing condition)
b) remove dam or partial breach of dam
c) construct fish ladder

3.1.2 (a) Maintain Existing Condition

If no project is implemented then the dam will remain as an impediment to upstream fish passage. Repairs to its gate structure and controls should be performed (See photo 6.)

Photo 6: Deteriorated Gate Control at Mill Street Dam

3.1.2 (b) Dam Removal or Partial Breach of Dam

Removing Mill Street Dam would create unimpeded access for fish to travel upstream. Criteria for partial or complete dam removal to allow migrating fish upstream was provided by USFWS. These included removal parameters, allowable flow conditions, and the maximum allowable change in water surface elevations at the dams for natural fish passage.

A partial breach of the Mill Street Dam called for removal of one-third of the spillway length in the middle channel section of the dam (55'wide by 4.5'high). The removal height was determined knowing the maximum allowable difference between the upstream and downstream water surfaces at the dams cannot be greater than 3 feet for a flow of 360 cfs. A 3-foot difference or less would allow migrating fish to access areas upstream naturally without need for a fish passage facility. The same elevation and flow criteria were applied to the complete dam removal alternative, which would return this section of the river to a nearly natural (pre-dam) state (see plate 13).

The HEC-RAS model results for the fish flow determined that for the dam removal alternative the water surface elevation difference was 3.5 feet at Mill Street dam. Again, as described earlier is section 3.1.1 (b), this difference is due to the model's inability to predict the new river bottom elevation after dam removal. This study did not identify the thickness of accumulated sediment behind the dam.

However, topographic surveys determined that ledge outcrops exists along the river bottom just below Mill Street Dam at a low enough elevation to permit natural fish passage. It is highly probable that this ledge outcrop exists under the dam structure at the same elevation and when the dam is removed, sediments will erode (or possibly removed) sufficiently to create a new river bottom at this ledge surface. A notch could be cut to ensure the target species can overcome the ledge if it is found to be a barrier to fish passage. In any event, if the HEC-RAS model were run with this adjusted river profile in place, the water surface elevation difference from upstream to downstream would be less than 3 feet for the dam removal option. Model results of the partial breaching of the dam (5.5 foot difference from upstream to downstream) indicate that this method of fish passage is not a viable solution. Further investigation on depth (sediment probes or cores) and particle size of the sediments behind the dam will need to be done during the final design phase to confirm the actual elevation difference between the upstream and downstream inverts when the dam is removed.

Calculated velocity increases, upstream of Mill Street Dam for the more frequent flows analyzed, ranged from 5.1 – 7.3 feet per second for the proposed dam removal. Plans for the Mill Street Bridge need to be obtained for a final design involving dam removal to be prepared. It is assumed that an 8-inch diameter sanitary sewer line upstream of the Mill Street Bridge would need to be relocated if dam removal is selected. Establishment of a new stable channel with vegetated banks would take time, so erosion of these structures needs to be accounted for in the site design. As with Wiley & Russell, predicting the amount and location of any sediment redistribution when the dam is removed was beyond the scope of this effort.

3.1.2 (c) Fish Ladder

A fish ladder would allow fish to pass upstream of the dam. The USFWS prepared a conceptual fish ladder and fish passage facility design for the Mill Street Dam (see Plates 14, 15, and 16). The fish ladder design would optimize the passage of some, but not all species. In conjunction with similar fish passage structures at the Swimming Pool and Pumping Station Dams, a fish ladder at Mill Street Dam would provide access to excellent spawning habitat upstream. Overall, the dam's concrete spillway appears to be in fair condition and the outlet works are in poor condition. The Town will need to repair the outlet gate structure prior to installation of a fish ladder.

3.1.3 Site 3 – Swimming Pool Dam

a) no action (maintain existing condition)
b) construct fish ladder

3.1.3 (a) Maintain Existing Condition

The Swimming Pool Dam is used by the town to create a seasonal recreational swimming area and it is, therefore, not a candidate for removal. If no project is implemented then the dam will remain as an impediment to upstream fish passage.

3.1.3 (b) Fish Ladder

A fish ladder would allow fish to pass upstream of the dam during periods where the flashboards are in place and a notch created in one bay of the dam would be effective at all other times. The USFWS prepared a conceptual fish ladder and fish passage facility design for the Swimming Pool Dam (see Plate 9, 10, and 11). The fish ladder design would optimize the passage of some, but not all species. In

conjunction with a fish passage structure at the Pumping Station Dam, a fish ladder at Swimming Pool Dam would provide access to excellent spawning habitat upstream.

3.1.4 Site 4 – Pumping Station Dam

Alternatives:

a) no action (maintain existing condition)
c) construct fish ladder

3.1.4 (a) Maintain Existing Condition

The town uses the Pumping Station Dam to create a backup municipal water supply and it is, therefore, not a candidate for removal. If no project is implemented then the dam will remain as an impediment to upstream fish passage.

3.1.4 (b) Fish Ladder

A fish ladder would allow fish to pass upstream of the dam and access to excellent spawning habitat upstream. The USFWS prepared a conceptual fish ladder and fish passage facility design for the Pumping Station Dam (see Plates 5, 6, and 7). The fish ladder design would optimize the passage of some, but not all species.

3.1.5 Site 5 – Leyden Woods

After dropping steeply over the first 1.5 miles below the Pumping Station Dam, the invert of the Green River becomes less steep. At about 2.3 miles below the dam, near the Leyden Woods apartments, the river is characterized by old oxbows, eroding riverbanks and depositional bars.

3.1.5 (a) In-stream Work for Habitat Restoration

Habitat improvements would consist of the placement of rock weirs extending from the banks in order to create pool and riffle sequences beneficial for resident trout and other species in a section of the Green River near the Leyden Woods apartments, and the stabilization of some of the severely eroded banks nearby.

3.1.6 Site 6 – Reach Between Mill Street and Meridian Street

The short, gently curving river segment between Mill Street and Meridian Street would benefit from channel alterations to improve fish habitat if the Wiley & Russell dam were removed and the lacustrine habitat reverted to a riverine one. These restoration measures include the placement of rock weirs extending from the banks to create slight meanders in the new low flow channel and also direct low flows away from areas such as the foot of the slide from the cemetery.

3.1.6 (a) In-stream Work for Habitat Restoration (only if Wiley & Russell dam removed)

Habitat improvements would consist of the placement of rock weirs extending from the banks in order to create pool and riffle sequences beneficial for resident trout and other species in the section of the Green River between Mill Street and Meridian Street.

3.2 Formulated Alternatives

The alternative measures considered for a given site are summarized in Table 1. Based upon known criteria for fish passage and recognizing prevailing site conditions and other planning constraints, the alternative measures discussed above were combined to create alternative plans for further study. Ten alternative plans were evaluated, including the "No Action" plan, by the study. These combinations are summarized in Table 2. Plates 4 through 22 that follow depict the existing conditions and the conceptual plans and details for the proposed alternative fish passage measures.

TABLE 1 DEERFIELD RIVER GI STUDY GREEN RIVER HABITAT IMPROVEMENT GREENFIELD, MA ALTERNATIVE MEASURES CONSIDERED BY SITE

SITE NO.	SITE	DESCRIPTION OF WORK PROPOSED	TYPE OF BENEFIT	SPECIFIC MEASURE	*ESTIMATED CONSTRUCTION COST	CONSTRUCTION ACCESS / REAL ESTATE NEEDS	NOTES
1	**Wiley & Russell Dam**	Consider dam removal for fish passage, rock ramp fishway for fish passage or fish passage structure.	increase anadromous fish access to habitat	Wiley & Russell Dam complete removal	$380,000	Municipal ownership. Temporary easements required for public & private land.	Analysis showed partial breach at this location to be unfeasible.
				Wiley & Russell Dam partial breach	N/A		
				Wiley & Russell Dam rock ramp fishway	$370,000		
				Wiley & Russell Dam denil fish ladder	$470,000		
2	**Mill Street Dam**	Consider dam removal for fish passage, partial dam breach for fish passage or fish passage structure.	increase anadromous fish access to habitat	Mill Street Dam complete removal	$530,000	Municipal ownership. Temporary easements required for public & private land.	Analysis showed partial breach at this location to be unfeasible.
				Mill Street Dam partial breach	N/A		
				Mill Street Dam denil fish ladder	$610,000		
3	**Swimming Pool Dam**	Consider fish ladder for fish passage.	increase anadromous fish access to habitat	Swimming Pool Dam steeppass fish ladder	$280,000	Municipal ownership. Temporary easement required on public land.	
4	**Pumping Station Dam**	Consider fish ladder for fish passage.	increase anadromous fish access to habitat	Pumping Station Dam denil fish ladder	$530,000	Municipal ownership. Temporary easement required on public land.	
5	**River channel in the vicinity of Leydon Woods**	Construct J-vanes and boulder groups in river channel to create riffle/pools.	improve fish habitat	Construct J-vanes and boulder groups in river channel.	$20,000	Access and staging area require easements on private land.	
6	**River channel Mill Street to Meridian Street**	Construct J-vanes and boulder groups in river channel to create riffle/pools.	improve fish habitat	Construct J-vanes and boulder groups in river channel.	$30,000	Access and staging area require easements on private land.	

* Doesn't include costs for developing Plans & Specifications, Permits, and Construction Phase Project Management and Value Engineering Study and Demobilization.

TABLE 2 DEERFIELD RIVER GI STUDY GREEN RIVER HABITAT IMPROVEMENT GREENFIELD, MA
DESCRIPTION OF ALTERNATIVE PLANS

ALTERNATIVE PLAN NUMBER	ALTERNATIVE PLAN DESCRIPTION
1	**No Action**
2	**Remove Wiley & Russell Dam** **Remove Mill Street Dam** **Construct Fish Ladder At Swimming Pool Dam** **Construct Fish Ladder At Pumping Station Dam**
3	**Construct Fish Ladder At Wiley & Russell Dam** **Construct Fish Ladder At Mill Street Dam** **Construct Fish Ladder At Swimming Pool Dam** **Construct Fish Ladder At Pumping Station Dam**
4	**Construct Rock Ramp Fishway At Wiley & Russell Dam** **Remove Mill Street Dam** **Construct Fish Ladder At Swimming Pool Dam** **Construct Fish Ladder At Pumping Station Dam**
5	**Construct Fish Ladder At Wiley & Russell Dam** **Remove Mill Street Dam** **Construct Fish Ladder At Swimming Pool Dam** **Construct Fish Ladder At Pumping Station Dam**
6	**Remove Wiley & Russell Dam** **Remove Mill Street Dam** **Construct Fish Ladder At Swimming Pool Dam** **Construct Fish Ladder At Pumping Station Dam** **Construct J-vanes and boulder groups in river channel downstream of Mill Street and near Leyden Woods**
7	**Construct Fish Ladder At Wiley & Russell Dam** **Construct Fish Ladder At Mill Street Dam** **Construct Fish Ladder At Swimming Pool Dam** **Construct Fish Ladder At Pumping Station Dam** **Construct J-vanes and boulder groups in river channel near Leyden Woods**
8	**Construct Rock Ramp Fishway At Wiley & Russell Dam** **Remove Mill Street Dam** **Construct Fish Ladder At Swimming Pool Dam** **Construct Fish Ladder At Pumping Station Dam** **Construct J-vanes and boulder groups in river channel near Leyden Woods**
9	**Construct Fish Ladder At Wiley & Russell Dam** **Remove Mill Street Dam** **Construct Fish Ladder At Swimming Pool Dam** **Construct Fish Ladder At Pumping Station Dam** **Construct J-vanes and boulder groups in river channel near Leyden Woods**
10	**Construct Rock Ramp Fishway At Wiley & Russell Dam** **Construct Fish Ladder At Mill Street Dam** **Construct Fish Ladder At Swimming Pool Dam** **Construct Fish Ladder At Pumping Station Dam**

Note: Alternatives 2 & 6, 3 & 7, 4 & 8, and 5 & 9 have common fish passage measures.

Plate 3 List of Plates Depicting Existing Conditions and Alternative Measures:

Plate 4 Site Plan – Existing Condition – Pumping Station Dam

Plate 5 Site Plan – Fish Ladder – Pumping Station Dam

Plate 6 Pumping Station Dam – Fishway Plan & Profiles

Plate 7 Pumping Station Dam – Sections

Plate 8 Site Plan – Existing Condition – Swimming Pool Dam

Plate 9 Site Plan – Fish Ladder – Swimming Pool Dam

Plate 10 Swimming Pool Dam – Plan, Section & Profile

Plate 11 Swimming Pool Dam – Sections & Details

Plate 12 Site Plan – Existing Condition – Mill Street Dam

Plate 13 Site Plan – Remove Existing Dam – Mill Street Dam

Plate 14 Site Plan – Fish Ladder – Mill Street Dam

Plate 15 Mill Street Dam – Sections & Details

Plate 16 Site Plan – Existing Condition – Wiley & Russell Dam

Plate 17 Site Plan – Remove Existing Dam – Wiley & Russell Dam

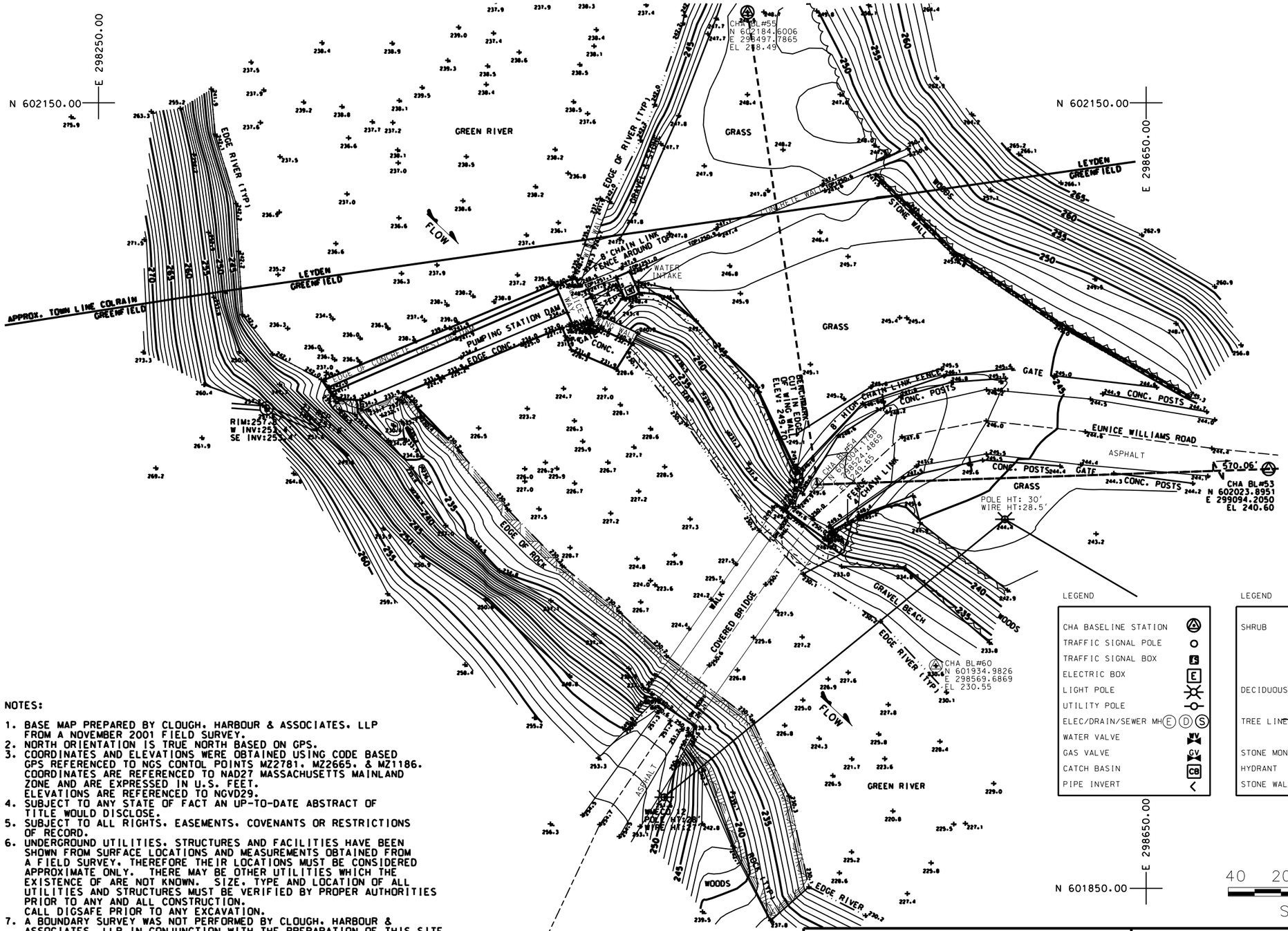
Plate 18 Wiley & Russell Dam –Section – Dam Removal

Plate 19 Site Plan – Fish Ladder – Wiley & Russell Dam

Plate 20 Site Plan – Rock Ramp Fishway – Wiley and Russell Dam

Plate 21 Wiley & Russell Dam – Fish Ladder Plan, Profiles, Section & Details

Plate 22 Wiley & Russell Dam – Rock Ramp Fishway Sections



NOTES:

1. BASE MAP PREPARED BY CLOUGH, HARBOUR & ASSOCIATES, LLP FROM A NOVEMBER 2001 FIELD SURVEY.
2. NORTH ORIENTATION IS TRUE NORTH BASED ON GPS.
3. COORDINATES AND ELEVATIONS WERE OBTAINED USING CODE BASED GPS REFERENCED TO NGS CONTOL POINTS MZ2781, MZ2665, & MZ1186. COORDINATES ARE REFERENCED TO NAD27 MASSACHUSETTS MAINLAND ZONE AND ARE EXPRESSED IN U.S. FEET. ELEVATIONS ARE REFERENCED TO NGVD29.
4. SUBJECT TO ANY STATE OF FACT AN UP-TO-DATE ABSTRACT OF TITLE WOULD DISCLOSE.
5. SUBJECT TO ALL RIGHTS, EASEMENTS, COVENANTS OR RESTRICTIONS OF RECORD.
6. UNDERGROUND UTILITIES, STRUCTURES AND FACILITIES HAVE BEEN SHOWN FROM SURFACE LOCATIONS AND MEASUREMENTS OBTAINED FROM A FIELD SURVEY. THEREFORE THEIR LOCATIONS MUST BE CONSIDERED APPROXIMATE ONLY. THERE MAY BE OTHER UTILITIES WHICH THE EXISTENCE OF ARE NOT KNOWN. SIZE, TYPE AND LOCATION OF ALL UTILITIES AND STRUCTURES MUST BE VERIFIED BY PROPER AUTHORITIES PRIOR TO ANY AND ALL CONSTRUCTION. CALL DIGSAFE PRIOR TO ANY EXCAVATION.
7. A BOUNDARY SURVEY WAS NOT PERFORMED BY CLOUGH, HARBOUR & ASSOCIATES, LLP IN CONJUNCTION WITH THE PREPARATION OF THIS SITE.
8. THE TOWN LINE SHOWN HEREON IS APPROXIMATE ONLY FROM TOWN LINE MONUMENT COORDINATES PROVIDED BY THE TOWN OF GREENFIELD DEPARTMENT OF PUBLIC WORKS.

LEGEND

- CHA BASELINE STATION
- TRAFFIC SIGNAL POLE
- TRAFFIC SIGNAL BOX
- ELECTRIC BOX
- LIGHT POLE
- UTILITY POLE
- ELEC/DRAIN/SEWER MH (E) (D) (S)
- WATER VALVE
- GAS VALVE
- CATCH BASIN
- PIPE INVERT

LEGEND

- SHRUB
- DECIDUOUS TREE
- TREE LINE
- STONE MONUMENT
- HYDRANT
- STONE WALL

LEGEND

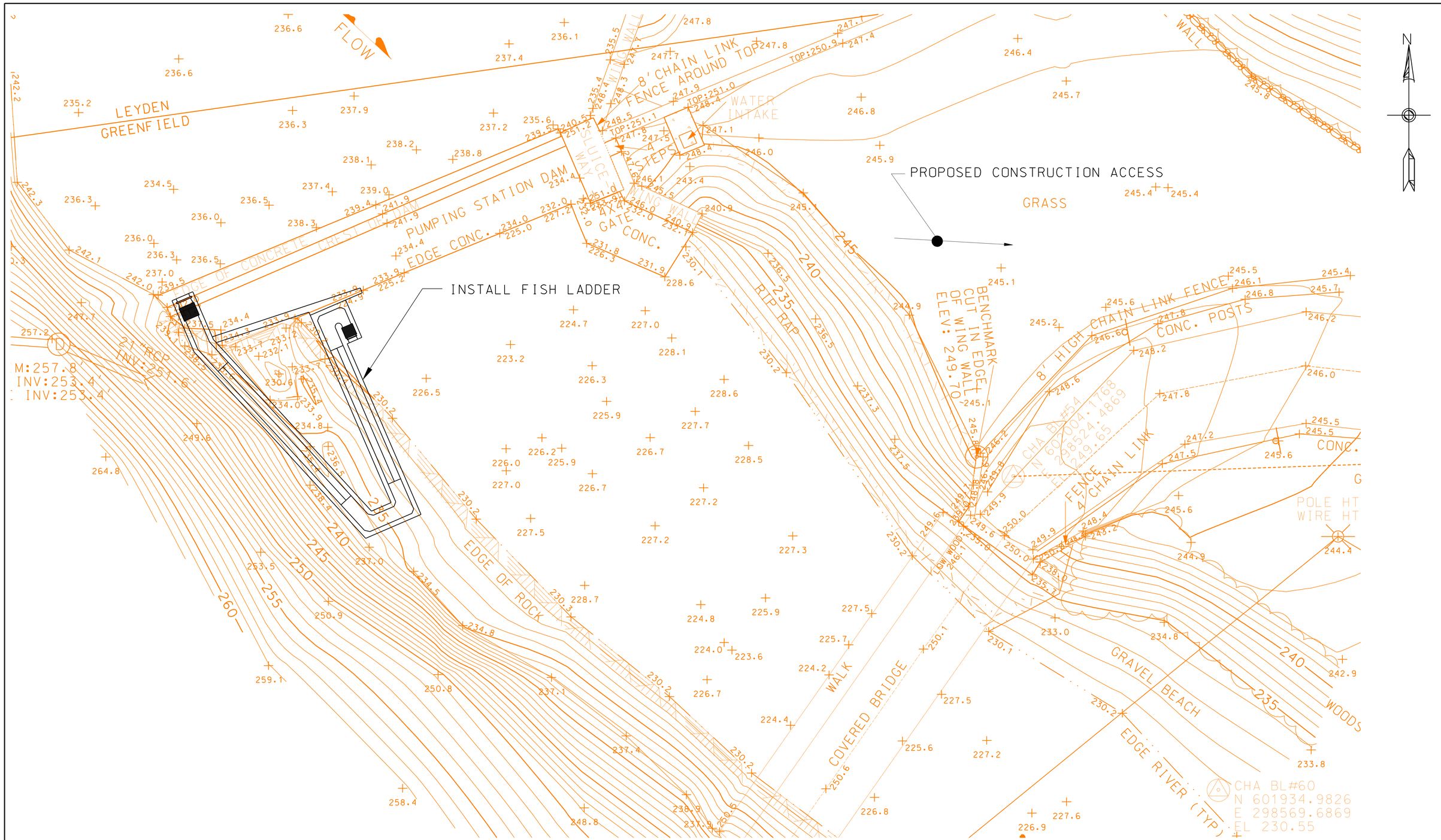
- OH UTILITY LINE — E —
- EDGE OF RIVER
- EDGE ROCK
- EDGE RIPRAP
- CONCRETE
- SAND

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

WATER RESOURCES DEVELOPMENT PROJECT
ENVIRONMENTAL RESORATION
GREENFIELD, MASSACHUSETTS
GREEN RIVER FISH PASSAGE

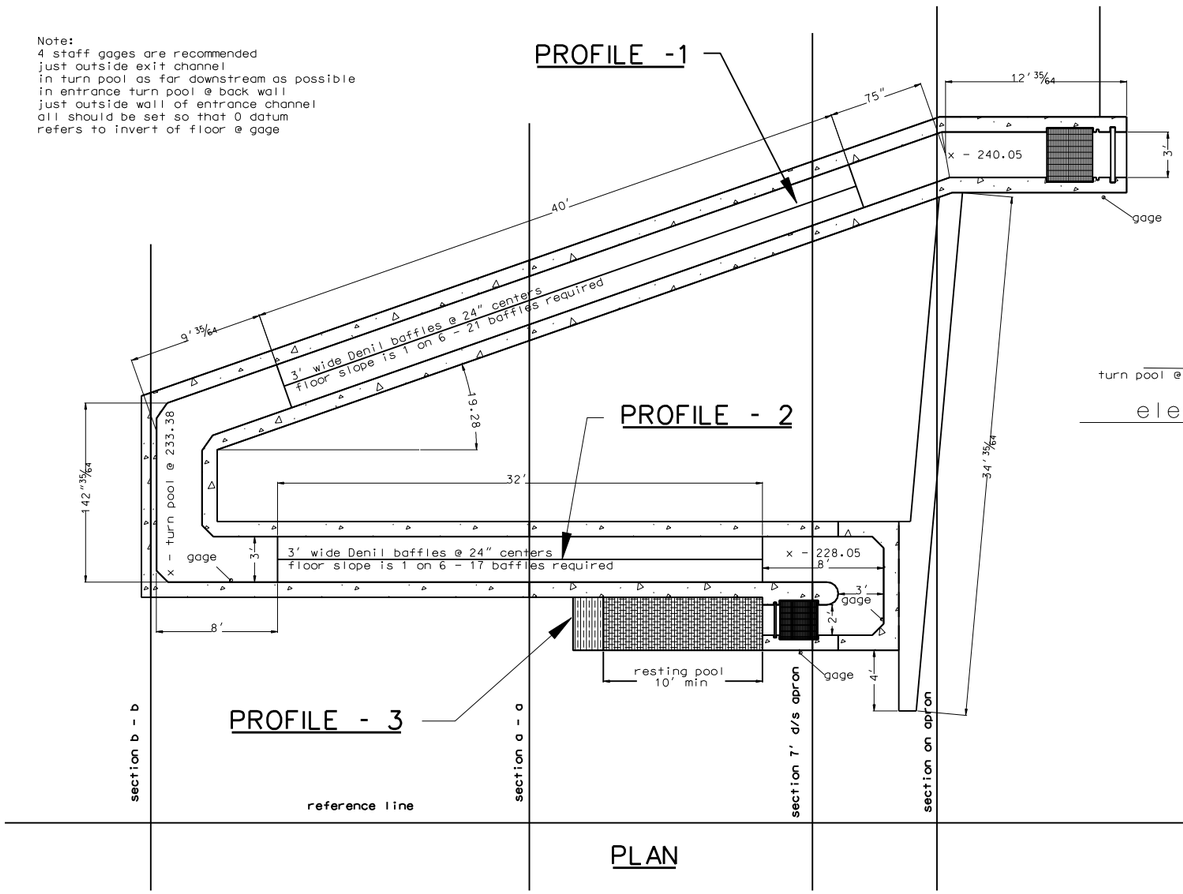
SITE PLAN - EXISTING CONDITION
PUMPING STATION DAM

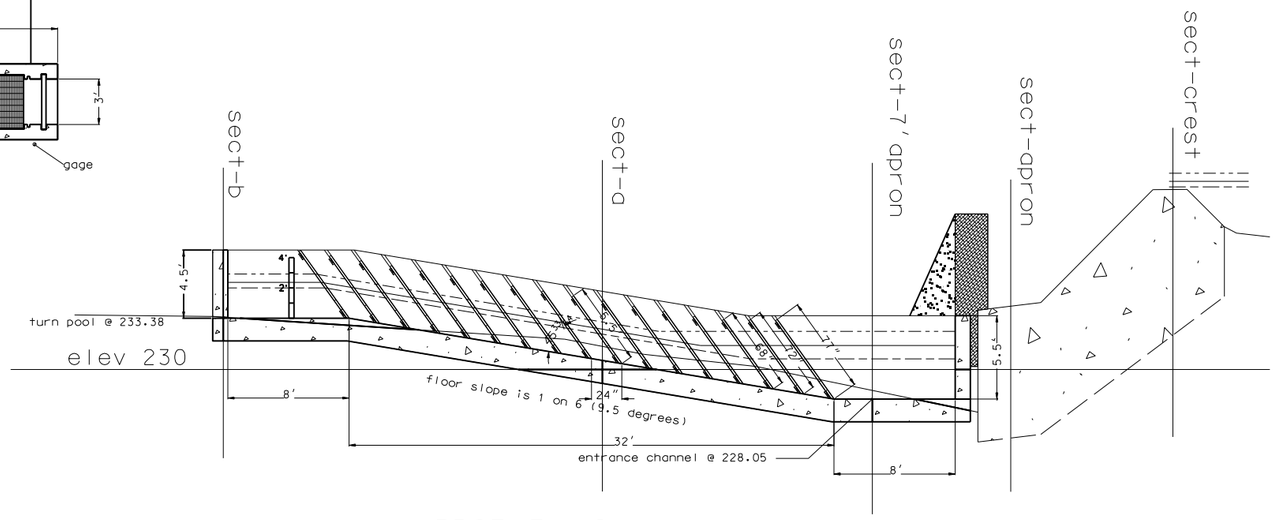
4
24



DEPARTMENT OF THE ARMY NEW ENGLAND DISTRICT CORPS OF ENGINEERS CONCORD, MASSACHUSETTS	WATER RESOURCES DEVELOPMENT PROJECT ENVIRONMENTAL RESORATION GREENFIELD, MASSACHUSETTS GREEN RIVER FISH PASSAGE **SITE PLAN - FISH LADDER PUMPING STATION DAM**	5 24

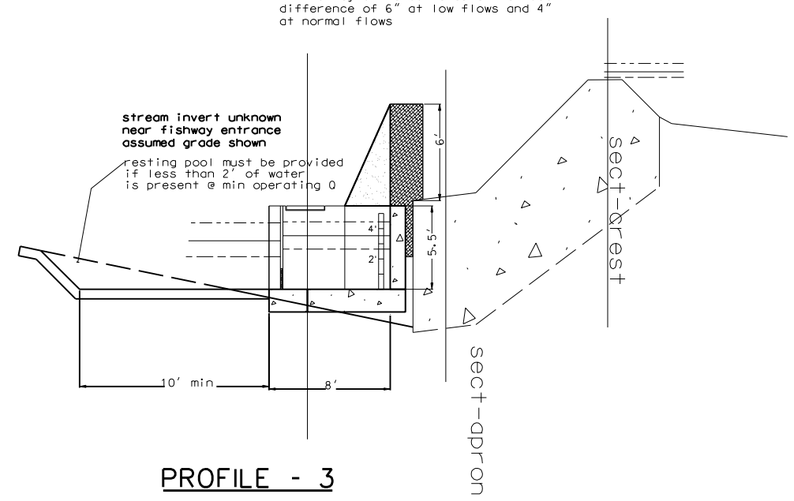
Note:
4 staff gages are recommended
just outside exit channel
in turn pool as far downstream as possible
in entrance turn pool @ back wall
just outside wall of entrance channel
all should be set so that 0 datum
refers to invert of floor @ gage



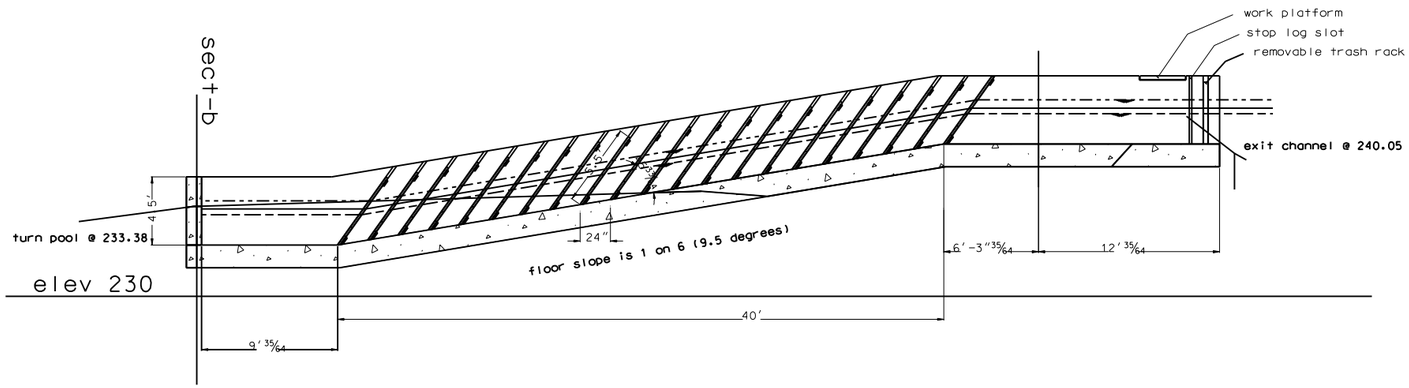


PROFILE - 2

Note:
stop logs must be adjusted inside of slots
in fishway entrance to obtain a head
difference of 6" at low flows and 4"
at normal flows



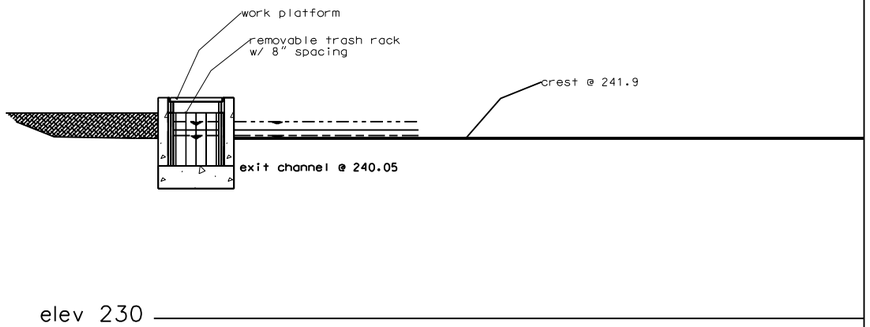
PROFILE - 3



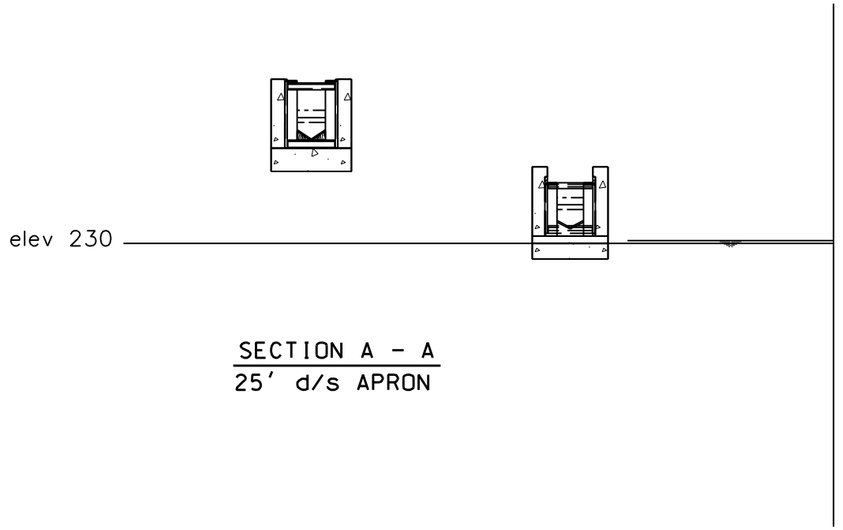
PROFILE -1

10 5 0 10 20FT
SCALE: 1"= 10'

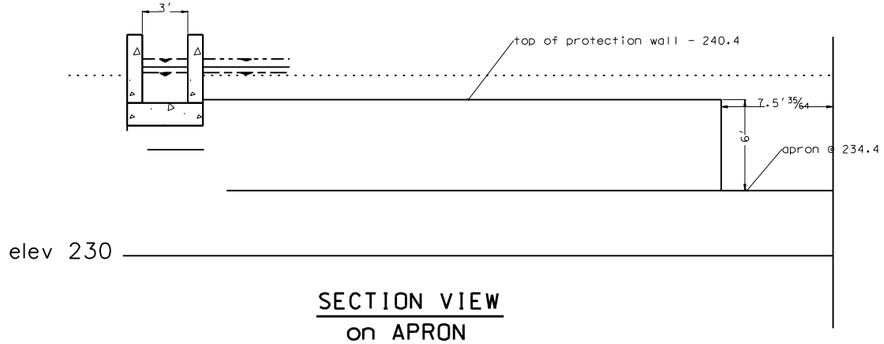
DEPARTMENT OF THE ARMY NEW ENGLAND DISTRICT CORPS OF ENGINEERS CONCORD, MASSACHUSETTS	WATER RESOURCES DEVELOPMENT PROJECT ENVIRONMENTAL RESORATION GREENFIELD, MASSACHUSETTS GREEN RIVER FISH PASSAGE PUMPING STATION DAM FISHWAY PLAN & PROFILES	6 24



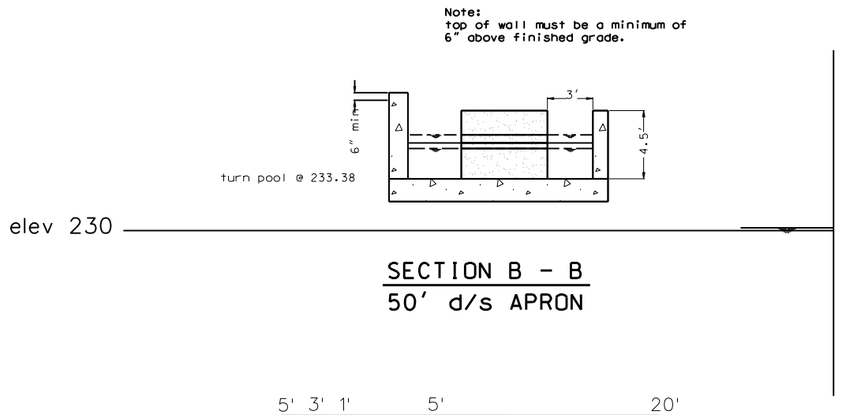
SECTION VIEW
@ CREST OF DAM



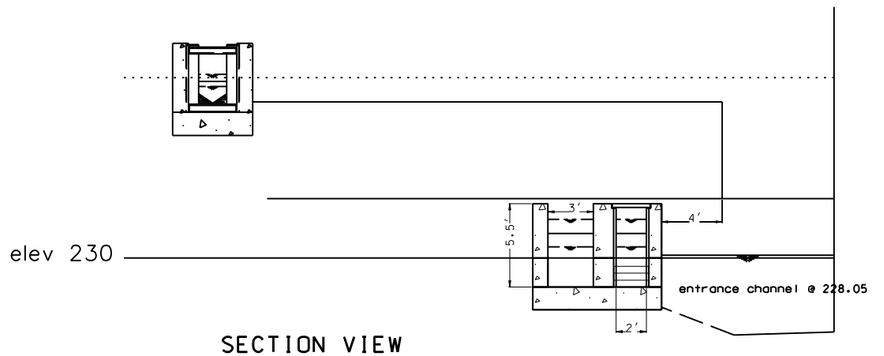
SECTION A - A
25' d/s APRON



SECTION VIEW
on APRON



SECTION B - B
50' d/s APRON



SECTION VIEW
7' D/S END OF APRON

DEPARTMENT OF THE ARMY
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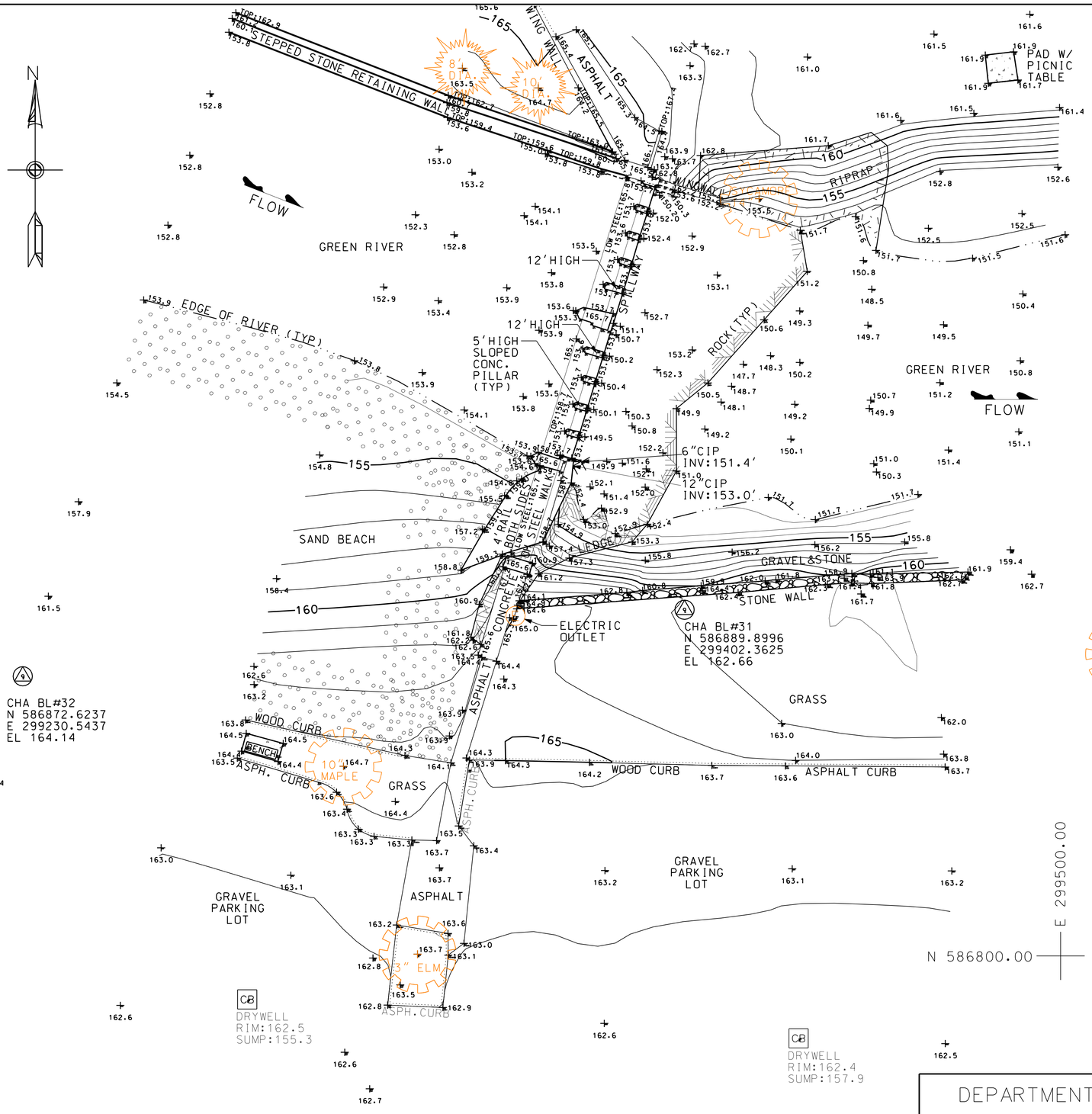
CONCORD, MASSACHUSETTS

WATER RESOURCES DEVELOPMENT PROJECT
ENVIRONMENTAL RESORATION
GREENFIELD, MASSACHUSETTS
GREEN RIVER FISH PASSAGE

PUMPING STATION DAM
SECTIONS

7
24



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DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

WATER RESOURCES DEVELOPMENT PROJECT
ENVIRONMENTAL RESORATION
GREENFIELD, MASSACHUSETTS
GREEN RIVER FISH PASSAGE

SITE PLAN - EXISTING CONDITION SWIMMING POOL DAM

8
24

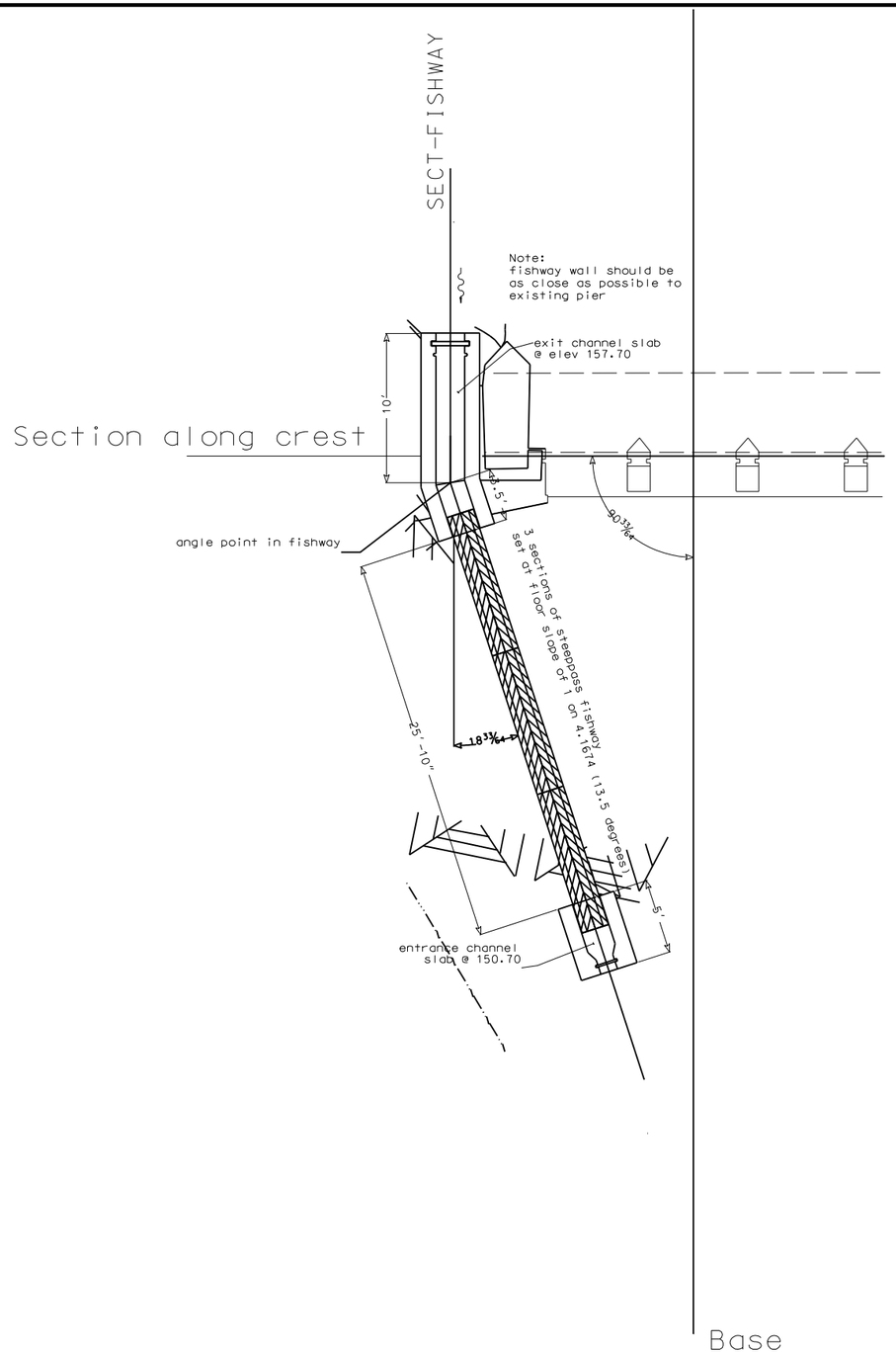
STEPPED STONE RETAINING WALL
8' DIA.
10' DIA.
WALL
ASPHALT
165
PAD W/ PICNIC TABLE
FLOW
GREEN RIVER
12'HIGH
SPILLWAY
LOW STEEL:165.8
WINDWARD SYCAMORE
RIPRAP
160
155
EDGE OF RIVER (TYP.)
5'HIGH SLOPED CONC. PILLAR (TYP)
ROCK(TYP)
INSTALL FISH LADDER
GREEN RIVER
FLOW
Base
Section of Fishway
6"CIP
INV: 151.4'
12"CIP
INV:153.0'
4'RAIL BOTH SIDES
LOW STEEL:165.7
CONCRETE
LEDGE
SAND BEACH
GRAVEL&STONE
STONE WALL
CHA BL#31
N 586889.8996
E 299402.3625
EL 162.66
ELECTRIC OUTLET
CONSTRUCTION ACCESS
ASPHALT
WOOD CURB
BENCH
ASPH. CURB
10" MAPLE
GRASS
H. CURB
WOOD CURB
GRASS
N
BENCHMARK #1
RR SPIKE IN
30" COTTONWOOD
ELEV: 164.60'
20 10 0 20 40FT
SCALE: 1"= 20'

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

WATER RESOURCES DEVELOPMENT PROJECT
ENVIRONMENTAL RESORATION
GREENFIELD, MASSACHUSETTS
GREEN RIVER FISH PASSAGE

SITE PLAN - FISH LADDER SWIMMING POOL DAM

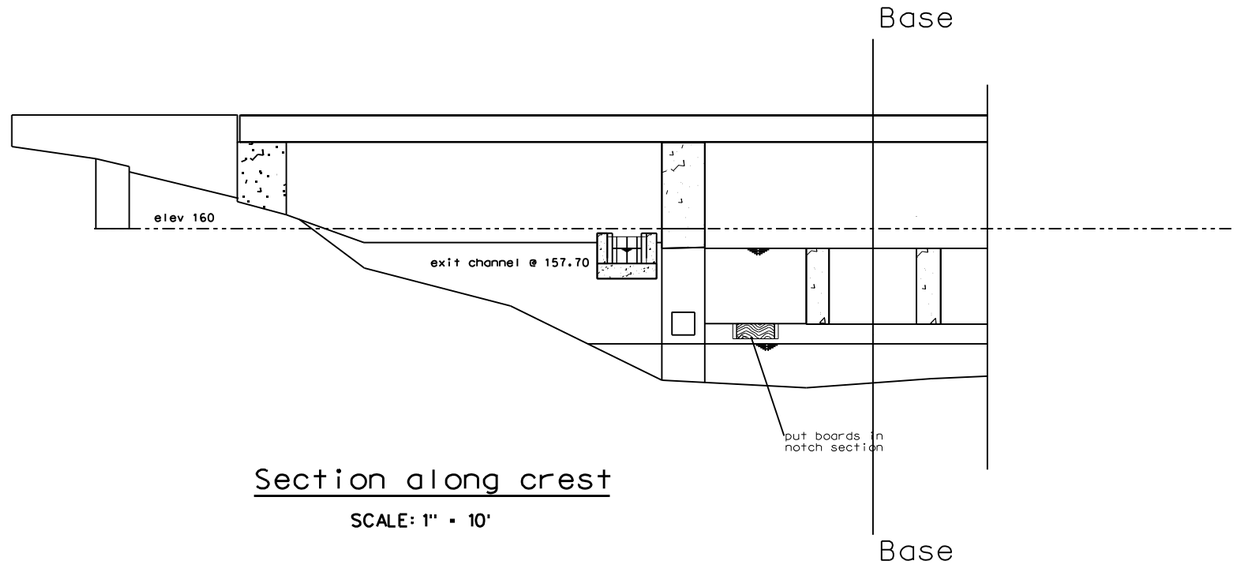
9/24



PLAN VIEW FISHWAY

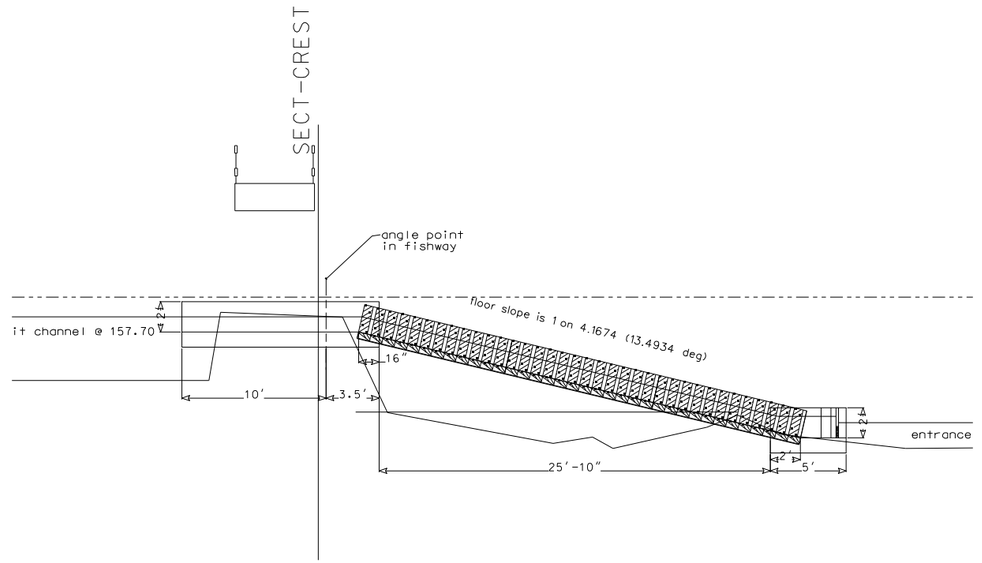
WITHOUT NOTCH

SCALE: 1" = 10'



Section along crest

SCALE: 1" = 10'



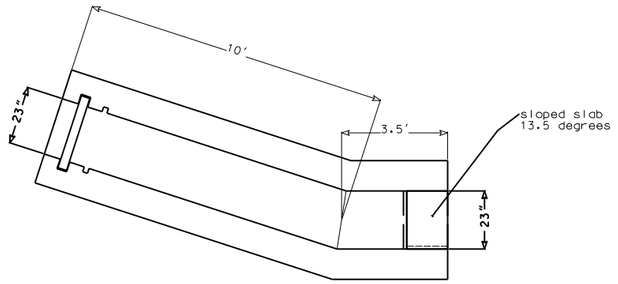
PROFILE ALONG FISHWAY

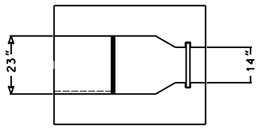
SCALE: 1" = 10'

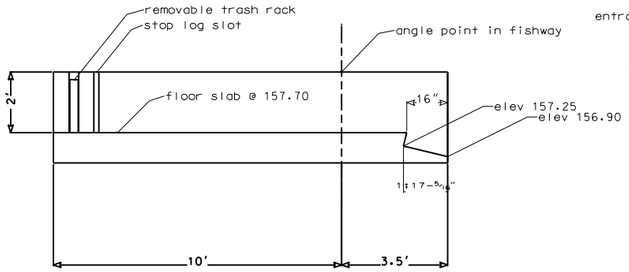
SCALE: 1" = 10'

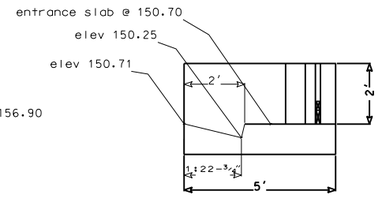
5' 3' 1' 5' 20'
4' 2' 0 10'

DEPARTMENT OF THE ARMY NEW ENGLAND DISTRICT CORPS OF ENGINEERS CONCORD, MASSACHUSETTS	WATER RESOURCES DEVELOPMENT PROJECT ENVIRONMENTAL RESORATION GREENFIELD, MASSACHUSETTS GREEN RIVER FISH PASSAGE SWIMMING POOL PLAN, SECTION & PROFILE	10/24





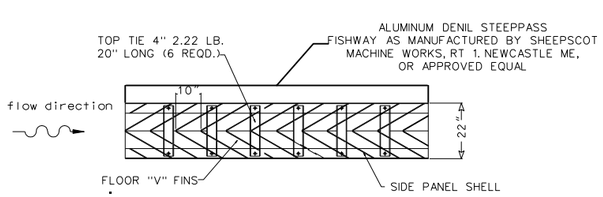




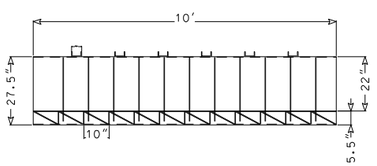
Note:
Measurements are along the center line of the fishway

ENTRANCE & EXIT DETAILS

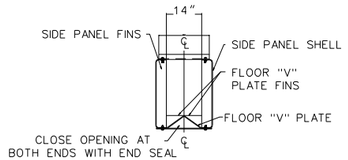
N.T.S.



PLAN - 10' STEEPPASS SECTION



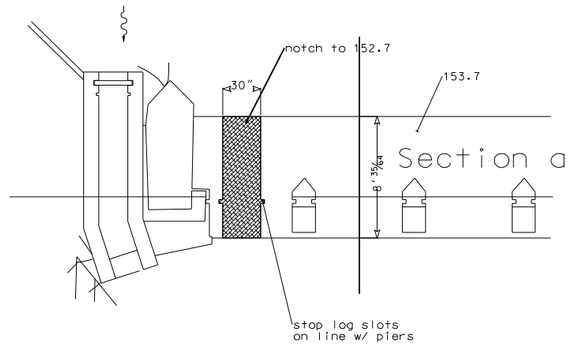
SECTION



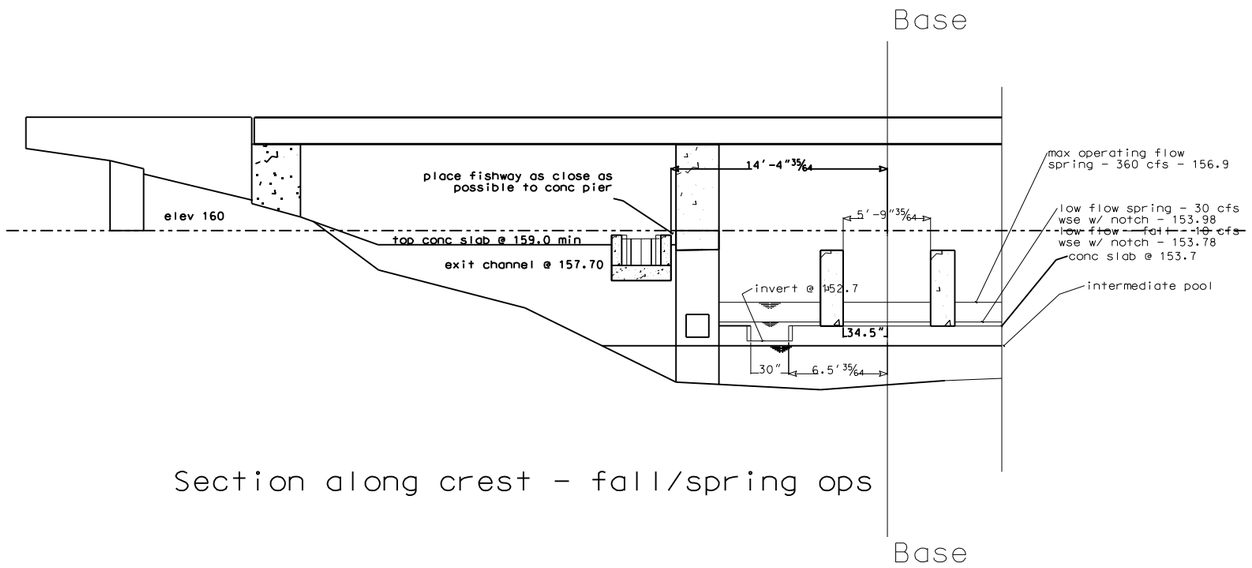
END SECTION

STEEPPASS DETAILS

N.T.S.



Section along crest

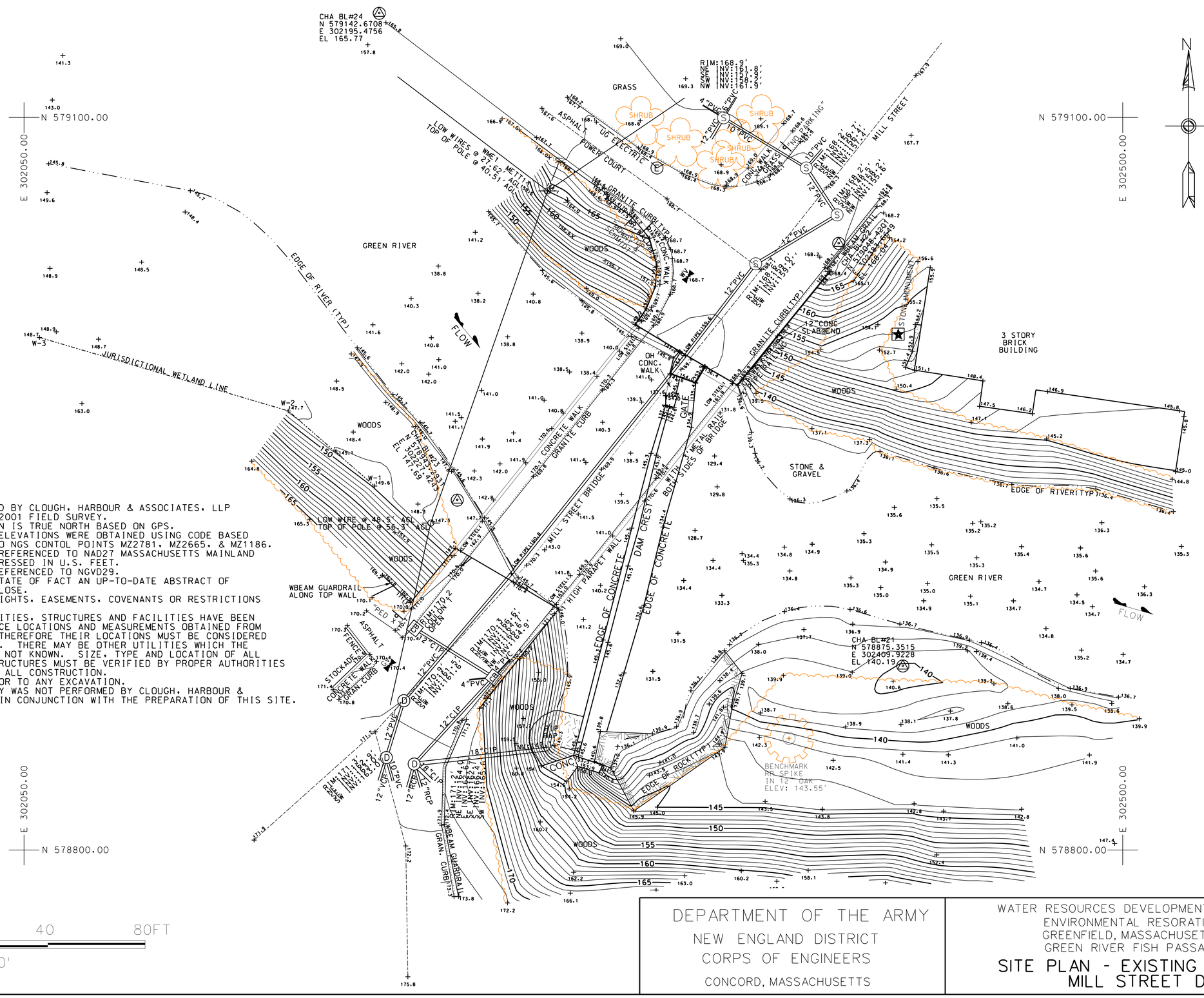


Section along crest - fall/spring ops

NOTCH DETAILS

N.T.S.

DEPARTMENT OF THE ARMY NEW ENGLAND DISTRICT CORPS OF ENGINEERS CONCORD, MASSACHUSETTS	WATER RESOURCES DEVELOPMENT PROJECT ENVIRONMENTAL RESORATION GREENFIELD, MASSACHUSETTS GREEN RIVER FISH PASSAGE **SECTIONS AND DETAILS** **SWIMMING POOL DAM**	11 24



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40 20 0 40 80FT

SCALE: 1"= 40'

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

WATER RESOURCES DEVELOPMENT PROJECT
ENVIRONMENTAL RESORATION
GREENFIELD, MASSACHUSETTS
GREEN RIVER FISH PASSAGE

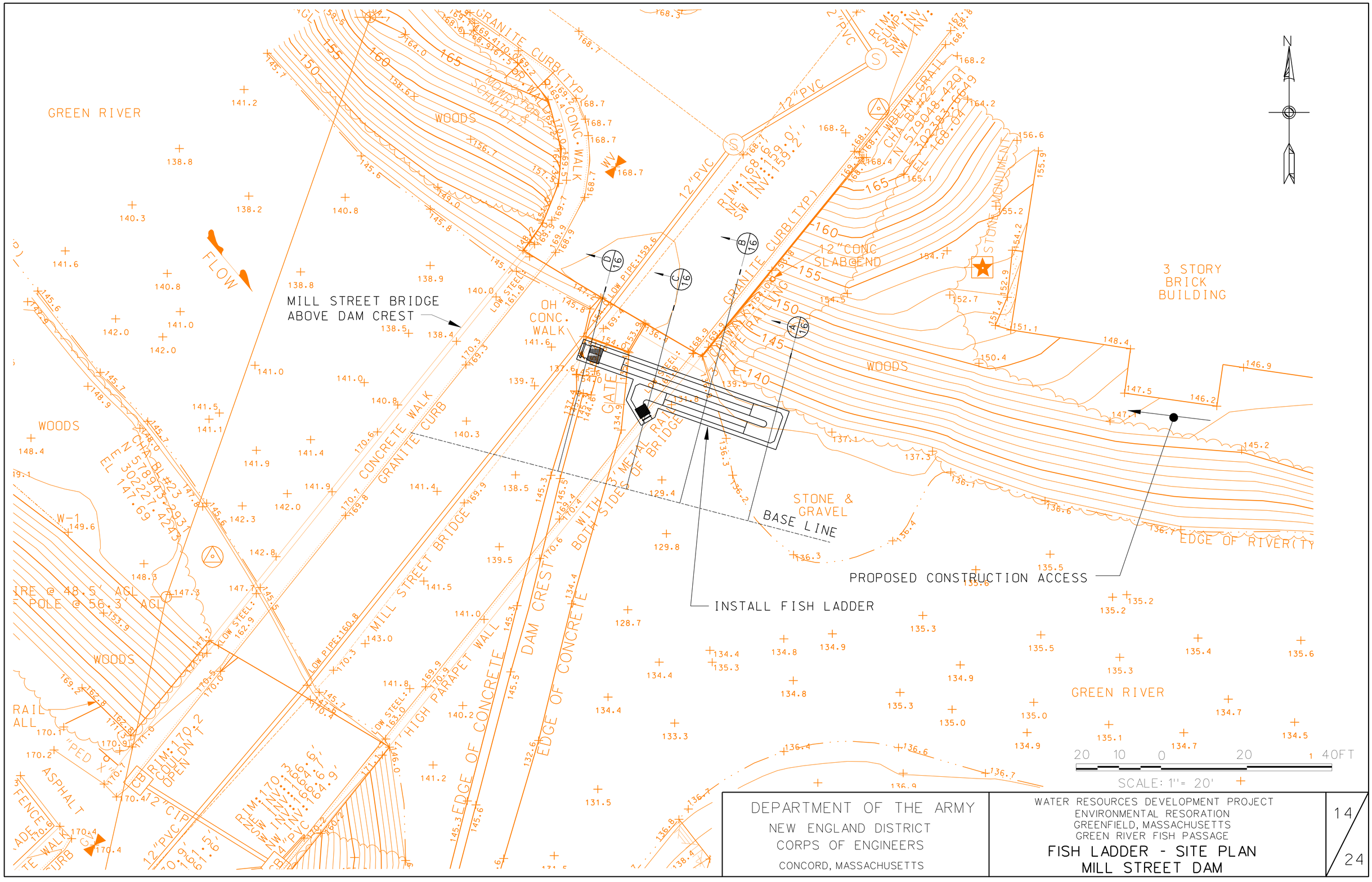
SITE PLAN - EXISTING CONDITION MILL STREET DAM

12/24

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

WATER RESOURCES DEVELOPMENT PROJECT
ENVIRONMENTAL RESORATION
GREENFIELD, MASSACHUSETTS
GREEN RIVER FISH PASSAGE
REMOVE DAM
MILL STREET DAM

13/24

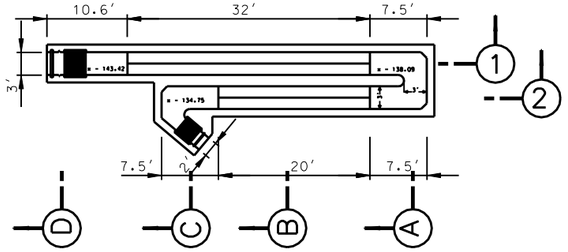


DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

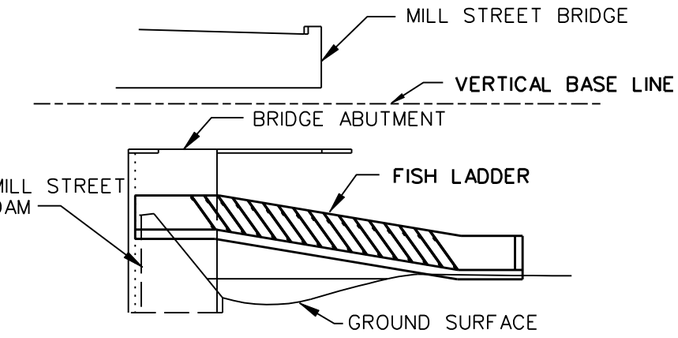
WATER RESOURCES DEVELOPMENT PROJECT
ENVIRONMENTAL RESORATION
GREENFIELD, MASSACHUSETTS
GREEN RIVER FISH PASSAGE

FISH LADDER - SITE PLAN
MILL STREET DAM

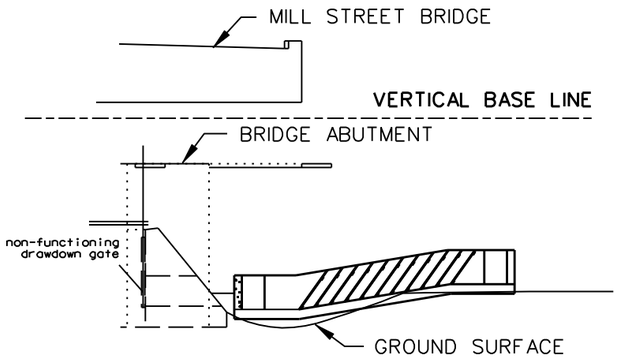
14/24



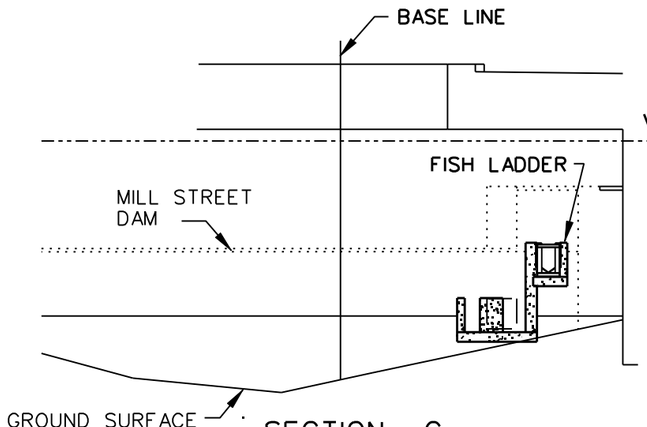
PLAN
SCALE: 1"=20'



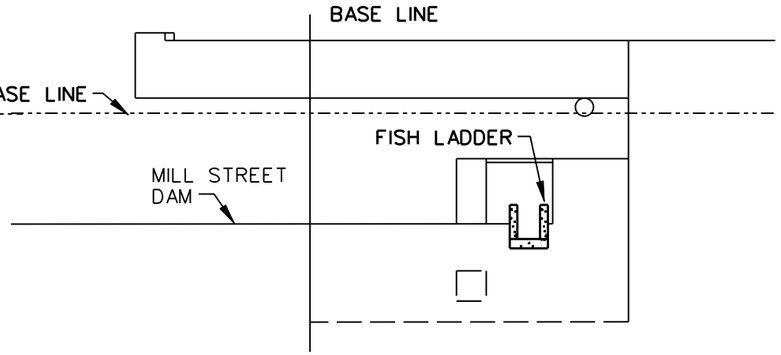
PROFILE 1
SCALE: 1"=20'



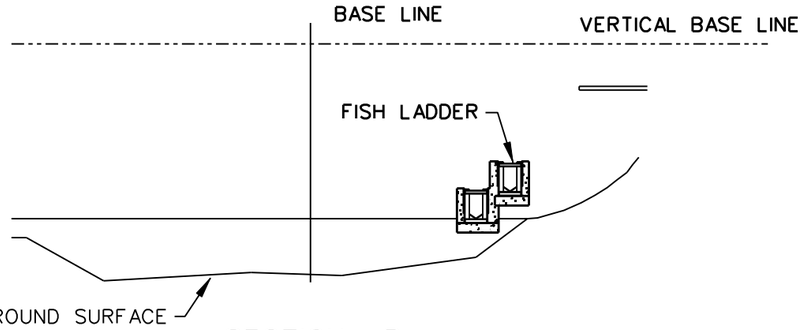
PROFILE 2
SCALE: 1"=20'



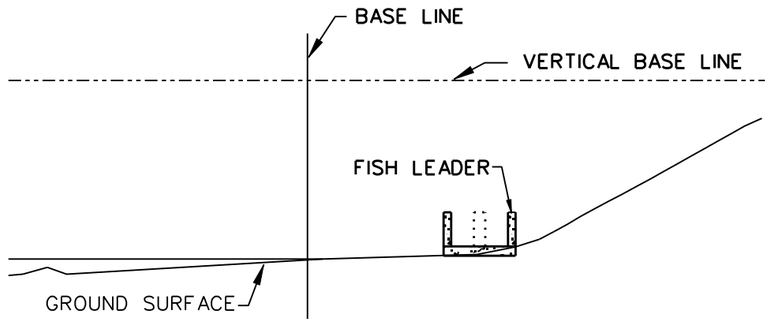
SECTION C
SCALE: 1"=20'



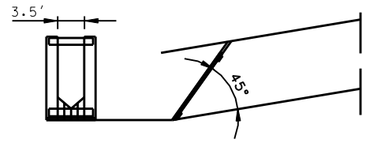
SECTION D
SCALE: 1"=20'



SECTION B
SCALE: 1"=20'



SECTION A
SCALE: 1"=20'



BAFFLE DETAILS
SCALE: 1"= 10'

GRAPHIC SCALE:
1" = 10' 10 0 10 20

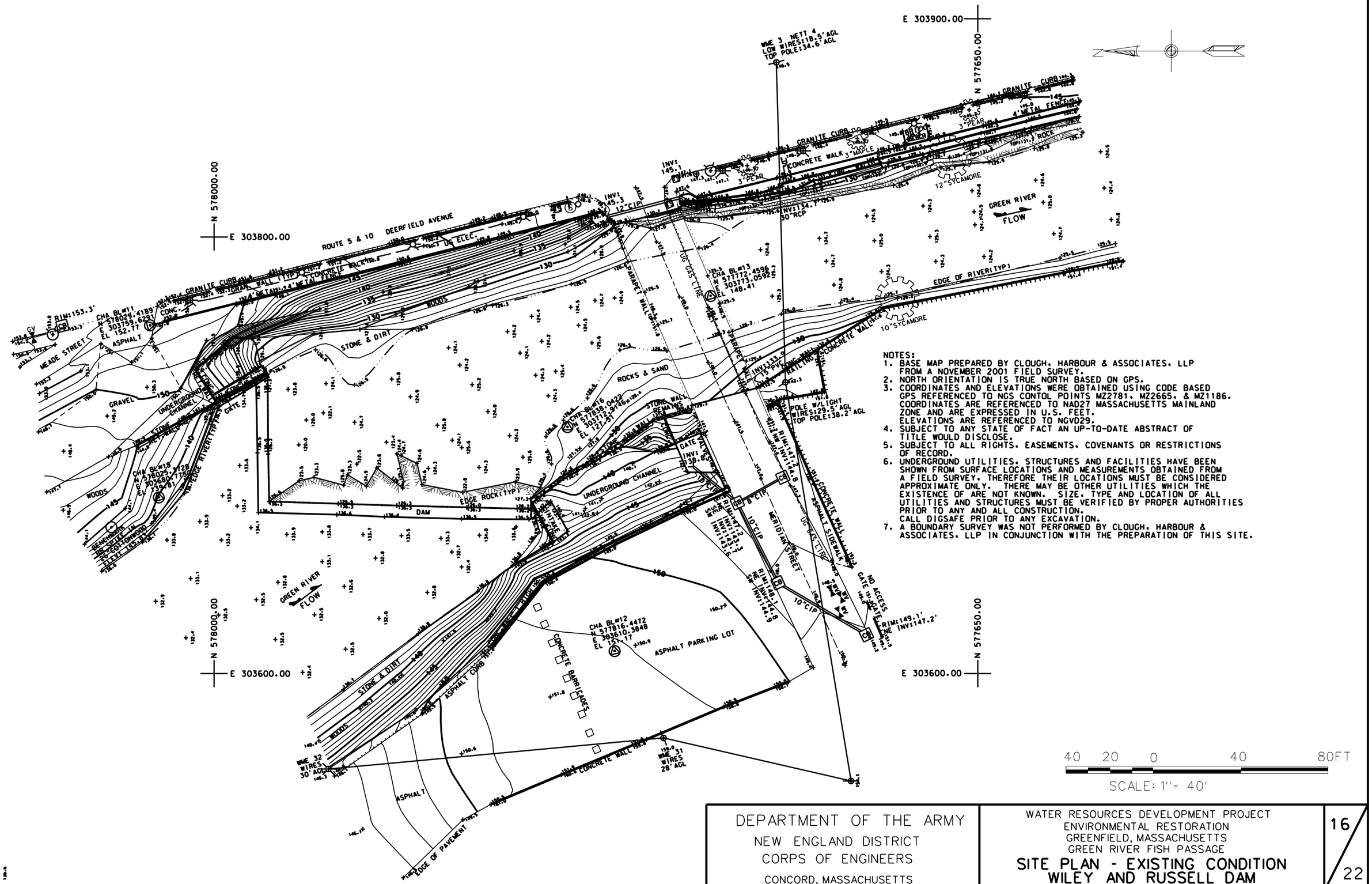
GRAPHIC SCALE:
1" = 20' 20 0 20 40

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

WATER RESOURCES DEVELOPMENT PROJECT
ENVIRONMENTAL RESTORATION
GREENFIELD, MASSACHUSETTS
GREEN RIVER FISH PASSAGE

SECTIONS AND DETAILS MILL STREET DAM

15/22



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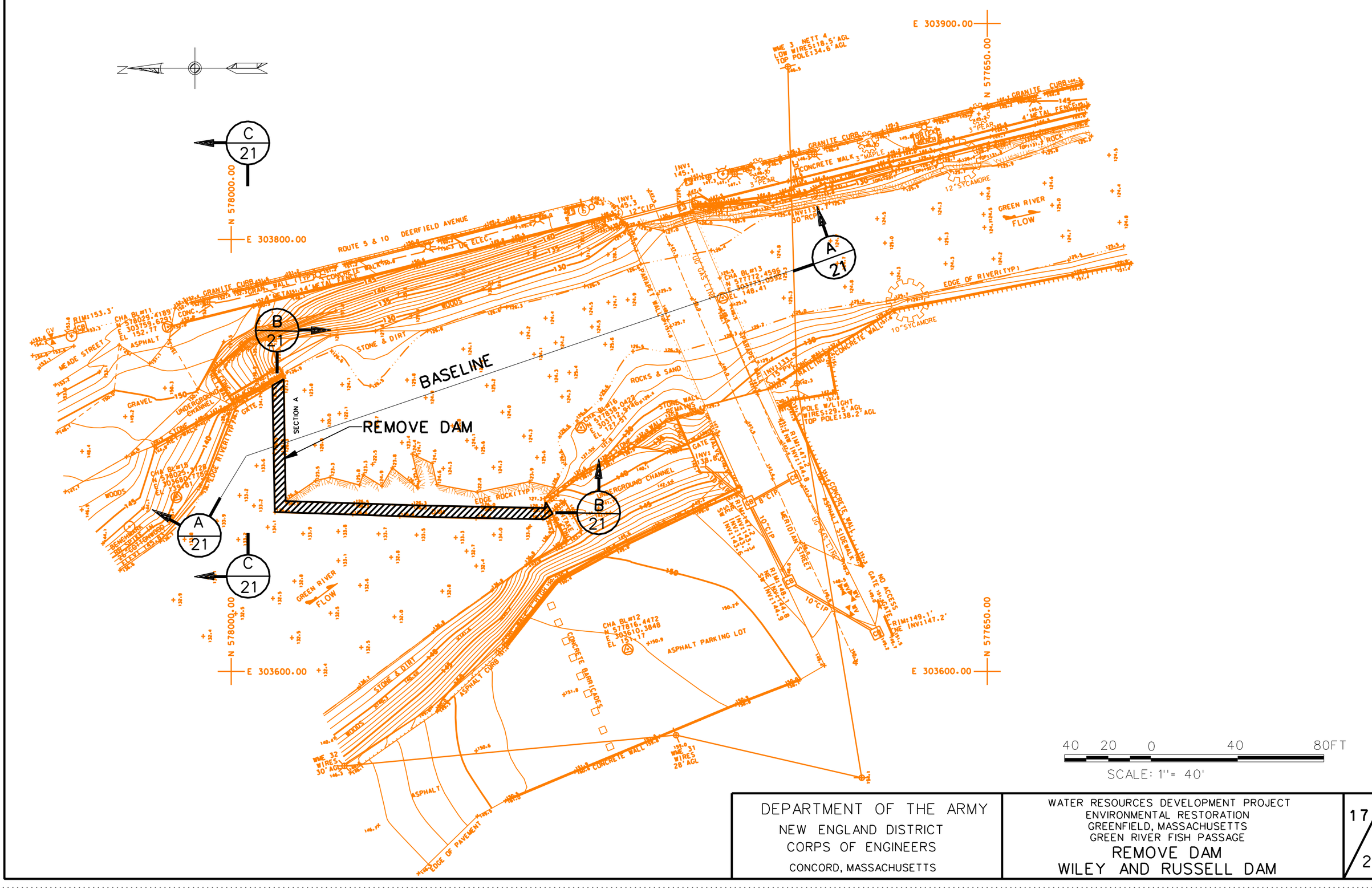
DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

WATER RESOURCES DEVELOPMENT PROJECT
ENVIRONMENTAL RESTORATION
GREENFIELD, MASSACHUSETTS
GREEN RIVER FISH PASSAGE

SITE PLAN - EXISTING CONDITION WILEY AND RUSSELL DAM

16/22

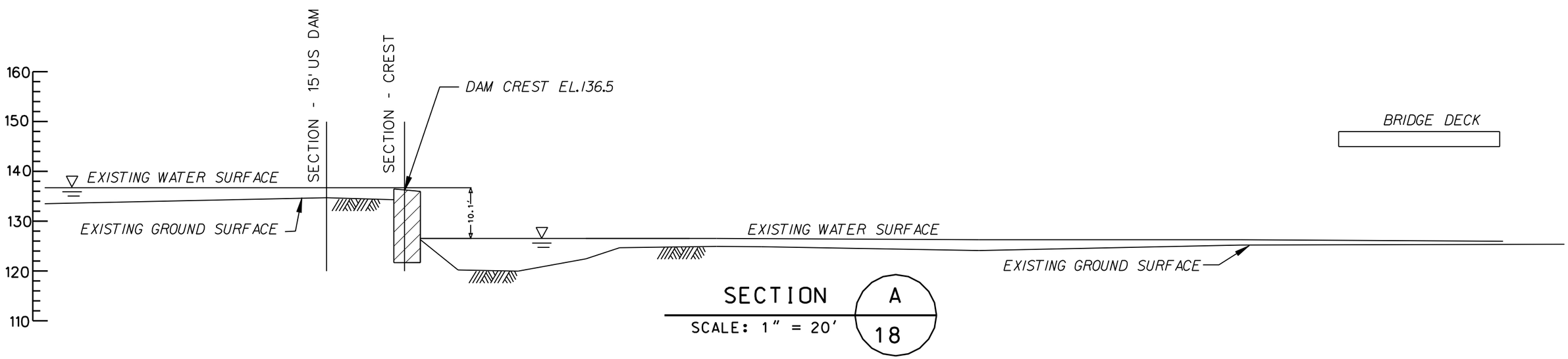


DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

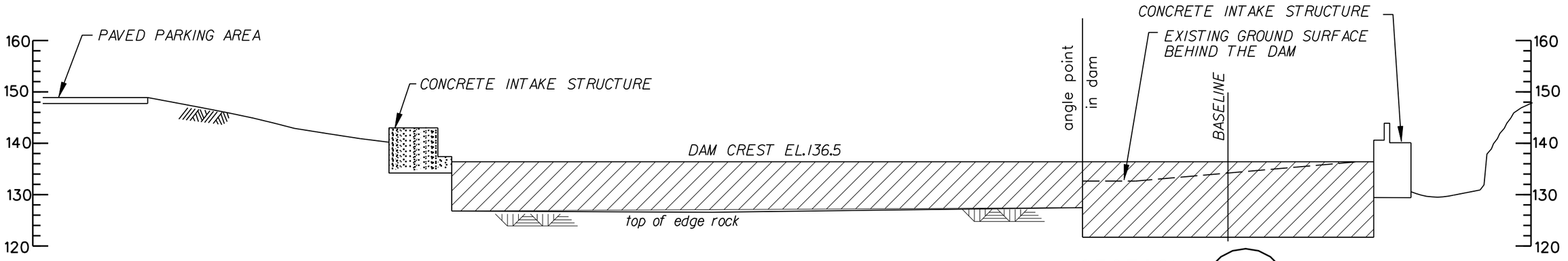
WATER RESOURCES DEVELOPMENT PROJECT
ENVIRONMENTAL RESTORATION
GREENFIELD, MASSACHUSETTS
GREEN RIVER FISH PASSAGE

REMOVE DAM
WILEY AND RUSSELL DAM

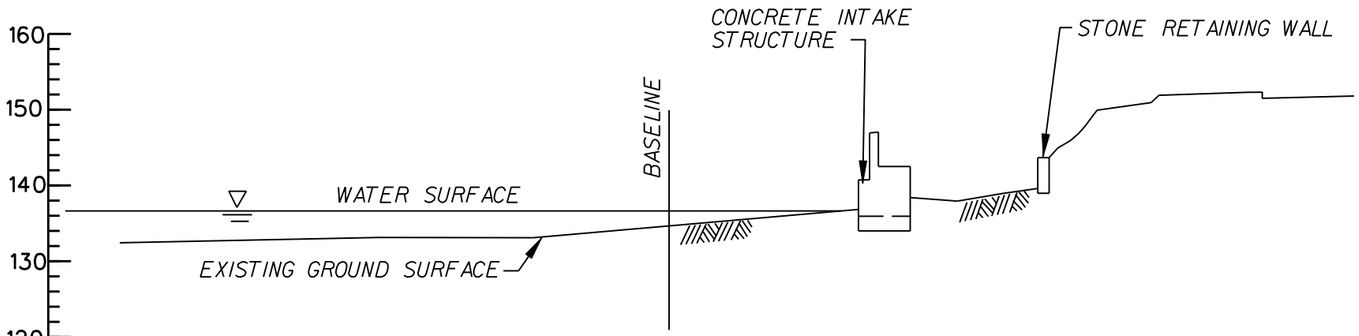
17/22



SECTION A
SCALE: 1" = 20'
18



SECTION B
SCALE: 1" = 20'
18



SECTION C
SCALE: 1" = 20'
18

GRAPHIC SCALE:
20 0 20 40
1" = 20'

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

WATER RESOURCES DEVELOPMENT PROJECT
ENVIRONMENTAL RESTORATION
GREENFIELD, MASSACHUSETTS
GREEN RIVER FISH PASSAGE
SECTIONS - DAM REMOVAL
WILEY & RUSSELL DAM

18
22

N 578000.

E 303800.00

ROUTE 5 & 10 DEERFIELD AVENUE

GRANITE CURB

GRAN. WALL (TYP.)

CONCRETE WALK

4' METAL FENCE

UG ELEC.

INV: 45.3 12"CIP

3"PEAR

CHA BL#11
N 578029.4189
E 303759.6291
EL 152.77
ASPHALT

CONC.

WOODS

STONE & DIRT

PARAPET WALL TOP: 151.8

UG GAS LINE

CHA BL#13
N 577772.4596
E 303773.0592
EL 148.41

INSTALL FISH LADDER

ROCKS & SAND

PARAPET WALL

INV:133.15" PVC

GRAVEL

UNDERGROUND CHANNEL

STONE RET. WALL

EDGE OF WATER

CONC. WALL

GATE

EDGE RIVER (TYP.)

CHA BL#15
N 578025.3728
E 303680.7750
EL 139.81

BENCHMARK
RR SPIKE IN
26" COTTONWOOD
ELEV.= 145.83

CHA BL#16
N 577838.0422
E 303712.9746
EL 127.51

STONE WALL REMAINS

CONC. WALL

STONE

GATE

INV: 138.8

VALVES

10"CIP

UNDERGROUND CHANNEL

EDGE ROCK (TYP.)

DAM

INTAKE CONC.

CB

8"CIP

10"CIP

MERIDIAN

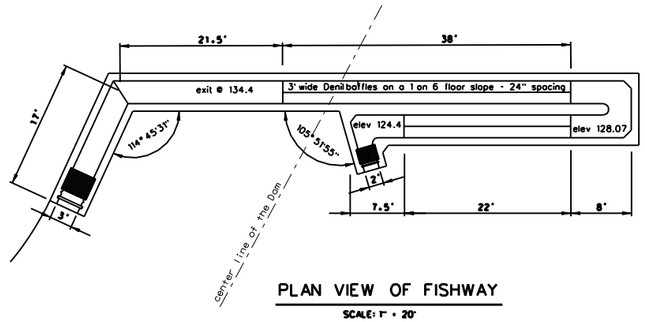
NE RIM=147.2
INV:143.3
SE INV:143.7
SW INV:143.6

GREEN RIVER FLOW

20 10 0 20 40FT

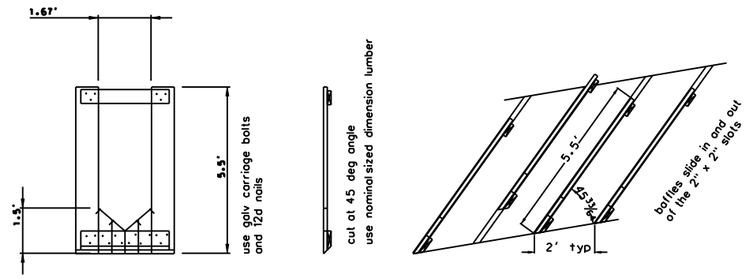
SCALE: 1"= 20'

DEPARTMENT OF THE ARMY NEW ENGLAND DISTRICT CORPS OF ENGINEERS CONCORD, MASSACHUSETTS	WATER RESOURCES DEVELOPMENT PROJECT ENVIRONMENTAL RESTORATION GREENFIELD, MASSACHUSETTS GREEN RIVER FISH PASSAGE **FISH LADDER-SITE PLAN** **WILEY AND RUSSELL DAM**	19 22



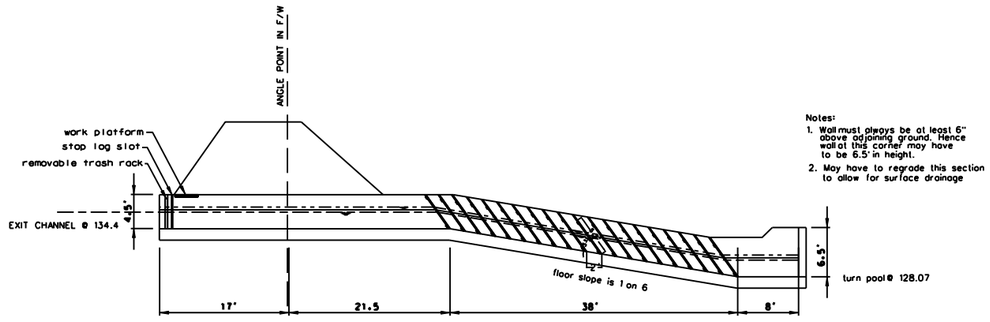
PLAN VIEW OF FISHWAY

SCALE: 1" = 20'



DENIL BAFFLE DETAILS

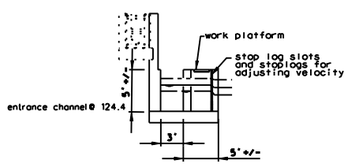
SCALE: 1" = 5'



Notes:
1. Wall must always be at least 6" above adjoining ground. Hence wall at this corner may have to be 6.5' in height.
2. May have to regrade this section to allow for surface drainage

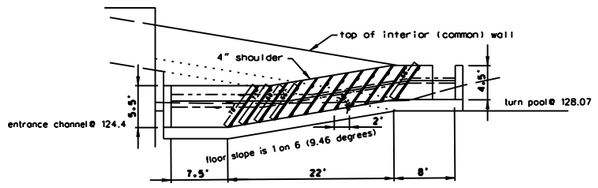
SECTION VIEW - UPPER DENIL LEG

SCALE: 1" = 20'



SECTION VIEW - ENTRANCE

SCALE: 1" = 20'



SECTION VIEW - LOWER DENIL LEG

SCALE: 1" = 20'

GRAPHIC SCALE:

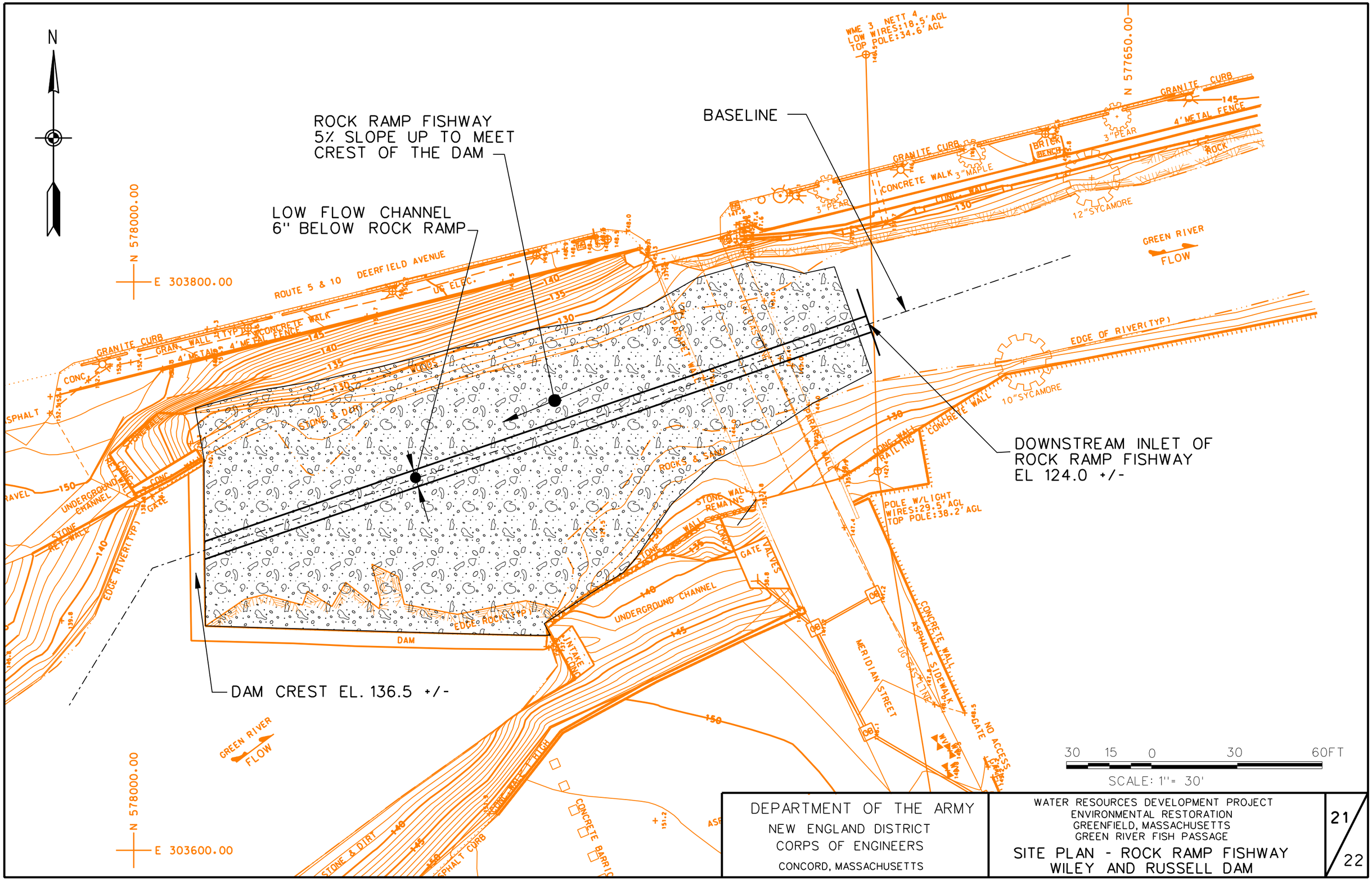
1" = 5'

5 0 5 10

1" = 20'

20 0 20 40

DEPARTMENT OF THE ARMY NEW ENGLAND DISTRICT CORPS OF ENGINEERS CONCORD, MASSACHUSETTS	WATER RESOURCES DEVELOPMENT PROJECT ENVIRONMENTAL RESTORATION GREENFIELD, MASSACHUSETTS GREEN RIVER FISH PASSAGE PLAN, SECTION & DETAILS OF FISHWAY WILEY AND RUSSELL DAM	20 22

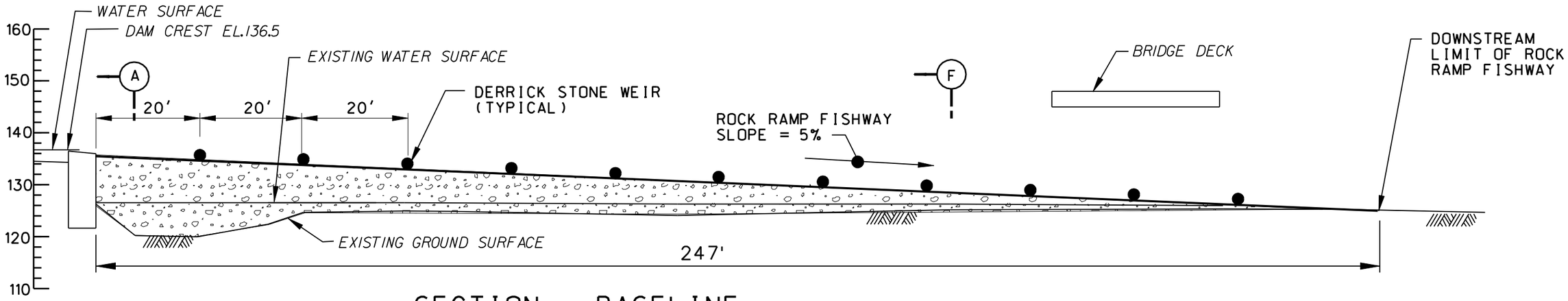


DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

WATER RESOURCES DEVELOPMENT PROJECT
ENVIRONMENTAL RESTORATION
GREENFIELD, MASSACHUSETTS
GREEN RIVER FISH PASSAGE

SITE PLAN - ROCK RAMP FISHWAY WILEY AND RUSSELL DAM

21/22



SECTION - BASELINE

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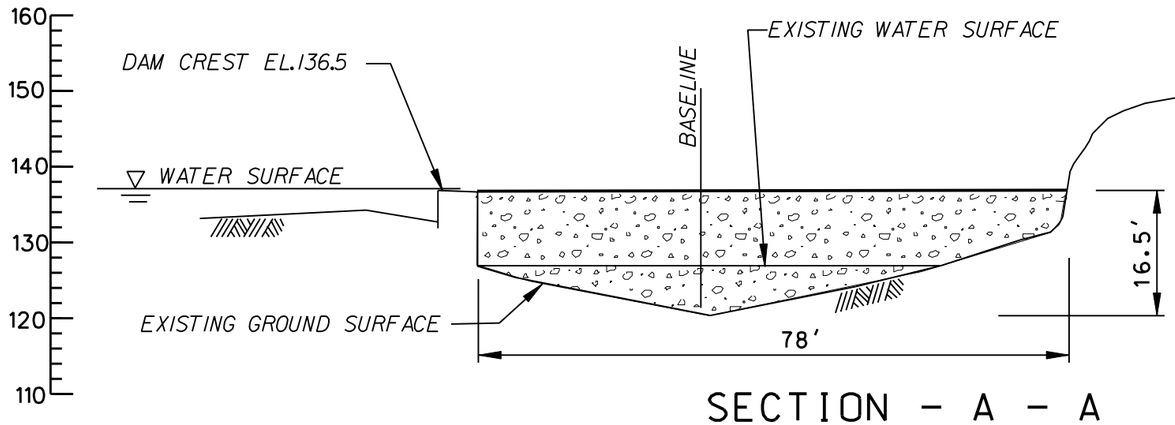

SECTION - A - A

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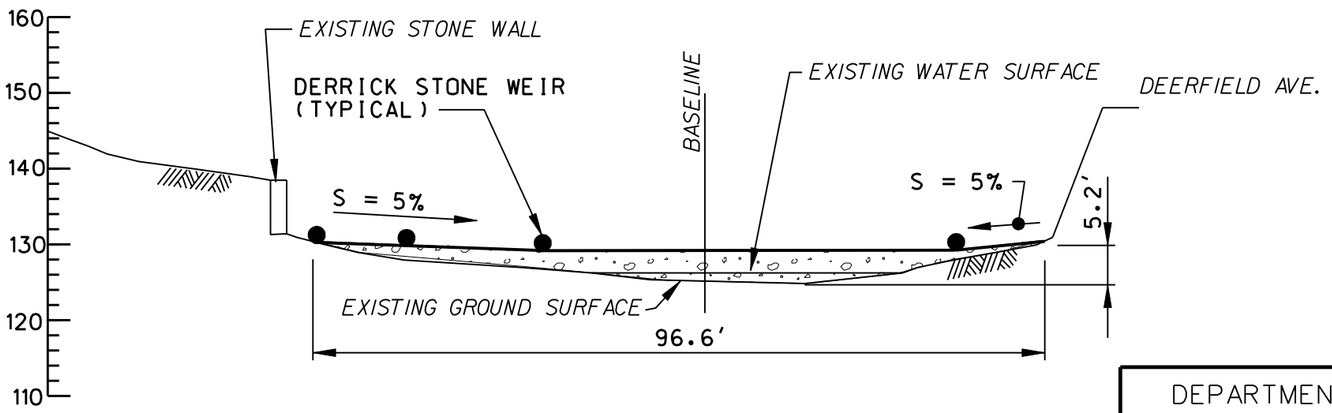

SECTION - F - F

GRAPHIC SCALE:

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DEPARTMENT OF THE ARMY NEW ENGLAND DISTRICT CORPS OF ENGINEERS CONCORD, MASSACHUSETTS	WATER RESOURCES DEVELOPMENT PROJECT ENVIRONMENTAL RESTORATION GREENFIELD, MASSACHUSETTS GREEN RIVER FISH PASSAGE ROCK RAMP FISHWAY SECTIONS WILEY & RUSSELL DAM	22/22

3.3 ENVIRONMENTAL CONSEQUENCES

This section summarizes the environmental consequences of plans developed to restore anadromous fish passage and riverine habitat to the Green River. A more complete discussion of the consequences of the various plans can be found in the Environmental Assessment. The purpose of this project is to restore the natural continuity of the river and provide fish access to habitat that the dams have excluded for many species. All plans except the no action plan involve construction of fish ladders at the Pumping Station Dam and the Swimming Pool Dam. Except for short-term negative effects, this project will primarily have positive effects on the environment. The habitat available to anadromous fish will be increased. A list of the most important environmental consequences is presented below.

- Restored access to the habitat will contribute to increased numbers of anadromous fish;
- The value of the restored river segments for fish and wildlife will be increased; and
- Recreational opportunities along the lower Green River will be improved.

The specific effects of the project are described in detail in the following sections.

3.3.1 Fish

Construction Phase Effects

The project will have minor effects on finfish during construction. Since fish are mobile they can avoid the relatively small area of increased turbidity that may result from construction. Fish that are close to and downstream of the two lower dams during construction may be exposed to higher turbidity levels as a result of sediment mobilization during construction. The dam removals will be scheduled for low flow periods and not during the time of anadromous fish runs.

Long Term Effects

The project will have a positive long-term effect on fisheries. The alternatives, with the exception of the no action alternative, will all have a positive effect on fish communities due to the increase in anadromous fish habitat and the removal of limited and segmented habitat for other resident species of fishes. Restoring fish passage beyond the four dams on the Green River is expected to have an overall benefit to the cultural and economic resources of the town of Greenfield. The restoration of anadromous fish to the Green River is expected to enhance recreational and/or cultural activities in several ways. These include fish viewing, since the up migrating fish will be visible in the restored river channel at Wiley & Russell and Mill Street, and in the fish ladders at Swimming Pool and Pumping Station Dams, as well as improved recreational fishing, since the influx of blueback herring into the system can improve the overall productivity of the existing fisheries in the river. Additional value will be added to the Deerfield and Connecticut River Ecosystems, and the Natural Heritage Status of the Connecticut River, as well as the as to the productivity of the Connecticut River estuary, by the restoration (i.e. return) of blueback herring to the ecosystem.

3.3.2 Wildlife

Construction Phase Effects

For all types of wildlife, there will be temporary disturbance of habitat during the estimated 9-month construction period. Some species may temporarily leave the area. Overall there will be a minor temporary decrease in the capacity to support wildlife populations during the construction time frame.

Long Term Effects

Effects of the project on particular wildlife species are summarized in the Environmental Assessment. The quality of wildlife habitat is based on the interrelationship (juxtaposition and interspersion) between three key elements (food, cover, and water). Juxtaposition refers to the distribution between the requirements of a species (i.e., food, cover and water) in relation to each other and the area normally traveled by the species. Interspersion refers to the distribution of habitat components in relation to the habitat as a whole or the pattern of mixing of habitat types.

The relationship between habitat elements will change with the restoration project. As a result, there will be a change in the relative abundance of the various species of wildlife using the site. However, none of the vegetation types on the site will be completely eliminated, or reduced so significantly that they no longer provide habitat as a result of the project. All of the species presently using the site are expected to remain, although at different population levels. Of course the target anadromous fish species are expected to reappear along the opened migration corridor.

3.3.2 (a) Birds

The unique location of the Green River, with its close proximity to the Connecticut and Deerfield Rivers, provides habitat for numerous avian species. Approximately eighty-one species of birds have been reported to use the various habitat types (i.e. hardwood and coniferous forests, scrub-shrub and meadows) within the Green River watershed for nesting, breeding and feeding (S. Laughlin, Atlas of Breeding Birds in Vermont, as cited in Green River Survey Course, 1999). Of these, approximately seventy-seven species are migratory, and twenty nine of these migratory species located in or near the Green River watershed use rivers and their adjacent shoreline brush as nesting habitat as opposed to open meadows, forested lands, etc. Although some of these birds can use other habitat types, all twenty-nine are known to be associated with a clean river or stream. Most of these eighty-one species occur in the more undeveloped sections of the Green River in Vermont, where the National Park Service has classified the river as an undeveloped river corridor.

Species that have been observed within the specific project area include various finches, swallows, and woodpecker species within riparian and upland areas; and great blue heron, common merganser, mallard duck, snowy egret associated with the wetlands. These birds have been specifically observed in the associated wetlands upstream from the Mill Street Dam discussed previously. In addition, the Connecticut River, which forms the eastern boundary of Greenfield provides habitat to numerous migratory and non-migratory avian species, which utilize the riparian corridor for migration, as well as various waterfowl species. These include the pied-billed grebe, sedge wren, black duck and possibly the least bittern (Watershed Rarity

Ranks for Species of Special Emphasis, in the Silvio O. Conte National Wildlife Refuge, Turner's Falls MA).

The change from lacustrine to riverine habitat with the loss of the impoundments behind the two lower dams will result in an increase in bird species that nest and feed in or around rivers.

3.3.2 (b) Mammals

The proposed project is generally not expected to have any long-term negative effects on terrestrial wildlife inhabiting the riparian areas of the Green River. The actual construction footprints (for both dam removal and fish ladder construction) will be limited to the areas immediately abutting each of the dams. These areas have been previously disturbed, and in the case of the Wiley & Russell and Mill Street Dams, (proposed for removal), are in urban settings adjacent to paved parking areas, roadways, and concrete bridges which are habitat impediments. Temporary construction access structures and roadways (as described for the Water Supply Dam) are planned to traverse the previously disturbed sections and/or existing components of the dams as much as possible in order to minimize any habitat disturbances. Most terrestrial wildlife species that may inhabit the immediate project footprint areas are expected to temporarily relocate. Any impacts that may occur will be temporary, and of short duration, lasting only until the project is completed.

The passage of migratory fish beyond the four Dams into the upper sections of the Green River is expected to have an overall positive effect upon the wildlife population in these areas. Both the upstream migration of pre-spawning adult alewives and shad, as well as the downstream migration of the juveniles, will provide beneficial forage to resident wildlife species, to include birds, as well as other predatory terrestrial wildlife. Many avian species including, herons, loons, and raptor species eat fish, as well as terrestrial mammals such as river otter and to a lesser extent raccoons, and black bear, all of which have previously been found in the areas of the Green River watershed.

3.3.2 (c) Threatened and Endangered Species

Recent coordination with the U.S. Fish and Wildlife Service has indicated that there are no federally listed or proposed, threatened or endangered species under its jurisdiction are known to occur in the study area, with the exception of occasional transient bald eagles (*Haliaeetus leucocephalus*). Coordination with the National Marine Fisheries has also indicated that there are no threatened or endangered species expected to be present within that region of the Connecticut River Watershed. Although shortnose sturgeon occupy the more downstream sections of the Connecticut River in the latitude of the Green River, they have not been documented in the Green River (see Environmental Assessment letters dated February 19, 2003 and February 11, 2003).

Coordination with the Commonwealth of Massachusetts Division of fisheries and Wildlife Natural Heritage and Endangered Species Program (NHESP) has indicated that the several plant fish and reptile species listed by the state as endangered and/or Special Concern occur within the study area. The plant species include Barren Strawberry (*Waldsteinia fragariodes*), Black Maple (*Acer nigrum*), both considered to be species of Special Concern; the fish species is Northern Redbellydace (*Phoxinus eos*), listed as Endangered; and reptile species, Wood Turtle (*Clemmys insculpta*). Barren Strawberry occurs in a diverse range of habitats, including a variety of forest types, wet thickets, clearings, dry sandy woods, barrens, slopes and rock outcrops. It has generally been found in rich wooded to semi-open banks in Massachusetts, as well as in rich mesic-shade forest on old floodplains with humus-rich soil. It has been associated with sugar maple, white ash, white pine, hickories, and ironwood, which often provide shade for it. The Natural Heritage and Endangered Species indicated that Priority Habitat for this species exists

along the Green River in the study area.

Black Maple occurs in rich moist soil in association with alluvial hardwood forests, and is highly tolerant of shade. In Massachusetts, all of the sites where it has been found have moderately moist, or mesic, soils with either shade or filtered light conditions. Specific habitat types in Massachusetts where this species has been found include floodplain forests, forested rocky slopes, and outcrops, and rich wood communities. In Massachusetts it is commonly found growing with sugar maple, (Acer saccharum), basswood (*Tilia Americana*), white and green ash (*Fraxinus americana and F. pennsylvanica*), sycamore, *(Platanus occidentalis*), American elm (*Ulmus Americana*), bitternut hickory (*Carya cordiformis*), hop hornbeam (*Ostrya Virginiana*), and various species of birch, (*Betula*), leatherwood (*Dirca palustris*), and wild leek (*Allium tricoccum*).

The Wood Turtle inhabits riparian areas, and is considered the most terrestrial of the North American turtles utilizing both aquatic and terrestrial habitats during its lifetime. It can feed in both of these habitats, and is considered semi-aquatic, although the terrestrial habitat occupied by this species is generally within a few hundred meters (approximately 1000 feet) from a stream or river system. It utilizes aquatic habitat for over wintering, where it burrows into either a muddy stream bottom, or muddy bank for hibernation. It becomes active in the spring when it leaves its burrow and begins its terrestrial activity, moving up onto the riverbank to bask in the sun, and eventually during the spring and summer occupying meadows and upland forests. By late summer it returns to the streams and/or rivers to mate and over-winter. It is omnivorous and in the terrestrial environment can feed on insects, carrion, worms, blackberries, dandelions, grasses sedges, mushrooms, and in the aquatic environment on fish, tadpoles, mollusks and filamentous algae. Their range is generally limited to within a few hundred meters (approximately 1000 feet) of the river, and moving linearly along the riparian corridor a distance of approximately a mile, although some individuals have been known to move greater distances using the riparian corridors for dispersal. Wood turtles are often found in riparian areas characterized by sandy-bottomed streams with slower moving water and heavily vegetated stream banks. They are generally attracted to tangles of vegetation.

Northern Redbelly Dace are generally found in quiet, cool, boggy stream and lakes, and in Massachusetts they are found in clear streams and spring-fed seepage pools. This species has been observed in the Green River in areas of the river that contain groundwater seeps, and areas of upwelling through the gravel bars. The river segment below the residential development at Leyden Woods is one such area they have been observed.

As noted, all of the above endangered and species of special concern have been found in priority habitats that are found along the Green River in the vicinity of Greenfield MA. A final determination by NHESP of what impacts to these species will occur, if any, and what steps are necessary to mitigate those impacts will take place during the design phase of this project.

3.3.3 Wetlands, Vegetation, and Cover Types

General

In general, the effect of the project on the vegetation community will minimal. Wetland and upland vegetation will populate the new channel fringes where the impoundments are now located. If the Mill Street Dam were removed, the effect on the wetlands upstream of Mill Street, specifically the pond and two historic oxbow segments, could be partially mitigated by the placement of a control weir in the ditch that connects the pond to the Green River.

Construction Phase Effects

There will be temporary impacts to wetland, riverbank, and upland vegetation during the construction period. Vegetation removal in the staging and access areas will temporarily disturb upland vegetation. The size of disturbance of the staging area and access roads will be limited to the minimum necessary for construction access and a line of erosion control devices will be established along the perimeter. The affected areas, other than those already cleared or paved, will be allowed to revegetate following construction and areas with severe slopes or disturbed soils with a high potential to impact water quality will be replanted to minimize erosion.

3.3.4 Water Quality

There may be a temporary short-term increase in turbidity and suspended solids in the vicinity of the project during construction and, in particular, mobilization of sediment load could temporarily affect water quality as a new channel is established. The amount and nature of the sediments behind both Wiley & Russell and Mill Street dams is not know at this time. Some of that material may be removed during the actual removal of the dam structure. Some of the sediments left in place during dam removal may be eroded over time and redistributed to downstream reaches of the river. However, predicting the amount and location of any sediment redistribution when a dam is removed was beyond the scope of this effort.

To minimize potential construction phase water quality impacts, temporary construction access roads will be constructed of clean granular material. Geotextile will be used for separation and strength and to facilitate removal of the temporary roads after the majority of work is complete. Appropriate controls on erosion and sedimentation will be employed throughout construction to isolate areas of disturbed soils and construction activity.

3.3.5 Air Quality

The project will have no long-term impacts on air quality. During construction, equipment operating on the site will emit pollutants including nitrogen oxides that can lead to the formation of ozone. In order to minimize air quality effects during construction, construction activities will comply with applicable provisions of the Massachusetts Air Quality Control Regulations pertaining to dust, odors, construction, noise, and motor vehicle emissions.

3.3.6 Sediment Quality

In 2001, sediment samples were collected by the Corps from ten locations along the river from its confluence with the Deerfield River, to just below the Water Supply Dam. Sampling locations are shown in Appendix C. The samples were analyzed for grain size, Total Organic Carbon, metals, PCB’s and PAH’s.

No PCB’s were detected in any of the samples collected. However, elevated concentrations of PAH’s were found adjacent to and downstream from the Berkshire Gas Company, which is located between the Wiley & Russell and Mill Street dams; upstream from the Mill Street Dam and below the railroad bridge at the Mohawk trail; and at the confluence of the Green and Deerfield Rivers. The lowest total PAH concentrations were found below Mill Street Dam and below the Pumping Station Dam, where out of a total of 27 PAH’s screened for in the samples, 23 were in concentrations below detection limits. PAH’s that were detected in the highest concentrations included Pyrene and Flouranthene. Pyrene was detected at 450

micrograms/kilogram (ug/Kg) and Flouranthene at 380 ug/Kg adjacent to and downstream from the Berkshire Gas Company. Concentrations of Benzo[a]anthracene, chrysene, and Benzo[a]pyrene were also elevated at this location.

Various criteria have been developed to determine levels of contaminants in sediments where biological effects can be expected to occur in benthic organisms. Among these are the Ontario Ministry of the Environment (OME) Sediment Quality Guidelines which were developed to protect aquatic life (Persaud, 1993). The OME guidelines were established as three levels of effect - the No Effect Level, Lowest Effect Level (LEL) and Severe Effect Level (SEL). The No Effect Level is that at which chemicals in the sediment do not affect fish or sediment-dwelling organisms. No transfer of chemicals through the food chain and no effects on water quality are expected at this level. The LEL is the level of a contaminant where no effect would be expected on the majority of sediment-dwelling organisms, and the sediment is considered clean to marginally polluted. The Severe Effects Levels (SEL) is applied to sediment containing concentrations of contaminants where a pronounced disturbance of the sediment-dwelling community can be expected. This is considered the concentration of a compound in the sediment that would be detrimental to the majority of benthic species, and the sediment would be classified as heavily polluted and likely to affect the health of sediment dwelling organisms.

More recently, the Commonwealth of Massachusetts Department of Environmental Protection developed a set of Recommended Freshwater sediment Screening Values (DEP, 2002). These are consensus based threshold effect concentrations (TEC's) for 28 chemicals for use in screening freshwater sediment for risk to benthic organisms. They are based on data from a variety of sources including the OME guidelines noted above. These TECs for a given contaminant are defined as the concentrations below which harmful effects on sediment dwelling organisms are not expected to occur, however, they are not necessarily protective of higher trophic level organisms exposed to bio-accumulating chemicals.

At the sampling station between the Wiley & Russell and Mill Street Dams, adjacent to the Berkshire Gas Company, Flouranthene was found in the highest concentration compared to all of the stations (380 ug/Kg), although it was below the Commonwealth of Massachusetts TEC level of 423 ug/Kg. However, concentrations of Pyrene, Benzo[a]anthracene, chrysene, and Benzo[a]pyrene from this station were all above these TEC levels. In addition, concentrations of Pyrene from below the railroad bridge and of Benz[a]anthracene from the confluence of the Green and Deerfield River were above the TEC screening concentrations. These results are summarized in Table 3. Results from all of the stations are presented in Appendix C.

The concentrations of the contaminants that are above the TECs suggest that harmful effects can be expected in the benthic organisms exposed to them. Since the concentrations of contaminants found in the Wiley & Russell impoundment exceed TECs, it may be necessary to remove or stabilize these sediments to prevent them from moving downstream in the event of a significant flow event and/or dam removal at Wiley & Russell.

TABLE 3. Concentrations of selected Polynuclear Aromatic Hydrocarbons from the three most contaminated stations on the Green River, Greenfield Massachusetts, relative to the Massachusetts DEP Threshold Effect Concentrations (TEC) for benthic organisms.

Compound	Confluence of Deerfield/Green Rivers (ug/Kg)	Adjacent To Berkshire Gas Company (ug/Kg)	Below Railroad Bridge (ug/Kg)	TEC (ug/Kg)
Flouranthene	210	380	260	**423**
Pyrene	190	**450**	**210**	**195**
Benz[a]anthracene	**110**	**220**	100	**108**
Chrysene	110	**210**	130	**166**
Benzo[a]pyrene	96	**190**	110	**150**

As noted previously, the sediment that was collected from the 9 stations described above was analyzed for the following 15 metals: Silver (Ag), Arsenic (As), Barium (Ba), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Copper (Cu), Mercury, (Hg), Nickel (Ni), Lead (Pb), Antimony, (Sb), Selenium (Se), Titanium (Ti), Vanadium (V), and Zinc (Zn). Results of the analyses from all stations are presented in Appendix C. Of these 15 metals, consensus based TECs have been developed for eight - Arsenic, Cadmium, Chromium, Copper Lead, Mercury, Nickel, and Zinc. Generally, the concentrations of these metals are well below the TECs, with the exception of Chromium and Mercury. The mean Chromium concentrations calculated for all of the sampling stations noted above was 43.9 milligrams/kilogram (mg/Kg) which slightly exceeds the consensus based TEC of 43.4 mg/Kg. Individual chromium concentrations range from 35.9 mg/Kg, measured upstream from the Mill Street Dam, to 56.8 mg/Kg, measured at the area immediately downstream from the Pumping Station Dam.

Reasons for these elevated levels are not known, although when compared to other rivers where there is relatively little watershed development, chromium concentrations have been found within a similar range. Some examples of these include several New England U.S. Army Corps of Engineer flood control reservoirs which are considered to have relatively pristine sediments due to the minimal watershed development. They are Ball Mountain and Townshend Lakes in Vermont, Barre Falls Dam in Massachusetts, Hancock Brook Lake in Connecticut, and Otter Brook Lake in New Hampshire, where chromium concentrations in sediments have ranged from 2.6 mg/Kg to 40 mg/kg (NAE, 1998; NED, 1993a, 1995, 1997b from NAE, 1999, French River Projects Priority Pollutant Scan). However as noted for the PAH results, the fact that these concentrations exceed the Massachusetts TECs suggests that biological effects to benthic organisms exposed to this sediments would be expected. These results are summarized in Table 4, and compared with the Massachusetts consensus based TECs. Results from all of these stations are presented in Appendix C.

TABLE 4. Chromium concentrations in sediments collected from all stations on the Green River in 2001, relative to Massachusetts DEP Threshold Effect Concentrations (TEC) for benthic organisms.

Station	Chromium (mg/Kg)	TEC (mg/Kg)
Confluence Deerfield/Green Rivers	38.8	43.4
Below Treatment Plant Outfall	**49.2**	43.4
Below Wiley & Russell Dam	**45.7**	43.4
Wiley & Russell Impoundment	39.9	43.4
Adjacent To Berkshire Gas Company	39.9	43.4
Below Mill Street Dam	**52.8**	43.4
Upstream Mill Street Dam Impoundment	35.9	43.4
Below Railroad Bridge	36.9	43.4
Below Water Supply Dam	**56.8**	43.4

Concentrations of Mercury (Hg) in sediment were below the detection levels at all sampling locations with the exception of the station just below the Wiley & Russell Dam where it measured 0.239 mg/Kg. This concentration exceeds the Commonwealth of Massachusetts Consensus Based TEC level of 0.18 mg/Kg. It is not known why this location was the only one where the mercury was not only detected, but exceeded threshold effects concentrations. Concentrations of Mercury from all stations on the Green River are presented in Appendix C.

Grain size analyses are presented in Appendix C, and generally indicate the sediment at the sampling locations ranging from 78% medium sand and 3% gravel in the impoundment behind the Wiley & Russell Dam to approximately 26% coarse sand, 34% medium sand, and 9% Gravel sand at the sampling station just below the Mill Street Dam. Generally, coarser material (including sand) is less likely to accumulate organic contaminants than finer materials.

A macroinvertebrate assessment in the Green River, conducted in the fall of 2004 by the Deerfield River Watershed Association, can be used to help ascertain the relative severity of the sediment contaminant results. A total of six sampling sites were examined along the stretch of the river extending from its confluence with the Deerfield River, to upstream of the Pumping Station Dam. Generally the study indicated that the macroinvertebrate communities at the sample sites are currently non-impacted relative to the regional reference location (i.e. the Cold River, a tributary of the Deerfield). It should be noted that the sampled locations for this study did not correspond directly with the areas of where the highest concentrations of PAH's were found. So it is possible that there may be local areas where the benthic community may be showing effects of the elevated concentrations of PAHs noted above. However, the fact that the river generally does not appear to be impacted indicates that the elevated levels noted at the specific locations above, are confined to those areas, and do not appear to be affecting the downstream communities.

3.3.7 Changes To River Levels

Alternatives that include removal of the Wiley & Russell Dam, the Mill Street Dam, or both structures would eliminate the existing impoundments and lower the river within the areas now influenced by the dams. Water levels at the two upstream impoundments will not be affected by the installation of fish ladders.

3.3.7 (a) Flooding and Bank Erosion

The project will not increase the flooding potential of surrounding developed areas. The existing impoundments behind the Wiley & Russell and Mill Street dams are relatively small and do not contribute to local flood control.

Two of the main issues with dam removal are the potential erosion of the dewatered riverbanks and release of the sediments stored behind the dam. The affected riverbanks are mainly fine granular soils where localized sloughing of the riverbanks during drawdown would be the primary concern. To minimize any potential sloughing, the storage pools behind the dams should be drawn down slowly to permit the finer bank materials to drain and gain strength, this will also allow time for natural vegetation to develop on its own.

The Town of Greenfield identified the river segment adjacent to the Green River Cemetery as an area of concern and requested that any changes to the river levels as a result of removing Wiley and Russell Dam be evaluated. The cemetery is located along the western riverbank at the upper end of the impoundment, about 1000 feet upstream of the Wiley and Russell Dam. The natural hillside slopes around the cemetery have historically experienced slope stability failures. At this upstream location removal of the dam would only lower the river level by about 1-foot and only increase average flow velocity by about ½-foot under lower-flow conditions and would have no effects under high flow conditions, this minor change would not affect the historical slope stability problems at the cemetery. A site inspection was conducted to observe several slope failures along the northern and eastern edges of the cemetery. The cemetery is located on a elevated plateau about 120 feet above the river valley that is comprised of fine-grained glacial lake silt and clay deposits overlain with medium to fine sands. A localized groundwater surface is present at about a 40-foot depth, or about 80-feet above the river valley, occurring at the fine sand and silt interface. During our site inspection on October 18, 2002, we observed water seeping from the slope at this level in the more recent slope failure areas, and water could also be heard running below the surface in several of the older slope failure areas. Most of the hillside around the cemetery is scarred from a series of slope failures that have probably occurred over many years. Some of these slope areas have mature trees up to 2-feet in size growing in the old failure areas. The slope failure areas all appear to be similar in configuration with a steep upper slope in the top 40-feet of sandy materials then flattening slightly when the groundwater and silty materials are encountered, with the lower half of the slide being comprised of an erosion gully up to 15-feet in depth through the clayey slope materials. These failures appear to be a flow type of slope failure with the upper materials loosing strength and flowing toward the bottom of the hillside and then into the river channel. The failure mechanism is probably a combination of rainfall, saturated upper slope materials, elevated groundwater levels, surcharges along the top of the slope (slope steepness, debris, fill materials, and trees) and deepening of the erosion gullies in the lower half of the slope from saturation and surface runoff. The historical slope failures being experienced at the cemetery are not the result of erosion along the riverbank but are the result of localized loading and groundwater conditions in the upper fine-grained slope materials. Removal of Wiley and Russell Dam should have no additional affects on these slopes.

The Mill Street Bridge is another potential problem area where erosion could possibly have unsatisfactory results. The bridge abutments are located immediately adjacent to the Mill Street Dam and at the edge of the existing river channel. Removal of the dam would result in the lowering of the riverbed by about 7-feet under the bridge which would also extend upstream a short distance. Since the bridge abutments were designed and built with the dam in place and no record bridge plans were available to review, it is only prudent to assume that erosion and

undermining of the bridge abutments may be a possibility. In addition, undermining of the riverbanks upstream of the bridge is also a possibility that may adversely affect private property located along the western riverbank about 700 feet upstream of the dam. A portion of this property is currently being scoured and eroded from natural river flows along the outside of a bend in the river. Under the dam removal scenario, additional investigation into the bridge abutment construction and upstream impacts is recommended during the project design phase. Placement of stone protection materials may be required in the river channel in order to protect the bridge abutments and riverbanks from being undermined.

Detail design and construction considerations for removing the dams should address site access and sequencing, lowering of the impoundments, sediment erosion or removal, wet vs. dry breaching of the dams, dewatering and diversion requirements, working during low-flow periods, long-term site stabilization, and temporary erosion control measures.

3.3.7 (b) Groundwater, Wells and Septic Systems

The proximity of wells and septic systems in the area was judged not to be a concern due to the distances and changes in elevation from the locations of the current impoundments to occupied dwellings and business establishments. In certain locations, the surrounding uplands will provide groundwater and runoff that will recharge water table in areas close to the river. The construction phase of the project would likely take place during the summer months that coincide with low flows. The impoundments at each dam would be drawn down to the extent possible. Potential for flooding during the Construction Phase is expected to be minimal based on statistical record of monthly rainfall.

3.4 INCREMENTAL COST COMPARISON OF PLANS

The costs and anticipated environmental benefits of the restoration measures that were combined to form the alternatives were estimated and compared in incremental cost analyses. The anticipated environmental benefits were assessed by estimating the benefits to various water-related habitats, including general riverine habitat, anadromous fish habitat (including that of alewife and blueback herring), riparian corridor, native wetlands species habitat, and waterfowl habitat. Costs ranged from $0 for the no-action alternative to over $1.3 million for Alternative 7 with fish ladders at all four dams and construction of in-stream works to create riffle-pool sequences in the channel near Leyden Woods. Anticipated environmental benefits ranged from 95.08 habitat units (effective habitat acres) for the no action alternative to 128.5 effective habitat acres for Alternative 6. The incremental analysis used “bare” costs associated with the actual construction, or, in the cases of dam removal, demolition, as a basis of comparison between the plans. Construction cost elements such as site preparation and erosion control that were common to all of the alternatives at each site were not included and have no negative effect on the analysis.

The first step in an incremental cost analysis is to determine what alternatives are cost effective. The incremental cost analysis shown in Appendix 4 demonstrated that alternatives 1, 2, 4, and 6 are cost effective (see Table 2 for description of alternatives). An alternative is considered cost effective if no other plans provide the same or greater number of habitat units for less cost.

The second step of the incremental cost analysis is to identify the best buy plans. Best buy plans are cost effective plans that have the lowest cost per habitat unit when compared to the no action

plan. A plan is considered a best buy plan if there are no other plans that will give the same or more output at a lower incremental cost when all plans are compared to the no action alternative. It was determined that Alternative 4 is not a best buy plan because Alternative 2 has a lower incremental cost per incremental habitat unit and greater HU in comparison to the no action plan. This leaves three best buy plans: alternatives 1, 2 and 6 (see Table 5).

TABLE 5 - INCREMENTAL COST COMPARISON OF PLANS

ALTERNATIVE	COST ($000)	HABITAT UNITS	COST EFFECTIVE PLAN	BEST BUY PLAN	INCREMENTAL COST	INCREMENTAL OUTPUT
1	0.0	95.08	YES	YES	---	
2	1,140.7	128.26	YES	YES	1,140.7	33.18
3	1,289.7	120.32	NO	NO	N/A	
4	1,128.9	118.94	YES	NO	47.3	
5	1,222.8	116.16	NO	NO	N/A	
6	1,205.4	128.50	YES	YES	64.7	0.24
7	1,324.0	120.45	NO	NO	N/A	
8	1,163.2	119.04	NO	NO	N/A	
9	1,257.1	116.26	NO	NO	N/A	
10	1,195.8	120.46	NO	NO	N/A	

These three best buy alternatives constitute the incremental cost curve. Development of the incremental cost curve facilitates the selection of the best alternative. The question that is asked at each increment is: is the additional gain in environmental benefit worth the additional cost? Of these three plans, Alternative 2 is the better plan as it has a much lower incremental cost/incremental habitat unit gained (34.4) versus Alternative 6 (269.6).

Table 6 below summarizes the total construction costs (“bare” costs plus site preparation and erosion control costs) for each alternative plan. It also includes the habitat unit gained and the results of the incremental cost analysis.

TABLE 6 DEERFIELD RIVER GI STUDY GREEN RIVER HABITAT IMPROVEMENT GREENFIELD, MA
COST & BENEFIT COMPARISON OF ALTERNATIVE PLANS

ALTERNATIVE PLAN NUMBER	ALTERNATIVE PLAN DESCRIPTION	ESTIMATED CONSTRUCTION COST	BENEFIT EXPRESSED AS HABITAT UNITS	NET BENEFIT EXPRESSED AS HABITAT UNITS	RANK OF COST EFFECTIVE PLANS
1	**No Action**	$0.00	95.08	0	N/A
2	**Remove Wiley & Russell Dam Remove Mill Street Dam Construct Fish Ladder At Swimming Pool Dam Construct Fish Ladder At Pumping Station Dam**	$1,720,000.00	128.26	33.18	1
3	**Construct Fish Ladder At Wiley & Russell Dam Construct Fish Ladder At Mill Street Dam Construct Fish Ladder At Swimming Pool Dam Construct Fish Ladder At Pumping Station Dam**	$1,890,000.00	120.32	25.24	Not cost effective
4	**Construct Rock Ramp Fishway At Wiley & Russell Dam Remove Mill Street Dam Construct Fish Ladder At Swimming Pool Dam Construct Fish Ladder At Pumping Station Dam**	$1,710,000.00	118.94	23.86	3
5	**Construct Fish Ladder At Wiley & Russell Dam Remove Mill Street Dam Construct Fish Ladder At Swimming Pool Dam Construct Fish Ladder At Pumping Station Dam**	$1,860,000.00	116.16	21.08	Not cost effective
6	**Remove Wiley & Russell Dam Remove Mill Street Dam. Construct Fish Ladder At Swimming Pool Dam Construct Fish Ladder At Pumping Station Dam Construct J-vanes and boulder groups in river channel downstream of Mill Street and near Leyden Woods**	$1,770,000.00	128.5	33.42	2
7	**Construct Fish Ladder At Wiley & Russell Dam Construct Fish Ladder At Mill Street Dam Construct Fish Ladder At Swimming Pool Dam Construct Fish Ladder At Pumping Station Dam Construct J-vanes and boulder groups in river channel near Leyden Woods**	$1,940,000.00	120.45	25.37	Not cost effective
8	**Construct Rock Ramp Fishway At Wiley & Russell Dam Remove Mill Street Dam Construct Fish Ladder At Swimming Pool Dam Construct Fish Ladder At Pumping Station Dam Construct J-vanes and boulder groups in river channel near Leyden Woods**	$1,760,000.00	119.04	23.96	Not cost effective
9	**Construct Fish Ladder At Wiley & Russell Dam Remove Mill Street Dam Construct Fish Ladder At Swimming Pool Dam Construct Fish Ladder At Pumping Station Dam Construct J-vanes and boulder groups in river channel near Leyden Woods**	$1,910,000.00	116.26	21.18	Not cost effective
10	**Construct Rock Ramp Fishway At Wiley & Russell Dam Construct Fish Ladder At Mill Street Dam Construct Fish Ladder At Swimming Pool Dam Construct Fish Ladder At Pumping Station Dam**	$1,790,000.00	120.46	25.38	Not cost effective

Note: Alternatives 2 & 6, 3 & 7, 4 & 8, and 5 & 9 have common fish passage measures.

SECTION 4 – RECOMMENDED ALTERNATIVE

4.1 PROJECT DESCRIPTION AND COSTS

The removal of both Wiley & Russell and Mill Street Dams and installation of fish passage structures at Swimming Pool Dam and Pumping Station Dam maximizes the environmental benefits, and in essence, offers the greatest degree of habitat restoration for each dollar invested in a project. The restoration project would extend migratory habitat and spawning habitat for anadromous fish over a distance of 30 river miles. The project will also improve riverine habitat quality (represented in the study by a gain of 33 habitat units compared to the existing conditions). It is a cost-effective plan that reasonably optimizes environmental benefits that are in the national interest and consistent with Corps regulations. The estimated construction cost for the recommended plan is $1,600,000. See Appendix 6 for a detailed breakdown of the construction cost estimate.

The future implementation cost of the project would include the cost of preparing plans and specifications (about $250,000); the cost of permits/planning (about $60,000); Value Engineering study (about $40,000); total construction costs, including contract administration and oversight of $1,600,000; and real estate requirements valued at $103,000. The total of those figures is $2,053,000.

This project would be cost shared 65 percent Federal and 35 percent non-Federal. The Federal share of the total project costs would be approximately $1,334,500. The non-Federal share would be approximately $718,500. Additionally, operations and maintenance (O&M) costs are estimated at $12,000 per year for a 50-year life of the project. Operations and maintenance at each of the new fish passage structures is a non-Federal responsibility. Operation & maintenance responsibility at each location typically consists of monitoring and control during fish operations and periodic maintenance.

4.2 IMPLEMENTATION SCHEDULE

Implementation of the recommendation contained in this report is subject to the Corps review, approval and funding processes and sponsor participation, including execution of a Project Cooperation Agreement (PCA). Upon receiving project approval from North Atlantic Division, the New England District must prepare plans and specifications prior to solicitation of bids and contract award.

4.3 FINANCIAL ANALYSIS

The non-Federal sponsor, the Commonwealth of Massachusetts Executive Office of Environmental Affairs (EOEA), has indicated its willingness to execute a Project Cooperation Agreement (PCA) for this project. EOEA is capable of meeting the financial obligations of a project sponsor and acquiring lands and easements necessary to construct a project.

4.4 REAL ESTATE CONSIDERATIONS

The real estate requirements identified for the recommended plan are spread over the four project locations. Credit for the real estate will be determined through the fair market appraisals perform after execution of a Project Cooperation Agreement (PCA). For planning purposes, a breakdown of ballpark values prepared by the New England District is as follows:

Wiley & Russell Dam: Three parcels of land, totaling approximately 3.77 acres of land, are required. The town of Greenfield owns two of the parcels in fee and the other is under private ownership. The value of a 1-year easement over 3.77 acres is $14,000.

Mill Street Dam: Two parcels of land, encompassing approximately one acre of land, are required. Both parcels are under private ownership. The value of a 1-year easement is $20,000.

Swimming Pool Dam: About 1.75 acres of land, a portion of a 20.1-acre parcel, are required for this project area. The land is owned in fee by the town of Greenfield. The value of a 1-year easement is $5,000 and the value of a fish ladder easement is $1,000.

Pumping Station Dam: About 1.5 acres of land, portions of two parcels, are required for the work to be done at this site; both parcels are owned in fee by the town of Greenfield. The value of a 1-year easement is $7,000. The value of a fish ladder easement is $3,000.

The administrative costs associated with the temporary easement acquisitions, such as title work, mapping, and closing, are estimated to be $5,000 per ownership. The sponsor has been informed that detailed records have to be kept in order to receive credit for these costs.

Following are the estimates costs for this project:

Temporary easements over 10.77 acres (4 sites) for 1 year	$46,000
Permanent easements at 2 sites	$ 4,000
Contingency, 25%	$12,500
Total land costs, rounded	$62,500
Total acquisition costs for 8 parcels	$40,000
Total real estate costs	$102,500
Total Estimated Real Estate Costs, rounded	$103,000

The Real Estate Planning Report appears in Appendix 5 of this report.

4.5 VIEW OF SPONSOR

The Massachusetts Executive Office of Environmental Affairs (EOEA) supports the plan for fish passage at their Green River dams. The Town of Greenfield also supports the plan. They recognize the value of restored anadromous fisheries and increased recreational potential on the Green River that the project will provide.

4.6 AGENCY COORDINATION

The U.S. Fish and Wildlife Service indicated their support for the project in a letter dated February 19, 2003. The National Marine Fisheries Service indicated its support for the project in a letter dated February 11, 2003.

SECTION 5 – CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The study team's analysis showed that the environmental benefit for each dollar spent is maximized for the alternative that removes the two downstream dams and constructs fishways at the two upstream dams in Greenfield. Implementation of the recommended plan will result in the removal of the Wiley & Russell Dam and the Mill Street Dam, construction of a steeppass fishway at the town's Swimming Pool Dam and construction of a denil fishway at the Pumping Station Dam in Greenfield.

5.2 RECOMMENDATIONS

I recommend that the project described in this report be approved and implemented subject to finding and identification of a non-Federal sponsor. In my judgment, the project is a justifiable expenditure of Federal funds and appropriate for implementation under the authority provided by Section 206 of the Water Resources Development Act of 1996, P.L. 104-303, as amended. Section 206 provides programmatic authority for the USACE to carry out aquatic ecosystem restoration projects that improve environmental quality, are in the public interest, and are cost effective. The restoration plan is consistent with current administration policy and could provide measurable environmental benefits to the Green River, Deerfield River and Connecticut River watersheds through modification of the Green River dams in Greenfield, Massachusetts.

It is also recommended that no further study be conducted under this General Investigation authority at this time.

The recommendations contained herein reflect the information available at this time and current Departmental of the Army policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of the national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, recommendations may be modified before they are authorized for implementation funding.

11 March 08 — Curtis L. Thalken

Date

Curtis L. Thalken
Colonel, Corps of Engineers
District Engineer

Green River Fish Passage Restoration Project
Greenfield, Massachusetts

Final Environmental Assessment

U.S. Army Corps of Engineers
New England District
Environmental Resources Section
696 Virginia Road
Concord, MA 01742

January, 2006

Green River Dam Fish Passage Restoration Project
Greenfield Massachusetts
Environmental Assessment

Table of Contents

Green River Dam Fish Passage Restoration Project
Greenfield Massachusetts

Draft Environmental Assessment

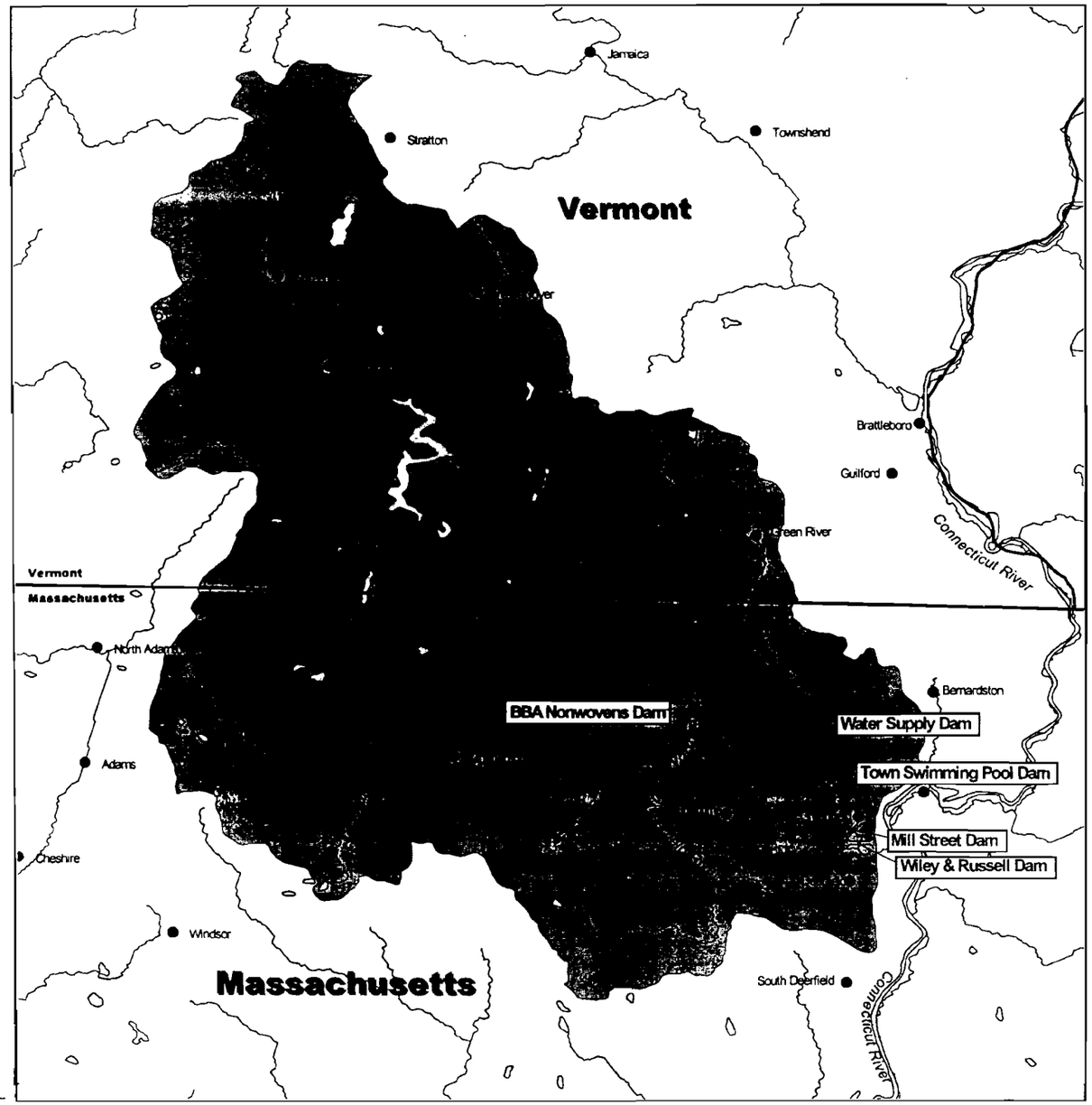
I. Introduction

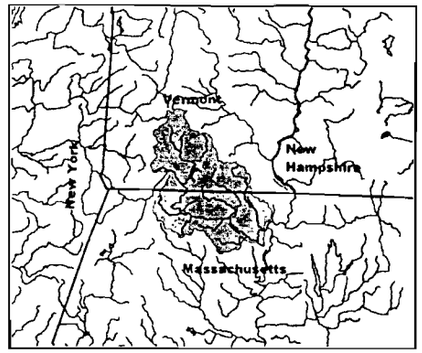
The Green River originates on the south slopes of Mt. Olga in Marlboro, Vermont and flows approximately 30 miles to its confluence with the Deerfield River in Greenfield Massachusetts, approximately 2 miles upstream from its confluence with the Connecticut River. Its watershed includes the Vermont towns of Marlboro, Brattleboro, and Halifax, and the Massachusetts towns of Leyden, Colrain, Shelbourne, and Greenfield. Total mileage through Massachusetts is approximately 15 and through Vermont 15 (Figure 1).

As a tributary to the Connecticut River, the Green River historically provided migratory, spawning and nursery habitat for native anadromous fish, including Atlantic salmon, American shad, blueback herring and sea lamprey, as well as the catadromous American eel. During the last 200 years, the construction of dams for various industrial uses along many New England Rivers, including the Connecticut, Deerfield, and Green Rivers, has blocked the migration of pre-spawning adults of these species to their historic upstream spawning habitat. Consequently, their populations were either eliminated or significantly reduced.

During the last two decades, various state and federal government agencies have been working cooperatively to restore anadromous fish to their historic habitat in the Connecticut River and its tributaries, the Deerfield and Green Rivers included. Restoration efforts have included identification of specific restoration locations, stocking of anadromous fish to historical upstream spawning and nursery habitats, and provision of fish passage beyond dams, by either dam removal, or creating by-pass structures such as fish ladders, lifts and/or partial dam breaching. In addition, studies of potential restoration areas have been conducted to identify anadromous fish habitat and the best methods to restore and/or access this habitat. Currently, sections of the Deerfield and Green Rivers are stocked with Atlantic salmon fry in order to reestablish anadromous populations in these rivers.

As a result of the restoration efforts, several fish passage facilities in the Connecticut River have been constructed, and many of the anadromous species noted above have been partially reestablished, and have access to its upstream regions as far north as Vermont. There is also unobstructed passage through the first several miles of the Deerfield River to its confluence with the Green River, and continuing through the Green River approximately 1.2 miles to the Wiley Russell Dam in Greenfield. However, there is no fish passage beyond this dam, preventing any further potential upstream migration of returning pre-spawning Atlantic salmon adults (as well as other migratory fish species). Three more dams along an approximate 8-mile reach of the Green River





Locus

40 0 40 Miles

Scale: 1" = 40 miles

N
W E
S

7 0 7 Miles

Scale: 1" = 7 miles

US Army Corps of Engineers
New England District

Deerfield River Basin

Figure 1

continue to obstruct fish passage to upstream regions beyond Greenfield. These are 1) the Mill Street Dam in Greenfield; 2) the Town Swimming Pool Dam in Greenfield; and 3) the Water Supply Dam in Greenfield. The proposed project would be to provide anadromous fish passage at each of these four dams on the Green River enabling fish migration to spawning and nursery habitat in areas of the Green River and its tributaries upstream of Greenfield. Also as part of this project, aquatic habitat improvements would be constructed at selected locations in the river to enhance existing fish populations.

II. Project Authorization

The reconnaissance and feasibility studies were initially authorized by a recommendation by the United State's Senate in the 1998 Appropriations Bill, to monitor operational changes on the Deerfield River in Searsburg and Somerset Vermont resulting from the conveyance of two Dams to the Corps to enhance ecosystem restoration. The study was originally proposed by the State of Vermont. However, shortly after the study's initiation the two dams of interest were sold to private interests along with their associated land as part of a deregulation plan. As a result the State of Vermont was no longer interested in Corps involvement with these dams, and the study was no longer considered necessary. However, both the Commonwealth of Massachusetts and the State of Vermont requested an expanded scope of the study to include the remainder of the Deerfield River. The expanded scope was authorized under a United States Senate Resolution Committee on Public works adopted on May 11, 1962, requesting that the Board of Engineers for Rivers and Harbors, created under the Rivers and Harbors Act of June 12, 1902, review the reports of the Connecticut River in Connecticut, Vermont, New Hampshire and Massachusetts, "…with a view to determining the advisability of modifying the existing project at the present time, with particular reference to developing a comprehensive plan of improvement for the basin in the interests of flood control, navigation, hydroelectric power development, water supply, and other purposes, coordinated with related land resources." Therefore the study was expanded to the entire Deerfield River, including the Green River, which is a significant tributary to it.

The following Environmental Assessment (EA) addresses the effects of constructing fish passage facilities at each of the four dams on the Green River (in the Connecticut River Watershed) in order to provide unobstructed access for anadromous and catadromous fish to habitat upstream from the dams, as well as other environmental enhancement features, in accordance with the National Environmental Policy Act of 1969 (NEPA).

III. Project History

A. General

The area near the Confluence of the Deerfield and Green Rivers historically was rich in fisheries resources, which included abundant runs of Atlantic salmon and shad (as

well as other species). In addition, the fertile flood plain soils in this area made it well suited for agriculture. Native Americans, who originally populated the area, utilized these resources. European settlement began in the late 1600's, and the area became known as the Green River Settlement in the north of Deerfield. In 1753 after breaking away from the Town of Deerfield it became the Town of Greenfield. During the 1700's the town began to grow, primarily because of its strategic location at the junction of the Connecticut and Deerfield Rivers. In addition, due to its abundant supply of water, manufacturing became established, and dams were built to harness the waterpower available from the rivers. Primary industries included the manufacture of metal products, including tools, and cutlery.

Most of the Dams along the Deerfield and Green River were constructed during the 1700's and 1800's. The early dams were built to power saw and grist mills, however later, the developing metals industries built dams in order to provide water power for machinery, and then later hydroelectric power. The Wiley & Russell Dam, which is the most downstream dam on the Green River, was constructed to provide waterpower for a tool-making factory, which most recently was known as the Greenfield Tap and Die Company. Approximately one mile upstream, the Mill Street Dam was constructed in order to provide hydroelectric power. The Town of Greenfield constructed the next two upstream dams, to provide a recreational area at the Town Swimming Pool Dam approximately four miles upstream, and for water supply at the water supply dam. Although these dams provided needed resources, they effectively blocked the upstream and downstream migrations of anadromous (and to a lesser extent, catadromous) fish, causing their populations to be either eliminated from the river or significantly reduced.

IV. Project Need

The four dams have created small impoundments along the Green River for a total of 8.7 miles from its confluence with the Deerfield River, and have also blocked the upstream (and downstream) migration of anadromous and catadromous fish. In 1999, the U.S. Army Corps of Engineers completed the Deerfield River Ecosystem Restoration Reconnaissance Report/Analysis to determine the need for aquatic habitat restoration on the Deerfield River and its tributaries, and to identify potential restoration alternatives. It was determined that river impediments in the form of dams in the Deerfield itself as well as those in its watershed (including the Green River) are blocking the upstream migration of pre-spawning anadromous fish (adults) to their historic spawning areas, as well as smolt and/or juvenile fish migration downstream to the ocean. Similarly, catadromous fish, which typically live in fresh water and spawn in the ocean, are not able to access their primary habitat as a result of these dams. The sectioning of the river has also impacted potamodromous fish, which are freshwater species that move to faster moving streams in the watershed to spawn. In addition, impounding the river causes the loss of spawning habitat for anadromous and riverine fish (e.g. removal of pool-riffle pattern, elimination of in stream cover and riparian vegetation, and establishment of unsuitable flow regimes and water depth).

Several species of fish were identified by the Conte Anadromous Fish Research Center in Turners Falls, Massachusetts for restoration or that would benefit from restored passage. These include: Atlantic salmon (*Salmo salar*), American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), sea lamprey *(Petromyzon marinus*), American eel (*Anguilla rostrata*), and the federally endangered shortnose sturgeon (*Acipenser brevirostrum*). Although not anadromous or catadromous, other native species that would benefit from fish passage by providing improved access for spawning include: brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), common carp (*Cyprinus carpio*), white perch (*Morone americana*), white sucker (*Catostomus commersoni*), redbreast sunfish (*Lepomis auritis*), bluegill (*Lepomis macrochirus*), yellow *perch (Perca flavescens*), and walleye (*Stizostedion vitreum*). For example, the installation of a fish passage structure at the DSI dam on the Westfield River (another tributary of the Connecticut River with obstructing dams) has resulted in the passage of 2,500 to 5,500 white sucker per year. Provision of fish passage beyond each of the four damson the Green River (noted previously) is expected to enhance the ecosystem by restoring an additional 8.7 miles of anadromous fish migratory and potential spawning habitat within sections of the obstructed river, and opening up a total of 21 river miles with associated tributaries for anadromous fish spawning and migration habitat. In addition, recommended improvements will ensure adequate downstream passage either by dam removal, construction of a rock ramp or notching an existing structure above a splash pool.

Other ecological benefits include the increase in productivity associated with the re-establishment of anadromous fish to their historical habitat. If shad and river herring become re-established in this river, the out-migrating juveniles could provide forage for resident lacustrine fish in the Green, Deerfield and Connecticut Rivers, and the returning adults could provide forage for larger fishes in the lower areas of the Connecticut River estuary. These include striped bass, which move into the areas around the same time as many of the returning alosid (i.e. shad, alewives, blueback herring) species.

V. Selected Plan (Alternative 2)

The project would involve provision of fish passage at each of the four dams on the approximate 8-mile section of the Green River in the Town of Greenfield. This will be accomplished by the removal of both the Wiley & Russell and Mill Street Dams, (Figures 2 and 3) and the Construction of fish ladders at the Swimming Pool and Water Supply Dams (Figures 4 and 5). The proposed activities are described below for each of the dams.

1) Wiley & Russell Dam. This is the most downstream dam on the Green River, located approximately 1.2 miles above the confluence with the Deerfield River. It is approximately 14 feet high and 165 feet long, constructed of timber crib and concrete. It was originally used for water supply to a tap and die complex adjacent to the site (Greenfield Tap and Die, Inc.) however with the closing of the factory it is no longer used for that purpose. It is in need of repairs, with the two low level gates being inoperable. The town of Greenfield currently owns it.

The proposed project would involve the demolition of the timber crib structure which would cause the impoundment behind the dam to drain and revert to its historical riverine habitat consisting of riffle/pools and runs. The sediment behind the dam would scour and revert to historical gravel/cobble substrate, more suitable for riverine/coldwater fish and invertebrates. The construction activities would be done during the low flow season, and would be expected to take approximately 3 months to complete. Upon completion the upstream bank areas would be stabilized and replanted with native riparian vegetation. Erosion controls will be in place during the actual construction in order to prevent runoff from entering the river.

2) The Mill Street Dam. This is located approximately 0.5 miles upstream from the Wiley & Russell Dam, below the Mill Street Bridge. It is a concrete dam about 12 feet high that was used by the Greenfield Electric Light and Power Company to generate hydroelectric power. It is now also owned by the Town of Greenfield and no longer used for its original purpose.

The proposed project would involve the demolition of the concrete structure, which would cause the impoundment behind the dam to drain and revert to its historical riverine habitat consisting of riffle/pools and runs (as with the Wiley & Russell Dam downstream). The sediment behind the dam would scour and revert to historical gravel/cobble substrate, more suitable for riverine/coldwater fish and invertebrates. The construction activities would be done during the low flow season, and would be expected to take approximately 3 months to complete. Upon completion the upstream bank areas would e stabilized and replanted with native vegetation riparian vegetation. Erosion controls will be in place during the actual construction in order to prevent runoff from entering the river.

3) The Town Swimming Pool Dam. This dam is located approximately 3 miles upstream from the Mill Street Dam. It is a concrete dam approximately 2 feet high and used to provide a recreational swimming pool by seasonally raising the water level with flashboards. A shallow winter pool is also maintained by the existing two-foot concrete weir. The town of Greenfield also owns this dam.

The proposed project would be the construction of an approximately four foot wide aluminum Alaska steep pass Denil fish ladder on the right bank (looking downstream) of the Green River at the Swimming Pool Dam. The fish ladder would notch into the existing concrete spillway structure and descend for approximately 25 feet to the entrance channel in the river. Flow will be controlled by stop logs at the top of the fish ladder in the exit pool, and diverted into it during anadromous fish migration/spawning season. Access to the section will be along the right bank of the river which is currently part of the town of Greenfield's recreation area (i.e. public beach). Construction would be during the low flow season and is expected to take approximately three months.

4) The Town Water Supply Dam. This is the last dam on the Green River in Massachusetts (also known as the Pumping Station Dam), located approximately four miles upstream from the Town Swimming Pool Dam. It is approximately 14 feet high, and was constructed in 1972 by the Town of Greenfield as a backup municipal water

supply. It is still used for that purpose.

The project will involve the construction of a four-foot concrete Denil fish ladder on the right bank (looking downstream) of the town water supply dam. The fish ladder would notch into the existing concrete spillway and descend along the right bank of the Green River for a distance of approximately 45 feet, to a 180-degree turning pool. It would then continue in the opposite direction for a distance of approximately 35 feet to another 180-degree turning/resting pool at its entrance below the dam in the Green River. A temporary access road will be constructed at the base of the dam on the downstream side of the dam across the river, with culverts in order to convey the river flow. Construction activities will be conducted during the low flow period in order to minimize any water quality impacts. Upon completion, the temporary access road will be removed, and the area restored to its previous condition.

Figure 2. Wiley & Russel Dam

Figure 3. Mill Street Dam

Figure 4. Swimming Pool Dam

Figure 5. Water Supply Dam

VI. Alternatives

A total of ten alternatives for fish passage were examined, including the No Action Alternative. These alternatives are numbered and described as follows.

A. Alternative 1 - No Action

The No Action Alternative, as defined under NEPA, serves as a benchmark against which the proposed action and alternatives can be compared. It can also be expressed as the future without project condition. The future without project condition is the assumption that the existing four dams on the Green River will continue to block the upstream migration of anadromous fish. This would preclude the restoration of self-sustaining runs of Atlantic salmon as well as shad, and river herring to the Green River upstream from Wiley & Russell Dam. Any future Atlantic salmon stocking efforts designed to restore Atlantic salmon to the river would serve only to provide downstream migrants, which would be unable to return to their natal spawning areas. In addition, restoration of river herring and shad, to the Green River would not occur. These fish currently inhabit the Connecticut and Deerfield Rivers downstream, but cannot utilize historic spawning and migratory habitat, which exists in the Green River upstream from the Wiley & Russell Dam. Also, the additional ecological benefits (described in section IV of this EA) resulting from the provision of upstream fish passage beyond the dam would not be realized.

B. Alternative 2 - Removal of Wiley Russell Dam and Mill Street Dam, and Construction of Fish Ladders at the Swimming Pool and Water Supply Dams

In this alternative, the two downstream dams, Wiley & Russell, and Mill Street, would be removed. This would allow the impoundments behind them to drain, resulting in the restoration of approximately four miles of free flowing riverine habitat to the section of the river extending from the Wiley Russell to the upstream limits of the Mill Street impoundment. The large amount of sediment which has accumulated behind both of the dams would be flushed from the former impoundments to depositional areas downstream in both the Green and Deerfield Rivers exposing historical benthic habitat consisting of scoured cobbles and gravel. The resulting loss of the marginal lacustrine habitat created by these impoundments would be replaced by free flowing riverine habitat with associated pool and riffle sequences, more suitable for riverine and anadromous fisheries spawning, migration and survival.

Advantages of this alternative would be the restoration of approximately 6 miles of historic free flowing river, and the associated ecological benefits. These include the total accessibility of this reach of the river to all anadromous fish species currently inhabiting the Deerfield and Connecticut River and those that are proposed for restoration to the Green River. It would also include the riverine species currently inhabiting the Green River. Since fish ladders range from being only 75% to 90% efficient in passing

fish (depending upon species and type of fish ladders), the removal of these dams would result in more fish being able to access the upstream areas of the Green River. In addition, the restored connectivity would benefit the benthic invertebrate communities, of which many species utilize the continuity of the benthic substrate for migration and re-colonization of upstream areas.

Disadvantages of this alternative would be that the displacement of these sediments would create a temporary increase in sediment load downstream that would increase turbidities and cover downstream benthic habitat. This would be expected to occur over a relatively short period depending upon the seasonal flow regime in the Green River. It is expected that most of the sediment would be washed out of the former impoundments during flood flows, and settle in areas of quieter water such as the confluence of the Deerfield River, which is approximately 1.5 miles downstream from the Wiley & Russell Dam. During the normal course of the year, it would be expected that sediments would continue to be flushed from these impoundments, settling out in downstream areas, and covering downstream benthic habitat. It is expected that these would most likely be flushed from these areas during higher flows however, re-exposing these habitats over time.

It should be noted that During high flood flows, the river normally carries a sediment load from upstream areas which is deposited downstream in quieter sections of either the Green or Deerfield Rivers, The existing dams have provided an artificial deposition area, trapping these sediments. Dam removal will cause these to once again be mobilized, although temporarily and disproportionately due to the amount of accumulation present. Unless these sediments are contaminated, their removal is not necessary since it is expected that the river will ultimately revert to a state of equilibrium once the dam is removed, with these clean sediments being redistributed downstream.

Other disadvantages of this alternative would be the potential loss of wetland habitat upstream from the Mill Street Dam. Approximately 10 acres of wetlands are located upstream from the Mill Street Dam impoundment, primarily on the east side of the River, and appear to be hydraulically connected to it during times of high water. These wetlands consist of an oxbow, as well as a small pond, locally referred to as “The Donut”, which is connected to the oxbow by three culverts. The pond appears to be hydraulically connected to the Green River (i.e. the Mill Street impoundment) by a narrow discharge channel that enters the impoundment approximately 0.25 miles upstream from the Mill Street Dam. These wetlands appear to be supported by the water level of the Mill Street Dam impoundment, and would most likely be impacted if the dam was removed and the impoundment drained. This would cause the existing wetland habitat to revert to upland habitat, and the small donut pond would drain, leaving an area of wet emergent wetland and bordering uplands instead. However, prior to the construction of the Mill Street Dam, it is assumed that this area consisted of a flood plain forest with lesser amount of wetlands, so the loss of wetland would actually be a reversion to historical riparian habitat.

The construction of Denil fish ladders at the two upstream dams would open up an additional 21 miles of anadromous fish migration and potential spawning habitat. In

addition the existing (potamadromous fish) riverine fish population would be able to access the areas upstream from theWater Supply Dam. These dams are currently in use by the Town of Greenfield, and therefore cannot easily be removed at this time. Consequently, providing fish passage in the form of Denil fish ladders is the only feasible method of fish passage. Other possible passage facilities such as a rock ramp or a bypass channel are not feasible given the limited space and access to these two dams.

Construction of fish ladders at the two upstream dams and removal of the two downstream dams would be the most feasible method of restoring migratory fish to areas upstream of the Water Supply Dam. However the above disadvantages would also be realized.

C. Alternative 3 – Construction of Fish Ladders at Wiley Russell, Mill Street, Swimming Pool, and Water Supply Dams

In this alternative, a four-foot concrete Denil fish ladder would be constructed on the left abutment (looking downstream) of the Wiley Russell Dam, and another similar fish ladder would be installed on the right abutment (looking downstream) of the Mill Street Dam. In addition, two four foot Denil fish ladders would be installed on both the Swimming Pool Dam and Water Supply Dam as described in Alternative 2 above. This would allow anadromous fish access to approximately 21 miles of migratory, spawning and nursery habitat previously obstructed by these dams. Advantages to this alternative would be that the impoundments behind both the Wiley Russell and Mill Street Dams would remain intact, therefore eliminating any of the previously mentioned impacts associated with their loss. These include the potential redistribution of sediment load to areas downstream of the dam, as well as the potential loss of the wetlands upstream from the Mill Street Dam, which includes the small Donut pond, that would most likely drain if the dam were removed.

Disadvantages to this alternative would include the reduced passage efficiency of fish ladders, which range from 75% to 90% passage at each location depending upon species and other factors. Therefore, by the time the fish reached the Water Supply Dam, there would be the potential of relatively few of the fish that had passed through Wiley Russell actually moving to areas upstream from it. In addition, the ecological benefits associated with the restoration of a free flowing river (as would occur in dam removal) would not be realized with fish ladders. These include the re-establishment of historic riverine habitat with associated pool and riffle complexes and cobble gravel substrate, as well as the benthic connectivity noted previously.

Another disadvantage of the construction of fish ladders at Wiley & Russell is that it is currently in a state of disrepair, and would require additional repair work prior to the installation of a fish ladder. Although the Mill Street Dam is in better repair, it would still require routine maintenance in order to ensure its continued operation.

D. Alternative 4- Rock Ramp Fishway at Wiley & Russell Dam, Removal of Mill Street Dam, and Construction of Fish Ladders at Swimming Pool and Water Supply Dams

In this alternative, a rock ramp fishway would be constructed at the Wiley Russell Dam, and Mill Street Dam would be removed. There would be no change from the previous alternative (Alternative 3) that would occur at the upstream dams. Advantages of a rock ramp fishway compared to a fish ladder would be its increased passage efficiency, which would be between 95% and 100%, compared to that of a fish ladder, which ranges between 75%-90%. In addition, the actual configuration of this type of fish passage structure with its combination of artificial pools and riffles may add some riverine habitat value, as well as provide additional benthic substrate (consisting of the boulders, and cobbles), which could restore benthic connectivity to the river. Other advantages would be that the large amount of accumulated sediments deposited behind Wiley Russell Dam would remain intact, and the temporary negative effects to the downstream habitat resulting from their release would not occur (as could occur with dam removal).

Disadvantages to the rock ramp fishway compared to dam removal would be that the ecological benefits associated with the restoration of a free flowing area in that location would not be realized. These include the restoration of the pool and riffle complexes extending the length of the impoundment, and the 100% passage efficiencies that would only occur with an unobstructed river. Also, compared to a fish ladder, rock ramp fishways are more prone to damage from flood flows, requiring periodic maintenance and replacement of the boulders, which can be more easily washed away.

This alternative also includes the removal of the Mill Street Dam. The advantages of removing this dam are noted above in Alternative 2, and with a rock ramp fishway at Wiley Russell as (opposed to a fish ladder) there would be more effective passage to the areas of the Green River upstream (i.e. at the Swimming Pool and Water Supply Dams). However, the disadvantages would be the potential loss of the associated wetlands behind the dam as well as the small donut pond adjacent to the oxbow. Other disadvantages would be the release of the sediments from behind the dam, with its associated negative effects to habitat.

The combination of a rock ramp fishway and dam removal in this alternative would more effectively pass fish from beyond these two dams to areas of the Green River upstream from the Water Supply Dam, compared to using fish ladders at these two dams. Therefore, with this alternative, better utilization of the habitat by anadromous fish would be expected (even the habitat upstream from the Water Supply Dam).

E. Alternative 5 - Fish Ladder at Wiley & Russell, Removal of Mill Street Dam and Fish Ladders at Swimming Pool and Pumping Station Dams

In this alternative, a fish ladder would be constructed at the Wiley Russell Dam as described in Alternative 3, instead of a rock ramp fishway as described above in alternative 4. Mill Street Dam would be removed as in Alternative 4. The advantages to this alternative (compared to a rock ramp fishway) would primarily be in the reduced maintenance associated with a fish ladder compared to a rock ramp fishway. The advantage to a fish ladder (as well as a rock ramp fishway) would be that the dam would remain intact, as well as the sediments behind them. Therefore, there would not be the impacts associated with the loss of sediment from the impoundment.

Disadvantages of this option compared to a rock ramp fishway include the reduced fish passage efficiency, as well not realizing the potential small habitat increase created by the rock configuration, which may include additional benthic habitat, as well as a small area of increased pool and riffle habitat.

Advantages of the combination of a fish ladder at Wiley Russell, and Removal of Mill Street would be that the improved fish passage efficiency through Mill Street would result in a greater number of fish reaching and passing the two upstream dams, (i.e. Swimming Pool and Water Supply Dam). However, disadvantages of removal of Mill Street Dam would be the associated wetland loss, as well as the release of sediments to downstream areas (as noted above in Alternatives 2 and 3).

F. Alternative 6 - Dam removal at Wiley & Russell and Mill Street and Fish Ladders at Swimming Pool and Pumping Station, In-Stream Work for Habitat Restoration Downstream of Mill Street and at Leyden Woods

This alternative would be the same as Alternative 2, with the addition of instream habitat improvement downstream of Mill Street Dam, as well as in a section of the Green River near the Leyden Woods apartments. This alternative would combine the benefits of unobstructed fish passage and the restoration of a free flowing river, with additional habitat improvements along the river at the two locations noted. Habitat improvements would consist of the placement of rock weirs extending from the banks in order to create pool and riffle sequences beneficial for resident trout and other species, and the stabilization of some of the severely eroded banks in the vicinity of the Leyden Woods apartments (in addition to placement of rock weirs). In addition, the pools could provide potential spawning habitat for blueback herring, which can spawn in swift flowing deeper sections of rivers and streams associated with hard substrate (Sholar 1975; Loesch and Lund 1977, from Pardue, 1983). Also the stabilization of the streambanks in these areas will reduce erosion, which will have an overall benefit on water quality in the areas downstream. In addition to the benefits associated with dam removal noted in Alternative 2, which includes improved fish passage efficiency and restored riverine habitat, this alternative would provide the added benefit of additional habitat restoration that would benefit resident as well as anadromous fish species.

Disadvantages of this alternative have been previously discussed in the description under Alternative 2 for the dam removal. Disadvantages that may be

associated with the instream habitat improvements would be those associated with periodic maintenance which may be required after severe flood flows which could deposit large amounts of silt behind these weirs.

G. Alternative 7- Fish Ladders at all Four dams, In-stream work for Habitat Restoration at Leyden Woods

This alternative would be similar to Alternative 5, with the addition of instream habitat restoration at the section of the Green River near the Leyden Woods apartment complex. These habitat improvements would consist of placement of rock weirs and streambank stabilization as described previously in Alternative 6. The advantages of this alternative would be that additional fish habitat would be created in the river which benefit resident fish species, as well as anadromous species, that have passed beyond the first two dams via the fish ladders. The advantages and disadvantages associated with fish ladders compared to other methods of fish passage have been discussed previously in Alternative 4.

H. Alternative 8- Rock Ramp Fishway at Wiley & Russell, Removal of Mill Street and fish ladders at Swimming Pool and Pumping Station, In -stream Work for Habitat Restoration at Leyden Woods

This alternative would be similar to Alternative 4 with the addition of instream habitat improvements as described in Alternative 7. Advantages and disadvantages of a rock ramp fishway compared to a fish ladder have been previously discussed in Alternative 5, as well as those of the removal of Mill Street Dam. The advantages of this alternative over Alternative 4 would be the improved habitat for resident and anadromous fish that would be provided at Leyden Woods, as well as the local improvements to water quality that would occur with the erosion control measures in that section.

I. Alternative 9 - Fish ladder at Wiley & Russell, removal of Mill Street and fish ladders at Swimming Pool and Pumping Station, In-Stream Work for Habitat Restoration at Leyden Woods

This alternative would be similar to Alternative 5 discussed previously, with the addition of instream habitat improvements as described in Alternatives 7 and 8. The benefits of the dam removal at Mill Street would allow 100% passage of fish that have passed the ladder at Wiley Russell, while the improvements at Leyden Woods will help to improve habitat for resident species. Advantages and disadvantages of the fish ladders as opposed to either dam removal or rock ramp fishways have been discussed previously in the preceding alternatives sections.

J. Alternative 10 – Rock Ramp Fishway at Wiley & Russell, and Fish Ladders at Mill Street, Swimming Pool, and Water Supply Dam with In-Stream Work for Habitat Restoration at Leyden Woods

This alternative would be similar to Alternative 7, with the with the exception of the fish ladder at Wiley Russell being replaced by a rock ramp fishway. Advantages of this alternative would be increased fish passage at Wiley Russell (compared to a fish ladder) and the retention of the wetlands above the Mill Street impoundment that are currently being maintained by the Dam. Also, the instream habitat improvements would provide additional benefits for the riverine fish present in Green River. Advantages and disadvantages of the fish ladders as opposed to either dam removal or rock ramp fishways have been discussed previously in the preceding alternatives sections.

A cost effectiveness analysis (see Incremental Analysis in the appendices section of the main report) completed for this study determined that alternatives 2 and 6 were best buy plans. A plan is considered a best buy plan if there are no other plans that will give the same or more output at a lower incremental cost when all plans are compared to the no action alternative. The question that is asked of each of these plans then is the additional gain in environmental benefit worth the additional cost? Of the two plans, Alternative 2 is the better plan as it has a much lower incremental cost/incremental habitat unit gained (34.4) versus Alternative 6 (269.6).

VII. Affected Environment

A. General

Greenfield is the largest community in Franklin County, located near the confluence of the Connecticut and Deerfield Rivers. It is situated in the Pioneer Valley of Western Massachusetts, where Interstate 91 intersects state Route 2, the Mohawk Trail. The Green River runs for a distance of approximately 10 miles through the town, ending its 25-mile course at the Deerfield River, the town's southern boundary. It is bordered by the Connecticut River on the east, and the Deerfield River on the south, which form the boundaries between the towns of Gill, Turner's Falls, Montague, and Deerfield. It is bordered on the west by the towns of Conway, and Shelbourne, and on the north by Colrain, Leyden, and Bernardston. Historically, the town's strategic location at the confluence of the Connecticut and Deerfield rivers, with their abundant supply of waterpower, attracted artisans and manufacturers. Businesses became established, beginning a long period of economic diversification, commercial growth, industrial growth, and agricultural decline. The success of such companies as J. Russell Cutlery, the nation's first cutlery firm, and Lunt Silversmiths distinguished the town as a good location for industry (Weeks, L. 2004).

B. Terrestrial Environment

1. Topography

The City of Greenfield ranges in elevation from approximately 118 ft (36 meters) above sea level at the confluence of the Green and Deerfield Rivers, to approximately 780 feet (240 meters) at Shearer Hill in its northwest corner between the borders of Shelbourne and Leyden. On its eastern border, it rises to approximately 492 feet (150 meters) at Poet's Seat Lookout on Rocky Mountain Ridge, which runs a distance of approximately 2 miles north to south along the western border of the Connecticut River. The Green River drops a total of approximately 118 feet as it runs from north to south through Greenfield, from an elevation of approximately 236 feet (72 meters) at the Water Supply Dam near the border of Leyden, to 118 feet at its confluence with the Deerfield River. The major topographic features of the City include the Green River and its flood plain, bordered by higher elevation ridges that run parallel to it on its eastern and western boundaries

2. Geology and Soils

Greenfield is bounded the Connecticut River on the east, and by the highlands of the Berkshire Hills on the west. The area is unique in that all three rock types; igneous, sedimentary, and metamorphic are visible on the landscape. The western side of the Green River it is underlain predominantly by igneous and meta-sedimentary rock types from Paleozoic and Precambrian origins, which include schist rocks which form the base of the Berkshire Hills. The center of the town is situated on the flat lake bottom plain of Lake Hitchcock, a glacial lake that drained approximately 12,500 years ago, and is underlain by sedimentary rocks of the Mesozoic era. Outcrops of sandstone are located

along the Connecticut River valley as the river flows through Greenfield. Surficial geology reflects the glacial activity, with large deposits of sand, gravel and clay being located throughout most of the town roughly parallel to the Green River, with concentrations of flood plain alluvium following along the river's edge. Larger deposits of flood plain alluvium are located at the more downstream section of the Green River near its confluence with the Deerfield River. The sandy nature of the soils is evident along much of the Green River, where there is progressive bank erosion, exposing the sand and gravel deposits through which the river flows (USGS, 2005a and Little, 1996).

3. Terrestrial Vegetation

Forested areas within the Green River watershed are generally within the northern hardwood and transition hardwood forest zone(s). Typical species include American beech, yellow birch, and sugar maple as the predominant species in the mature woodlands. In addition, associated species such as eastern white pine, eastern hemlock, black cherry, white ash, American elm, oaks and hickories can be found. Generally, the forested areas are second growth forests that have reclaimed land that was once cleared for farming and timber harvesting.

The Green River is bounded by forested uplands along much of its course as it flows through the Town of Greenfield. Areas bordering the river upstream from the Water Supply Dam are predominated by stands of eastern hemlock, which transitions into mixed hardwoods, downstream. These forested areas characterize much of the river and continue throughout most of its course interrupted by areas of farm fields and scrub-shrub wetland vegetation in the vicinity of Greenfield Meadows. In addition, there are breaks in the forest near the Town Recreation area, as well as downstream through Greenfield Center. However, even in some of the more urbanized areas, the banks remain forested providing a certain amount of riparian canopy. Examples of this include the Mill Street impoundment as well as downstream from the Mill Street Dam along the banks of the Wiley Russell impoundment, and downstream from it. Characteristic bank species in this section include black cherry, elm, sycamore and black locust.

Almost all of the habitat types in the Deerfield River watershed, including areas of the Green River, have become populated by invasive plant species. A listing of these invasive species and their habitat types is given in Appendix C. On floodplains and stream banks, one of the primary invasive plant species that has been spreading is Japanese Knotweed (*Polygonum cuspidatum).* A recent survey conducted by the Deerfield River Watershed Association found that this species was present along the Green River in several locations. Densities ranged from small patches and single plants in the area of the river upstream of West Leyden to continuous patches near the confluence of the Green and Deerfield Rivers extending from the Route 2A Bridge downstream.(Deerfield River Watershed Association, 2005).

Several plant species listed as rare and/or endangered plant species by the Commonwealth of Massachusetts Natural Heritage Program have been identified in

Greenfield near the Green River. These include black maple (*Acer nigrum*) and barren strawberry (*Wasldsteinia fragarioides*).

4. Wildlife

a. Mammals

The relatively undeveloped nature of the Green River upstream from Greenfield Center provides habitat for a number of mammalian wildlife species, which use the river and associated riparian areas for feeding, breeding and migration. These include larger mammals such as white tailed deer (*Odocoileus virginianus*), black bear (*Ursa americanus*), and moose (*Alces alces*) as well as eastern coyote (*Canis latrans*) and bobcat (*Lynx rufus*). Within the Deerfield River watershed, which includes the Green River sub-watershed, the black bear populations are relatively extensive. The annual bear harvests from this area have ranked among the highest in Massachusetts, compared to other areas of the state. Although this species was hunted to near extirpation in the nineteenth century, changes in land use and reduction in hunting pressure have allowed the bear populations to increase. The population is currently increasing at approximately 8 to10% annually, and is expanding eastward into more densely populated areas (Massachusetts Division of Fisheries and Wildlife, 2000, as cited in Deerfield River Watershed 5- Year Watershed Action Plan-DRAFT FINAL, 2004-2008, MA EOEA).

In addition to the above, many of the smaller mammals common to areas of western Massachusetts (including Franklin County) can also be found along upper sections of the Green River, as well as in some of the more developed areas of the river, closer to the center of Greenfield. These include red fox (*Vulpes vulpes*), common porcupine (*Erethizon dorsatum*), common raccoon (*Procyon lotor*), striped skunk (*Mephitus mephitus*), Virginia opossum (*Didelphis virginiana),* red squirrel (*Tamiasciurus hudsonicus*) eastern gray squirrel (*Sciurus carolinensis*), eastern chipmunk (*Tamias striatus*), as well as several species of mice, voles and shrews. In addition, beaver (*Castor canadensis*)are common throughout much of the Green River, as well as muskrat (*Ondatra zibethicus*). Beaver activity was noted in the impoundment along the river upstream from the Mill Street Dam, as well as in sections upstream between the Swimming Area and Water Supply Dams. An approximately 20-acre area of privately owned residential property is located along the Green River immediately upstream from the Mill Street Impoundment, which contains a mix of wetlands, upland field and forest. This area provides additional habitat for numerous wildlife species including several mammals. Anecdotal reports have indicated the presence of white tailed deer, red fox, woodchuck (*Marmota monax*) fisher (*Martes pennanti*) river otter (*Lontra canadensis*) muskrat and beaver in the immediate area (Patricia Conway, personal communication, 2001).

A section of the Green River and its adjacent lands upstream from the Massachusetts border are listed on the National Park Service's National Rivers Inventory. In order to be listed on the NRI, a river must be free-flowing and possess one or more Outstandingly Remarkable Values (ORVs). The eligibility analysis consists of an

examination of the river's hydrology, including any man-made alterations, and an inventory of its natural, cultural, and recreational resources. The section listed extends from the Vermont-Massachusetts Border to its headwaters, and its Outstandingly Remarkable Values include botanical features in a pond near its headwaters which provide unique wetland vegetation characteristic of areas much further north, and not generally seen in southern Vermont (National Park Service, Rivers, Trails and Conservation Assistance Programs (http://www.nps.gov/ncrc/programs/rtca/nri/states/vt.html) website accessed April 27, 2005). This area has been reported to provide habitat for numerous migratory birds, waterfowl and other wildlife.

b. Avian Species

The unique location of the Green River, with its close proximity to the Connecticut and Deerfield Rivers, provides habitat for numerous avian species. Approximately eighty-one species of birds have been reported to use the various habitat types (i.e. hardwood and coniferous forests, scrub-shrub and meadows) within the Green River watershed for nesting, breeding and feeding (S. Laughlin, Atlas of Breeding Birds in Vermont, as cited in Green River Survey Course, 1999). Of these, approximately seventy-seven species are migratory, and twenty nine of these migratory species located in or near the Green River watershed use rivers and their adjacent shoreline brush as nesting habitat as opposed to open meadows, forested lands, etc. Although some of these birds can use other habitat types, all twenty-nine are known to be associated with a clean river or stream. Most of these eighty-one species occur in the more undeveloped sections of the Green River in Vermont, where the river has been classified by the National Park Service as an undeveloped river corridor.

Species that have been observed within the specific project area include various finches, swallows, and woodpecker species within riparian and upland areas; and great blue heron, common merganser, mallard duck, snowy egret associated with the wetlands. These birds have been specifically observed in the associated wetlands upstream from the Mill Street Dam discussed previously. In addition, the Connecticut River, which forms the eastern boundary of Greenfield provides habitat to numerous migratory and non-migratory avian species, which utilize the riparian corridor for migration, as well as various waterfowl species. These include the pied-billed grebe, sedge wren, black duck and possibly the least bittern (Watershed Rarity Ranks for Species of Special Emphasis, in the Silvio O. Conte National Wildlife Refuge, Turner's Falls MA).

C. Aquatic Environment

1. Hydrology

a. Surface water

The Green River flows approximately 30 miles from its headwaters in Marlboro Vermont (approximately 1870 feet above sea level) to its confluence with the Deerfield River in Greenfield, Massachusetts (approximately 118 feet above sea level), descending approximately 1800 feet along its course. The total watershed area is approximately 89.9 square miles. It is joined by more than 15 mapped tributaries, which drain the relatively steeply sloping hills through which it flows. Elevations of the surrounding hillsides range from approximately 2,000 feet near its headwaters, to approximately 1,200 feet as it flows through the northern sections of Massachusetts, toward Greenfield. Major tributaries in Vermont include Pond Brook, in Harrisville, and Roaring Brook; and in Massachusetts include Borden Brook, Thorne Brook, Harris Brook, Hibbard Brook, Stafford Brook, Browning Brook, Workman Brook, Punch Brook, Glen Brook, Hinsdale Brook, Allen Brook, Mill Brook, Arms Brook, and Cherry Rum Brook; moving from north to south along the river's course.

Mean annual discharge (as measured from the USGS Gage 01170100 located near Colrain, Massachusetts) for a period of 36 years has ranged from 58 CFS in 1980, to 134 CFS in 1973, with a mean for the 36-year period of 89.54 CFS. Daily Mean Flow is 178 cubic feet per second, (CFS) based upon 36 years of record. This gage measures 41.4 square miles of watershed within the Green River, which is less than half of its total watershed area of 89.9 square miles, so it is likely that total discharge into the Deerfield River is considerably higher from the additional drainage area downstream of the Colrain gage.

The major hydrological features of the Green River watershed consist primarily of the river and its numerous tributaries and associated wetlands. Most of the larger water bodies consist of the artificial impoundments created by dams on either the river itself or one of its tributaries. Impoundments exist behind all four dams in the study area, with surface areas ranging from approximately 2 acres behind the Water Supply Dam, to 4 acres at the Wiley & Russell Dam. Additional impoundments exist at the two remaining upstream dams. The Greenfield Reservoir is formed by a dam on Glen Brook, a tributary of the Green River in Greenfield. It is probably the largest water body in the Green River watershed outside of the Green River itself.

b. Groundwater

The principal aquifers in the Deerfield River basin are alluvial sand and gravel deposits that occur along the Deerfield River and its tributaries and in the Connecticut Valley lowlands near Greenfield and Deerfield. Water from wells in these areas is largely derived from rivers and streams by induced infiltration. These aquifers can usually yield several hundred gallons per minute to single wells. However, the lowland area of

Greenfield and Deerfield is also underlain by thick deposits of fine sand, silt, and clay that yields little water to wells.

Crystalline bedrock in the basin can supply about 5 gal/min of water to wells, and sedimentary rocks, which occur only in the southeastern part of the basin, can supply about 10 to 80 gal/min wells. In general, wells in both crystalline and sedimentary rocks yield more in valleys than those on slopes and hills. (USGS website Accessed 5/03/05 http://ma.water.usgs.gov/basins/deerfieldgw.htm).

2. Water Quality

The Green River has been divided into three segments for water quality classification by the Massachusetts Department of Environmental Protection (DEP), according the Massachusetts Surface Water Quality Standards (314 CMR 4.00). These segments include the 8.5 miles extending from the Vermont Massachusetts Border downstream to the Greenfield Water Supply Dam; the 4.6 miles extending from Greenfield Water Supply Dam, downstream to the Greenfield Swimming Pool Dam; and the 3.7 mile segment extending downstream from the Greenfield Swimming Pool to its confluence with the Deerfield River,(to include the Mill Street and Wiley Russell Dams and their impoundments).

All three of these segments, which comprise the total length of the Green River in Massachusetts, have been designated as Class B, Cold Water Fishery. These standards designate the most sensitive uses for which the surface waters of the Commonwealth shall be enhanced, maintained and protected; prescribe minimum water quality criteria required to sustain the designated uses; and include provisions for the prohibition of discharges (MA DEP 1996,). These regulations undergo public review every three years. The three classes assigned to inland surface water (*i.e.*, freshwater) are described below. It should be noted that these classifications represent a goal to which the water quality should attain, and do not necessarily indicate that the standards are being met.

Class A *– These waters are designated as a source of public water supply. To the extent compatible with this use they shall be an excellent habitat for fish, other aquatic life* and *wildlife,* and *suitable for primary* and *secondary contact recreation. These waters shall have excellent aesthetic value. These waters are designated for protection as Outstanding Resource Waters (ORW's) under 314 CMR 4.04(3).*

Class B *– These waters are designated as a habitat for fish, other aquatic life,* and *wildlife,* and *for primary* and *secondary contact recreation. Where designated they shall be suitable as a source of water supply with appropriate treatment. They shall be suitable for irrigation* and *other agricultural uses* and *for compatible industrial cooling* and *process uses. These waters shall have consistently good aesthetic value.*

Class C *– These waters are designated as a habitat for fish, other aquatic life* and *wildlife,* and *for secondary contact recreation. These waters shall be suitable for the*

irrigation of crops used for consumption after cooking and *for compatible industrial cooling* and *process uses. These waters shall have good aesthetic value.*

As noted above, all three segments of the Green River are further designated as a Coldwater Fishery. This is defined as waters in which the maximum mean monthly temperature generally does not exceed 68°F (20°C) and, when other ecological factors are favorable (such as habitat), is capable of supporting a year-round population of cold-water stenothermal aquatic life such as trout (salmonidae).

Generally, the two upstream segments along the Green River in Massachusetts meet Class B standards. Exceptions include the first segment, located between the Vermont Border and the Water Supply Dam in Colrain and Greenfield. This area was listed on the 1998 303(d) list, which lists specific locations and/or bodies of water that are impaired (DEP, 1996). The cause of the impairment is listed as elevated levels of metals and pathogens. The source of these is unknown, however there are two possible areas near or within this section of the river that could contribute to these elevated levels. These are an automobile junkyard located along the banks of the Green River in Guilford Vermont, and an historic and current area of chronic dumping along the eastern side of Green River Road in Colrain. Most of this material deposited in this location consists of household appliances, trash, construction debris, paint cans, and old furniture. The Town of Greenfield has addressed these problems by working with representatives of the Town of Guilford Vermont to request the property owner to remove the vehicles from the banks of the Green River in Vermont. The Town of Greenfield is also working with local property owners in Colrain in order to discourage access to some of the illegal dumping spots.

In the segment between the Water Supply Dam and the Town Swimming Pool Dam, elevated fecal coliform bacteria levels occurred in Allen Brook during wet weather sampling. This brook is a tributary that enters the Green River upstream from the Town Swimming Pool Dam. However, only one of the elevated bacteria levels occurred during the primary contact recreation season. It should be noted that the Town Swimming Area, which is sampled weekly during the summer recreation season, did not indicate levels high enough to require beach closure during 2001 and 2002.

The most downstream segment of the Green River, between the Town Swimming Pool Dam and the river's confluence with the Deerfield River, generally meets Class B Water Quality Criteria, however several tributaries were found to have elevated levels of fecal coliform bacteria during wet weather sampling. These include Cherry Rum, Arms, Maple and Wheeler brooks, which enter the Green River below the Town Swimming Pool Dam. Sources contributing to these elevated levels include leaky sewer pipes on Maple Brook, and cows on Arms Brook. Since the time of the sampling, both the cows, and the field adjacent to Arms Brook were sold. At Maple Brook, the Greenfield DPW was notified of the leaky sewer pipes, and is working to correct the problem. Sources of contamination on the other brooks were not identified, however optical brightener studies (an indicator of household detergents) did not indicate sewage and/or failing septic systems as the source (DEP, 2004). It should also be mentioned that this segment of the river includes the drainage from Greenfield Center which is the most urbanized area of the Green River watershed. In addition, trash and other debris were found along isolated

sections of the river during the sampling. Although this section of the river supports the primary and secondary contact recreational uses, they are identified with and "Alert" status due to the elevated levels of fecal coliform bacteria that have occurred there at various times during the season.

3. Riverine Processes

Sediment transported downstream in the Green River during normal and higher flow events settles out in the impoundments behind each of the dams along its course. The sandy soils that predominate in the section of the Green River extending from the Water Supply Dam downstream to its confluence appear to significantly contribute to the sediment noted in the impoundments and backwater areas of the River. With the exception of the Swimming Pool Dam, layers of extremely fine sediment have accumulated behind each of the dams in the lower section of the river to depths of several feet. The sediment in these impoundments covers the historical riverbed substrate, effectively eliminating the benthic habitat characteristic of the more free flowing un-impounded areas of the river. Much of the sediment in these impoundments may have originated from the progressive bank erosion, which occurs along sections of the river in this area (i.e. the downstream sections below the Water Supply Dam). Severe bank erosion is present in the Greenfield Meadows area between the Water Supply Dam and the Swimming Pool Dam, including areas in the vicinity of the Leyden Woods Apartments. These areas are characterized by collapsing banks, where large trees have been undermined and fallen into the river, directly exposing the bank soil to the water.

As with most rivers flowing through flood plains, the Green River downstream from the Water Supply Dam appears to be in a dynamic state of flux, continuously changing its course in areas that have not been stabilized by man made structures such as bridges, highways, erosion control structures and dams, and/or by natural geological features. Aerial photographs of the River as it flows through Greenfield show the historical patterns its former channel(s), as well as oxbows, which were created from former meanders that were cut off. In the section immediately upstream from the Mill Street impoundment, anecdotal reports indicate that as recently as fifty years ago, the main channel of the Green River was approximately fifty feet northwest of its current location (Peter Conway, 2001, Personal Communication) and at this time the continuing erosion in this area indicates that it is still changing (or attempting to change) its course.

In the un-impounded areas of the river, higher flow events (flushing flows) periodically scour deposited sediment and re-expose gravel and/or cobble substrate. This was specifically noted in a section of the River downstream from Wiley Russell Dam, in the area of the footbridge near the Green River School and Recreational Park. During a site visit in May of 2001, large amounts of sediment had accumulated in the middle of the River channel, covering a large section of the existing cobble substrate. However, in July of 2001, this sediment had been flushed from the riverbed, exposing clean cobble/gravel substrate. Apparently a significant flow event occurred between the two visits, which scoured the area carrying the deposited sediments further downstream.

The presence of dams along the river reduces these flushing flows, and creates large depositional areas behind them, which are not easily flushed.

4. Sediment Chemistry

In 2001, sediment samples were collected from nine locations along the river from its confluence with the Deerfield River, to just below the Water Supply Dam. Sampling locations are shown in Appendix B, and the sampling stations identified as AAK-001, the confluence of the Green and Deerfield Rivers; AAK-002, the Green River just below the Greenfield Wastewater Treatment Plant outfall; AAK-003, the Green River below Wiley Russell Dam; AAK-004, the Green River upstream of the Wiley Russell Dam in the impoundment; AAK-005, between the Wiley Russell and Mill Street Dams adjacent to the Berkshire Gas Company; AAK-006, below the Mill Street Dam; AAK-007, upstream from the Mill Street Dam impoundment; AAK-008, below the railroad bridge; AAK-009, below the Water Supply Dam. These samples were analyzed for grain size, Total Organic Carbon, metals, PCB's and Polynuclear Aromatic Hydrocarbons (PAHs). No PCB's were detected in any of the samples collected from all of the above sampling locations. However, elevated concentrations of PAH's were found at stations AAK-005, the area adjacent to and downstream from the Berkshire Gas Company, located between the Wiley Russell and Mill Street dams; AAK-008, located upstream from the Mill Street Dam below the railroad bridge at the Mohawk trail; and AAK-001 located at the confluence of the Green and Deerfield Rivers. The lowest total PAH concentrations were found at stations AAK-006, below Mill Street Dam, and AAK-009, below the Water Supply Dam, where out of a total of 27 PAH's screened for in the samples, 23 were in concentrations below detection limits. For stations AAK-005, AAK-008, and AAK-001, the compounds that were detected in the highest concentrations included Pyrene and Flouranthene. Pyrene was detected at 450 micrograms/kilogram (ug/Kg) and Flouranthene at 380 ug/Kg at station AAK-005, located in the Green River adjacent to and downstream from the Berkshire Gas Company. Concentrations of Benzo[a]anthracene, chrysene, and Benzo[a]pyrene were also elevated at this location.

Various criteria have been developed in order to determine levels of contaminants in sediments where biological effects can be expected to occur in benthic organisms. Among these are the Ontario Ministry of the Environment (OME) Sediment Quality Guidelines which were developed to protect aquatic life (Persaud, 1993). The OME guidelines were established as three levels of effect - the No Effect Level, Lowest Effect Level (LEL) and Severe Effect Level (SEL). The No Effect Level is that at which chemicals in the sediment do not affect fish or sediment-dwelling organisms. No transfer of chemicals through the food chain and no effects on water quality are expected at this level. The LEL is the level of a contaminant where no effect would be expected on the majority of sediment-dwelling organisms, and the sediment is considered clean to marginally polluted. The Severe Effects Levels (SEL) is applied to sediment containing concentrations of contaminants where a pronounced disturbance of the sediment-dwelling community can be expected. This is considered the concentration of a compound in the sediment that would be detrimental to the majority of benthic species, and the sediment

would be classified as heavily polluted and likely to affect the health of sediment dwelling organisms.

More recently, the Commonwealth of Massachusetts Department of Environmental Protection developed a set of Recommended Freshwater sediment Screening Values (DEP, 2002). These are consensus based threshold effect concentrations (TEC's) for 28 chemicals for use in screening freshwater sediment for risk to benthic organisms. They are based on data from a variety of sources including the OME guidelines noted above. These TECs for a given contaminant are defined as the concentrations below which harmful effects on sediment-dwelling organisms are not expected to occur, however, they are not necessarily protective of higher trophic level organisms exposed to bio-accumulating chemicals.

At station AAK-005 Flouranthene was found in the highest concentration compared to all of the stations (380 ug/Kg), although it was below the Commonwealth of Massachusetts TEC level of 423 ug/Kg. However, concentrations of Pyrene, Benzo[a]anthracene, chrysene, and Benzo[a]pyrene from this station were all above these TEC levels. In addition, concentrations of Pyrene from station AAK-008 (below the railroad bridge) and of Benz[a]anthracene from station AAK-001 (the confluence of the Green and Deerfield River) were above the TEC screening concentrations. These results are summarized in Table 1. Results from all of the stations are presented in Appendix B.

The concentrations of the contaminants that are above the TECs suggest that harmful effects can be expected in the benthic organisms exposed to them. Since the highest concentrations were found in the Wiley Russell impoundment, it may be necessary to remove or stabilize these sediments to prevent them from moving downstream in the event of a significant flow event and/or dam removal at Wiley Russell.

Table 1. Concentrations of selected Polynuclear Aromatic Hydrocarbons from the three most contaminated stations on the Green River, Greenfield Massachusetts, relative to the Massachusetts DEP Threshold Effect Concentrations (TEC) for benthic organisms.

Compound	AAK-001 Concentration (ug/Kg)	AAK-005 Concentration (ug/Kg)	AAK-008 Concentration (ug/Kg)	TEC (ug/Kg)
Flouranthene	210	380	260	**423**
Pyrene	190	450	210	**195**
Benz[a]anthracene	110	220	100	**108**
Chrysene	110	210	130	**166**
Benzo[a]pyrene	96	190	110	**150**

As noted previously, the sediment that was collected from the 9 stations described above was analyzed for 15 metals. These include silver (Ag), Arsenic (As), Barium (Ba),

Beryllium (Be), Cadmium (Cd), Chromium (Cr), Copper (Cu), Mercury, (Hg), Nickel (Ni), Lead (Pb), Antimony, (Sb), Selenium (Se), Titanium (Ti), Vanadium (V), and Zinc (Zn). Results of the analyses from all stations are presented in Appendix B. Of these 15 metals, consensus based TECs have been developed for eight - Arsenic, Cadmium, Chromium, Copper Lead, Mercury, Nickel, and Zinc. Generally, the concentrations of these metals are well below the TECs, with the exception of Chromium and Mercury. The mean Chromium concentrations calculated for all of the sampling stations noted above was 43.9 milligrams/kilogram (mg/Kg) which slightly exceeds the consensus based TEC of 43.4 mg/Kg. Individual chromium concentrations range from 35.9 mg/Kg measured at station AAK-007 (upstream from the Mill Street Dam), to 56.8 mg/Kg measured from station AAK-009, (the area immediately downstream from the Water Supply Dam).

Reasons for these elevated levels are not known, although when compared to other rivers where there is relatively little watershed development, chromium concentrations have been found within a similar range. Some examples of these include several New England U.S. Army Corps of Engineer flood control reservoirs which are considered to have relatively pristine sediments due to the minimal watershed development. They are Ball Mountain and Townshend Lakes in Vermont, Barre Falls Dam in Massachusetts, Hancock Brook Lake in Connecticut, and Otter Brook Lake in New Hampshire, where chromium concentrations in sediments have ranged from 2.6mg/Kg to 40 mg/kg (NAE, 1998; NED, 1993a, 1995, 1997b from NAE, 1999, French River Projects Priority Pollutant Scan). However as noted for the PAH results, the fact that these concentrations exceed the Massachusetts TECs suggests that biological effects to benthic organisms exposed to this sediments would be expected. These results are summarized in Table 2, and compared with the Massachusetts consensus based TECs. Results from all of these stations are presented in Appendix B.

Table 2. Chromium concentrations in sediments collected from all stations on the Green River in 2001, relative to Massachusetts DEP Threshold Effect Concentrations (TEC) for benthic organisms.

Station	Chromium (mg/Kg)	TEC (mg/Kg)
AAK-0001	38.8	43.4
AAK-0002	49.2	43.4
AAK-0003	45.7	43.4
AAK-0004	39.9	43.4
AAK-0005	39.9	43.4
AAK-0006	52.8	43.4
AAK-0007	35.9	43.4
AAK-0008	36.9	43.4
AAK-0009	56.8	43.4

Concentrations of Mercury (Hg) in sediment were below the detection levels at all sampling locations with the exception of station AAK-003 (just below the Wiley Russell

Dam) where it measured 0.239 mg/Kg. This concentration exceeds the Commonwealth of Massachusetts Consensus Based TEC level of 0.18 mg/Kg. It is not known why this location was the only one where the mercury was not only detected, but exceeded threshold effects concentrations, however it is possibly due to the metal tool and die manufacturing activities that have occurred there in the past. Concentrations of Mercury from all stations on the Green River are presented in Appendix B.

Grain size analyses are presented in Appendix B, and generally indicate the sediment at the sampling locations ranging from 78.08% medium sand, and 2.9% gravel in the impoundment behind the Wiley Russell Dam, to approximately 39% Gravel, 26.% coarse sand, and 34% medium sand at the station AAK-006, just below the Mill Street Dam. Generally coarser material (including sand) is less likely to accumulate organic contaminants than finer materials.

A macroinvertebrate assessment in the Green River was conducted in the fall of 2004. A total of six sampling sites were examined along the stretch of the river extending from its confluence with the Deerfield River, to upstream of the Water Supply Dam. Generally the study indicated that the macroinvertebrate communities at the sample sites are currently non-impacted relative to the regional reference location (i.e. the Cold River, a tributary of the Deerfield). It should be noted that the sampled locations for this study did not correspond directly with the areas of where the highest concentrations of PAH's, so it is possible that there may be local areas where the benthic community may be showing effects of the elevated concentrations of PAHs noted above. However, the fact that generally the river does not appear to be impacted indicates that the elevated levels noted at the specific locations above, are confined to those areas, and do not appear to be affecting the downstream communities.

D. Biological Resources

1. Wetlands/Aquatic Vegetation

Wetlands along the Green River are associated with the areas of the impoundments behind the dams, as well as with the flood plain as the river flows downstream from the Water Supply Dam through the Town of Greenfield. Major areas of scrub shrub wetland occur in the section of the river near Greenfield Meadows, in the vicinity of the Leyden Woods apartments near the confluence of Punch and Hinsdale Brooks. These wetlands are associated with several bends in the river and extend along the floodplain of the river, in what appears to be one of its former channels. Oxbows are also present in this location. Scrub shrub vegetation was present in this area, including willow and alder.

Another major wetland area is located behind the Mill Street Dam impoundment. These are significant because they are associated with the impoundment and could be affected by one of the dam removal alternatives noted above. These cover an area of approximately 10 acres, and are located primarily on the east side of the Green River, and

appear to be hydraulically connected to it particularly during times of high water. These wetlands consist of an oxbow, as well as a small pond, locally referred to as "The Donut," which is connected to the oxbow by three culverts. The pond appears to be hydraulically connected to the Green River (i.e. the Mill Street impoundment) by a narrow discharge channel that enters the impoundment approximately 0.25 miles upstream from the Mill Street Dam. If the Mill Street Dam were removed, the effect on the wetlands upstream of Mill Street, specifically the pond and two historic oxbow segments, could be partially mitigated by the placement of a control weir in the ditch that connects the pond to the Green River.

The emergent wetland vegetation noted in the oxbow included cinnamon fern (*Osmmunda cinnamomea*), tussock sedge (*Carex stricta*), and scrub-shrub along the edges included alder (*Alnus* sp.) and poplar (*Populus* sp.) A large stand of reed canary grass (*Phalaris arundinacea*) dominated the inside of the bow. In the connected pond, areas of aquatic bed species included yellow water lily (*Nuphar*)and water shield (*Brassica*). Small swales were located along the banks of the Mill Street impoundment that were vegetated by sedges and stands of cattail (*Typha*). Stands of staghorn sumac (*Rhus typhina*) were located along the upper bank areas upstream (outside of the wetland), and also along the upper wetland boundaries adjacent to the oxbow and pond. In the oxbow immediately adjacent to the Donut pond, the emergent vegetation along the edges was dominated by bur-reed (*Sparganuim sp*.). The forested area between the oxbow and the main impoundment had been highly modified, but consisted predominantly of white pine (*Pinus strobus*).

Additional areas of fringing wetland are located along the banks and edges of the riverbed, as well as along the margins of the impoundments (riverine) behind the four dams. These are confined primarily to areas within the banks, due to the steepness and elevation of the banks above the riverbed. Species noted along these banks included large amounts of the invasive Japanese knotweed (*Polygonum cuspidatum*) This species has become established along the Green and Deerfield Rivers, and large areas along the river have been vegetated by this single species. Although not specifically a wetland species, it can be found in areas along riverbanks, near the borders of wetland and upland areas.

2. Fisheries

As mentioned in the water quality section, the Green River as it flows through Massachusetts as been classified as a coldwater fishery by the Commonwealth of Massachusetts DEP. A listing of species that have been found in the river is presented in Table 3. The River is believed to have historically supported runs of anadromous river herring (alewives and blueback herring), shad, sea lamprey, and Atlantic salmon, as well as the catadromous American eel. With the construction of the first dams downstream on the Connecticut and Deerfield Rivers, as well as the four dams on the Green River, these fish were no longer able to access their upstream spawning areas (and/or rearing areas for catadromous species), and consequently those populations were eliminated and/or

reduced. In addition, the creation of impoundments upstream from these dams has locally changed these habitats from riverine to lacustrine, with resulting shifts in fish species composition. In the spring of 2005, seven Atlantic salmon reportedly reached the pools below the Wiley & Russell Dam, most likely returns from the fry stocking efforts upstream in past years.

The coldwater fish species currently inhabiting the Green River include brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*), which are seasonally stocked in various locations. In addition, largemouth bass (*Micropterus salmoides*) , smallmouth bass (*Micropterus dolomieui*). Bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*) pumpkinseed (*Lepomis gibbosus*), red breasted sunfish (*Lepomis auritus*), common shiner (*Luxilus cornutus*), and brown bullhead (*Ameiurus nebulosus*) can be found in the impoundments behind the dams and in backwaters (warmwater species). Atlantic salmon fry are stocked in tributaries including Hinsdale Brook, which joins the Green River upstream from the Swimming Pool Dam, and downstream from the Pumping Station dam. In addition, anadromous alewives, blueback herring, and American shad, are found in the Deerfield River and the lower sections of the Green River below the Wiley & Russell Dam, however they are unable to pass upstream of the Wiley & Russell Dam. Other riverine species include fallfish (*Semotilus corporalis*), white sucker (*Catastomas commersoni*), tessellated darter (*Etheostoma olmstedi*), slimy sculpin (*Cottus cognatus*), longnose dace (*Rhnichthys atratulus*), and blacknose dace (*Rhinichthys cataractae*). In addition, the state listed endangered Northern Redbelly Dace (*Phoxinus eos*) has been found in the study area. A listing of these species is presented in Appendix C.

Past fisheries sampling in the Green River has been conducted by various state and federal agencies. More recently, the U.S Army Corps of Engineers, the Commonwealth of Massachusetts Division of Fisheries and Wildlife, and the Commonwealth of Massachusetts Department of Environmental Protection Division of Watershed Management have conducted sampling of various sections of the river. A section of the river downstream from the foot bridge of the Green River Park was sampled for fish on August 20, 2001 by backpack electroshocking. A small section of the riffle area was sampled qualitatively in order to get a general idea of species composition in that location. Fish species that were collected included white sucker, smallmouth bass, longnose dace, blacknose dace, and two types of unidentified shiner species. These species are generally associated with riverine habitat. It should be noted that in this sampling, no trout or salmon species (salmonids) were collected from this area. A listing of the fish collected from this sampling is included in Table 4.

Table 4. List of fish collected from the Green River Downstream from the Green River Park footbridge, on August 20, 2001 by the U.S. Army Corps of Engineers.

Species (Common Name)	Species (Scientific Name)	Number Collected	Mean Length (Cm)	Mean Weight (Grams)
Blacknose dace	*Rhinichthys atratulus*	1	4.1	0.8
Longnose dace	*Rhinichthys cataractae*	1	7.4	4.2
Smallmouth bass	*Micropterus dolomieu*	2	6.95	5.5
Unidentified shiner I		1	9	5.9
Unidentified Shiner II		6	5.5	1.9
White Sucker	*Catostomous commersoni*	3	7.5	5

The Commonwealth of Massachusetts Division of Fisheries and Wildlife has sampled additional sections of the Green River and its tributaries for fish. Two reaches of the section of the Green River between the Vermont border and the Water Supply dam were sampled in August of 2000. The first reach was located just south of the Vermont border, and the second reach located in the Green River south of Hibbard Brook in Leyden. Only three individuals of three different species were collected from the first reach, and included, slimy sculpin (*Cottus cognatus*), brown trout (*Salmo trutta*), and longnose dace (*Rhinichthys cataractae*). From the second section, below Hibbard Brook, a total of only longnose and blacknose dace were collected. Although in both these reaches the species were representative of riverine conditions (with coldwater species being present in the first), there was concern about the relatively few specimens collected (DEP, 2000), which may warrant further investigation. However it may also be attributable to low sampling efficiency (Richards, 2003, as cited in DEP 2004).

Other areas that were sampled include Hinsdale Brook, a tributary of Punch Brook, located downstream from the Water Supply Dam, which joins Punch Brook, approximately 0.2 miles upstream from the its confluence with the Green River in the vicinity of Greenfield Meadows, and the Leyden woods apartments. Hinsdale Brook was sampled in 1996 by the Commonwealth of Massachusetts Division of Watershed Management. Fish species that were collected included (in order of abundance) Atlantic salmon, slimy sculpin, blacknose dace, brook trout and brown trout, longnose dace and golden shiner. Generally the fact that multiple age classes of Atlantic salmon and the presence of pollution intolerant species indicated good habitat and water quality conditions as well as stable flow regimes in this brook (MA DEP 1996 as cited in MA DEP 2004). The good coldwater fish habitat present in this stream would potentially become available for habitat by up-migrating Atlantic salmon adults (i.e. for spawning and/or nursery of young) if fish passage is provided at the three downstream dams (i.e. Swimming Pool, Mill Street, and Wiley & Russell).

3. Benthic Invertebrates

A benthic invertebrate study was conducted by the Deerfield Watershed Association in the fall of 2004 (Cole, 2004). The purpose of the study was to assess the condition of the

macroinvertebrate communities in the river above and below the town of Greenfield in order to identify river segments with impaired biological conditions, and to identify longitudinal (i.e. upstream-downstream) trends in macroinvertebrate community composition related to natural physico-chemical gradients or human disturbance. The study compared the benthic communities with a reference site, the Cold River, which is an undisturbed tributary of the Deerfield River in Deerfield. A total of six stations were sampled along the stretch of the Green River from its confluence, to the Vermont/Massachusetts border. The macroinvertebrates were analyzed using methods employed by the Commonwealth of Massachusetts Department of Environmental Assessment based upon the US EPA Rapid Bioassessment Protocols (RBPs) for wadeable streams and rivers. Generally the results indicated that the benthic community was non-impacted relative to the regional reference station on the Cold River, with all sampled communities being composed of pollution intolerant organisms, being well balanced and not heavily skewed towards filter feeding functional groups or dominance by a single taxon. However, there was a general trend in the distribution patterns of some of the individual taxa, with the more pollution tolerant forms being found in the lower reaches of the river (downstream from the Center of Greenfield). This was indicated by the abundance of oligochaetes and the absence of several intolerant mayflies, including *Rithrogena* and *Epeorus* (Cole, 2004). This is consistent with the water quality data discussed previously, that indicated that the Class B water quality standards in this location were not always met due to elevated coliform levels. Further information can be found in the report Green River Watershed 2004 Macroinvertebrate Assessment (Cole, 2004) which can be downloaded from the website, http://www.deerfieldriver.org/pdf/GreenRiverStudy_2004_Report.pdf .

It should be noted that during the fisheries sampling conducted by the U.S. Army Corps of Engineers in 2002, a cursory examination of the substrate in the section of the river downstream from the footbridge at Green River Park, indicated the presence of abundant caddisfly larvae (order Trichoptera) generally a pollution intolerant form along the bottom of the rocks. This is consistent with the detailed study noted above, which concluded that water the benthic communities in the sampled reach of the Green River, were not impacted.

E. Threatened and Endangered Species

Recent coordination with the U.S. Fish and Wildlife Service has indicated that there are no federally listed or proposed, threatened or endangered species under its jurisdiction are known to occur in the study area, with the exception of occasional transient bald eagles (*Haliaeetus leucocephalus*). Coordination with the National Marine Fisheries has also indicated that there are no threatened or endangered species expected to be present within that region of the Connecticut River Watershed. Although shortnose sturgeon occupy the more sections of the Connecticut River in the latitude of the Green River, they have not been documented in the Green River (see letters dated February 19, 2003 and February 11, 2003, Appendix A).

Coordination with the Commonwealth of Massachusetts Division of fisheries and Wildlife Natural Heritage and Endangered Species Program has indicated that the several

plant fish and reptile species listed by the state as endangered and/or Special Concern occur within the study area. The plant species include Barren Strawberry (*Waldsteinia fragariodes*), Black Maple (*Acer nigrum*), both considered to be species of Special Concern; the fish species is Northern Redbelly dace (*Phoxinus eos*), listed as Endangered; and reptile species, Wood Turtle (*Glyptemys insculpta*).

Barren Strawberry occurs in a diverse range of habitats, including a variety of forest types, wet thickets, clearings, dry sandy woods, barrens, slopes and rock outcrops. It has generally been found in rich wooded to semi-open banks in Massachusetts, as well as in rich mesic-shade forest on old floodplains with humus-rich soil. It has been associated with sugar maple, white ash, white pine, hickories, and ironwood, which often provide shade for it (Commonwealth of Massachusetts, 1994). The Natural Heritage and Endangered Species has indicated that Priority Habitat for this species exists along the Green River in the study area.

Black Maple occurs in rich moist soil in association with alluvial hardwood forests, and is highly tolerant of shade. In Massachusetts, all of the sites where it has been found have moderately moist soils (mesic) with either shade or filtered light conditions. Specific habitat types in Massachusetts where this species has been found include floodplain forests, forested rocky slopes, and outcrops, and rich wood communities. In Massachusetts it is commonly found in growing with sugar maple, (*Acer saccharum*), basswood (*Tilia Americana*), white and green ash (*Fraxinus americana and F. pennsylvanica*), sycamore, *(Platanus occidentalis*), American elm (*Ulmus americana*), bitternut hickory (*Carya cordiformis*), hop hornbeam (*Ostrya virginiana*), and various species of birch, (*Betula*), leatherwood (*Dirca palustris*), and wild leek (*Allium tricoccum*).

The Wood Turtle inhabits riparian areas, and is considered the most terrestrial of the North American turtles utilizing both aquatic and terrestrial habitats during its lifetime (Commonwealth of Massachusetts, 1994). It can feed in both of these habitats, and is considered semi-aquatic, although the terrestrial habitat occupied by this species is generally within a few hundred meters (approximately 1000 feet) from a stream or river system (Commonwealth of Massachusetts, 1994). It utilizes aquatic habitat for over wintering, where it burrows into either a muddy stream bottom, or muddy bank for hibernation. In southern Coastal Massachusetts, it can become active in March (and presumed at approximately the same time in southern New Hampshire) when it leaves its burrow and begins its terrestrial activity, moving up onto the riverbank to bask in the sun, and eventually during the spring and summer occupying meadows and upland forests. By late summer it returns to the streams and/or rivers to mate and over-winter. It is omnivorous and in the terrestrial environment can feed on insects, carrion, worms, blackberries, dandelions, grasses sedges, mushrooms (Wisconsin Department of Natural Resources, 2003), and in the aquatic environment on fish, tadpoles, mollusks and filamentous algae. Their range is generally limited to within a few hundred meters (approximately 1000 feet) of the river, and moving linearly along the riparian corridor a distance of approximately a mile, although some individuals have been known to move greater distances using the riparian corridors for dispersal (Harding, 2002). Wood turtles are often found in riparian areas characterized by

sandy bottomed streams with slower moving water and heavily vegetated stream banks (MADFW, 1994). They are generally attracted to tangles of vegetation.

Northern Redbelly Dace are generally found in quiet, cool, boggy stream and lakes, and in Massachusetts they are found in clear streams and spring-fed seepage pools. This species has been observed in the Green River in the vicinity of the Leyden Woods apartments (Alex Haro, 2005, Personal Communication), where there are areas of the river that contain groundwater seeps, and areas of upwelling through the gravel bars.

As noted all of the above endangered and species of special concern have been found in priority habitats that are found along the Green River in the vicinity of Greenfield MA.

F. Essential Fish Habitat

The 1996 amendments to the Magnuson-Stevens Fishery Conservation Management Act strengthen the ability of the National Marine Fisheries Service and the New England Fishery Management Council to protect and conserve the habitat of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. This habitat is termed "essential fish habitat", and is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Connecticut River (into which the Green River eventually flows) has been designated Essential Fish Habitat for Atlantic salmon Juveniles and Adults for the freshwater areas as well as the mixing and salinitiy zones (in the estuary). In addition, the Connecticut River estuary has been designated as essential fish habitat (EFH) for at least one or more life stage(s) of several marine, estuarine, and anadromous finfish species. For the 10' x10' square of latitude and longitude which extends from the Connecticut River toward Saltworks Bay, Money Point and Long Rock, the managed EFH species listed are Atlantic salmon, pollock, red hake, windowpane flounder, Atlantic sea herring, bluefish, king mackerel, Spanish mackerel, cobia and sand tiger shark. A listing of these species and their affected life stages is located in Appendix D.

On the Connecticut River itself the EFH designation extends only as far as Haddam Connecticut for all designated species except Atlantic salmon. The New England Fisheries Management Council Essential Fisheries Habitat Amendment (October 7, 1998) identifies the Connecticut River upstream from Haddam as EFH, using the criteria for designation as; all rivers where Atlantic salmon are currently present, for any of the life stages of eggs and larvae, juveniles, and adults. As noted previously, the Connecticut River historically supported Atlantic salmon, and has been the subject of ongoing Atlantic salmon restoration efforts, which have resulted in returns of pre-spawning adults to areas upstream of the Holyoke Dam, potentially, including the Deerfield and Green Rivers. In addition, the Green River and its tributaries upstream from the Deerfield River has been stocked with Atlantic salmon fry, which could return there to spawn once fish passage is provided at the Wiley & Russell, Mill Street, Swimming Pool, and Water Supply Dams.

In addition to the EFH designation of the Connecticut River and its estuary for Atlantic salmon and other species listed above, the River supports an existing river herring run (alewives and blueback herring) as well as shad. With the proposed fish passage along the Green River, an additional 21 miles of river are expected to become accessible to these fish with its potential spawning habitat. Although river herring and shad are not designated as EFH species, they are prey for many EFH and/or federally managed species (i.e. bluefish, Atlantic salmon), which occur in both the Connecticut River estuary as well as Long Island Sound. Therefore by restoring anadromous fish passage to areas of the Green River upstream from the four dams, EFH for both Atlantic salmon as well as forage for some of the estuarine and marine species inhabiting the marine and estuarine environments may be positively affected. Further discussion of these effects can be found in the EFH assessment in the Environmental Consequences section of this EA (Section 6.3.4).

G. Historical and Archaeological Resources

1. Prehistoric Resources

There are over 80 identified prehistoric sites in the vicinity of Greenfield. These sites are located on the Connecticut, Deerfield, and Green Rivers. These sites date from the earliest period of prehistory (the PaleoIndian, 12,500 to 10,000 Before Present [B.P.]) to European settlement (Contact Period, 450 to 300 B.P.). These sites have been documented through avocational collecting, academic research, and a number of cultural resource management surveys completed for various construction projects.

PaleoIndian occupation in the Connecticut River Valley has been documented by the recovery of fluted projectile points in Gill, Deerfield, Montague, Sunderland, and Hadley. A single, fluted point was reportedly found in Greenfield. PaleoIndians settled in the area after the retreat of the Wisconsin glacier sometime between 12,500 and 10,000 years ago. Their subsistence strategy is characterized as gathering and hunting large animals such as mastodon, mammoth, caribou, and elk.

Evidence of Early Archaic (10,000 to 7,500 B.P.) period sites in this area is rare. Single, bifurcate base projectile points, the most diagnostic stone tool artifact from this period, are recorded for locations in Deerfield and Gill. The scarcity of documented PaleoIndian and Early Archaic sites are most likely due to changes in the landscape causing site destruction or burial under alluvium deposits. This area may also have been near the northern limit of habitable lands for human adaptations during these periods. River valley lowlands may have been the location for Early Archaic sites.

Middle Archaic Period (7,500 to 5,000 B.P.) sites are more numerous than earlier period sites. Middle Archaic sites are located in both lowland and upland sections adjacent to large rivers and small streams. Concentrations of prehistoric sites near falls, rapids, and at confluences of smaller tributaries with larger rivers would be expected for this period. Several Middle Archaic sites have been identified in Gill and Deerfield, with

documented anadromous fish remains indicating that these species were an important part of this period's diet.

Late Archaic Period (5,000 to 3,000 B.P.) sites in New England are much more common than in previous periods. Modern environmental conditions were present and the wild resources available were the same as those observed by the early European settlers. A broad spectrum of resources was exploited during this period. Sites can be found in many diverse settings, including near falls, on the banks of large and small rivers and streams, on floodplain terraces, on lake bottom soils, and in upland locations. Known Late Archaic sites have been identified in Gill, Florida, and Deerfield.

The Woodland Period in the Connecticut River valley is the most documented archaeologically than any other period. Occupation dating to the Woodland Period is typically identified by the presence of prehistoric ceramics. Woodland settlement focused on lake bottom and alluvial soils of the river valley lowlands. Excavated Woodland Period sites in the Greenfield area exhibit a wide range of sizes, contain diverse subsistence-related activities, and occupy a variety of habitats.

Sites dating to the Early and Middle Woodland Period (3,000 to 1,000 B.P.) in the area are predominantly found on floodplain locations of the river drainages, however small, upland sites have also been reported. Sites have been documented in Gill, Belchertown, and Montague. During the Late Woodland and Contact Periods (1,000 to 300 B.P.), the general subsistence patterns during the Archaic and earlier Woodland periods most likely remained in place in the Connecticut River drainage. Other parts of New England have documented that these periods are marked by the introduction of horticulture and a shift in settlement to nucleated villages. This has not been noted in the Connecticut River Valley for the Woodland period, however evidence for an extensive exchange network has been found at sites in Holyoke, South Hadley, Turner Falls, Wendell Depot, and Gill. At Contact Period sites in Northfield and Deerfield, large storage pits have been documented, indicating a surplus of crops, so a shift to horticulture took place.

Information collected from sites in the vicinity of Greenfield suggests that Native American groups inhabited the area continuously from the Middle Archaic to the Contact Periods. The river systems served as a transportation corridor for the area's earliest inhabitants. Environmental conditions along the Green River would be conducive to prehistoric settlement. Prehistoric sites could be small, single occupation seasonal campsites, or larger (Late Archaic and Woodland) multi-component settlements.

2. Historic Resources

During the Contact and Plantation Period (1500 to 1675 A.D.) the confluence of the Deerfield and Connecticut Rivers formed one of several core areas for native settlement. Information on Contact Period sites is limited in the Connecticut River valley to three known sites in Gill, Hadley, and Palmer, and two probable sites in Westfield. Early historic accounts describe the Pocumtucks as living in sedentary, agricultural

villages, located on alluvial plains. These villages were made up of individual families, each controlling adjoining agricultural fields. Smaller settlements were probably located along the tributaries or on smaller lakes and ponds. Earliest interactions with Europeans were focused on trade, not settlement. The establishment of permanent trading posts in the Connecticut River valley led to an increase in intertribal warfare and shifting alliances as the tribes competed for the fur trade. In addition, epidemic diseases brought to the area by Europeans resulted in a major de-population of native settlements. By the end of the seventeenth century, most Native American settlement had shifted from dispersed hamlets to colonial villages.

Anglo-Indian warfare, which climaxed with King Philip's War (1675 to 1676), continued sporadically during the Colonial Period (1675 to 1775 A.D.), until the 1760s. Economic productivity in the Connecticut River valley was hindered by the unsettled tensions between the two groups. The economy during this period was dominated by agriculture, with crops cultivated along the river floodplain, and the uplands utilized for grazing livestock.

Greenfield prospered during the Federal Period (1775 to 1830 A.D.) with the establishment of Franklin County. Greenfield became a shire town. The South Hadley Canal was completed in 1795, and the district of Cheapside in Greenfield became the head of navigation for the Connecticut River, and an important trading center. During this period, Greenfield had a small, industrial area, which included a gristmill, a cotton factory, nail factory, cooper shop, potash works, tannery, and slaughterhouse. The population of Greenfield by the end of this period was 1,540.

The opening of the Troy and Greenfield Railroad in 1867 led to increased industrialization and commercialism during the Early Industrial Period (1830 to 1870 A.D.). Greenfield's manufacturing economy was dominated by the Green River Works of the John Russell Manufacturing Company. Other manufactories included a woolen mill on the Fall River, the Greenfield Tool Company, and a growing industry around the production of baby carriages.

During the Late Industrial Period (1870 to 1915 A.D.), Greenfield held a prominent place in the tap and die industry. This would continue well into the twentieth century. The cutlery industry also continued to prosper. The agricultural economy was also important with Franklin County towns becoming leading producers of beef and pork.

Greenfield's industry and population continued to grow during the Modern Period (1915 to present) until around 1940. Greenfield continues to have the largest population of any community in Franklin County, with a population of 18,000.

Solon W. Wiley and Charles P. Russell bought the J. Russell & Co. Green River Works in 1872. In 1912, four companies consolidated as Greenfield Tap and Die, and the Meridian Street, home of earlier industrial activities, became the focus of the local tap and die industry until the company closed in 1992. Greenfield became world-renowned

as the home of a precision machine tool manufacturer that was the major, local employer for much of the twentieth century.

The Wiley & Russell Dam, proposed for removal, is part of the Greenfield Tap and Die Plant No. 1 district, which was determined eligible for the National Register of Historic Places (NR) in 1996. However, the Greenfield Tap and Die Plant complex has been demolished, therefore, the continued eligibility of the Wiley & Russell Dam is questionable, since it was a contributing element of the district, not individually eligible for the NR. In 1987, the adjacent Meridian Street Bridge, over the Green River, was determined individually eligible for the NR. Based on research at the Massachusetts State Historic Preservation Office (MA SHPO), there is no information on any other historic resources adjacent to the Mill Street, Swimming Pool, or Pumping Station dams. There are no NR listed or eligible historic districts surrounding these dams. This research also assisted in determining that the other three dams are not 50 years old, and are not significant for method of construction or engineering. The covered bridge, located just upstream of the Pumping Station dam was constructed in 1972 in a classic Howe truss design, but is not yet 50 years old, so is not NR eligible. This determination was noted in the MA SHPO files, which also noted that the bridge should be re-evaluated once it reaches 50 years of age.

H. Cultural and Economic Resources

The Town of Greenfield is a residential community of approximately 20,000 people, located at the cross roads of Interstate 91, Route 2 (the Mohawk Trail) in Western Massachusetts, 98 miles from Boston. The unique location of the Town in the vicinity of the confluence of the Green, Deerfield and Connecticut Rivers, made it desirable for numerous industries dependent upon its abundant sources of water-power. Various industries existed in the area, which were influential in the economy of the region. These included metal working and manufacturing, with one of the primary manufacturing companies being the Greenfield Tap and Die Company However, in approximately the 1940's, demand for its products diminished leading to its eventual closure. In addition, cutlery was and still is manufactured in the town. Today the Greenfield economy consists of a mixture of industry, service, business, agriculture, transportation and education.

Numerous cultural and recreational opportunities exist in the town, which include, theaters, drama groups, local newspapers, restaurants, radio stations, library, YMCA, churches, golf courses, Farmers Market, a covered bridge, historic walking district, skiing and skating areas, museum, hospital, motels, post office, senior center, internationally famous private schools, court house and professional services. In addition, the Pioneeer Valley Symphony Orchestra is located in the town. Poet Seat Tower, a tower built on the ridge overlooking the Connecticut River, provides a view of the Greenfield Community College Campus as well as the surrounding town with its topographical and geographical features, which includes the Green, Connecticut and Deerfield Rivers.

(Narrative supplied by community) (http://www.mass.gov/dhcd/profile/113.pdf) website accessed 7/27/05).

I. Environmental Justice

Executive Order 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" requires federal agencies to examine proposed actions to determine whether they will have disproportionately high and adverse human health or environmental effects on minority or low income populations. The Commonwealth of Massachusetts Executive Office of Environmental Affairs defines Environmental Justice populations as those meeting any of the following criteria: 1) having a median household income that is at or below 65% of the statewide median income; 2) 25% or more of the residents are classified as minority; 3) 25% or more of the residents are foreign-born; or 4) 25% or more of the residents lack English language proficiency. A map of environmental justice areas published in 2002 by the above office, indicates that an Environmental Justice population (meeting one or more of the above criteria) are near the downtown section of the town of Greenfield Massachusetts (D. Marrier, 10/01/2002, MASS GIS, http://maps.massgis.state.ma.us/ej/ej.pdf), in the vicinity of the proposed project.

The four dams along the Green River are owned by the city of Greenfield. The two lower dams are abutted by residential property including private dwellings on both sides of the river. The population section meeting the criteria on the map is located in the general area of the downtown section in the vicinity of the Wiley & Russell and Mill Street Dams, however the Swimming Pool and Water Supply dams are located outside the general boundaries of the Environmental Justice Populations. The purpose of the project is to restore habitat by providing fish passage to the upper areas of the Green River beyond Greenfield. This is expected to benefit all segments of the population, including those meeting the criteria for Environmental Justice Populations.

J. Protection of Children

Executive Order 13045 "Protection of Children from Environmental Health Risks and Safety Risks" sees to protect children from disproportionately incurring environmental health risks or safety risks that might arise as a result of Army policies, programs, activities and standards. Environmental health risks and safety risks include risks to health and safety attributable to products or substances that a child is likely to come in contact with or ingest.

The proposed project involves the removal of the two most downstream dam, and provision of fish passage at the two upstream dams along the Green River. Several schools serve the town of Greenfield, and are located within the general vicinity of the Green River. These include the North Parish School, located on Place Terrace near the Swimming Pool Dam, the Four Corners School and The Federal Street School, both

located on Federal Street near the downtown section, the Newton School, located on Shelbourne Road, upstream from the Mill Street Dam, and the Green River School, located on Meridian Street, downstream from the Wiley Russell Dam. Although these schools and playgrounds do not directly abut the actual project footprint, they are in the vicinity of the Green River as well as the Swimming Pool, Mill Street and Wiley Russell Dams. The proximity of these schools to the proposed project area and the possibility of any effects occurring as a result of the project will be discussed in the Environmental Consequences section of this EA.

K. Air Quality

Ambient air quality is protected by Federal and state regulations. The U.S. Environmental Protection Agency (EPA) has developed National Ambient Air Quality Standards (NAAQS) for certain air pollutants, with the NAAQS setting concentration limits that determine the attainment status for each criteria pollutant. The six criteria air pollutants are ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead.

The entire State of Massachusetts, including Franklin County, is designated as a non-attainment area for ozone. Effective June 15, 2004 all of Western Massachusetts are designated by the EPA as moderate non-attainment areas for the 8-hour ozone standard, including Greenfield, Franklin County where the project is located (U.S. Environmental Protection Agency, 2004b).

VIII. Environmental Consequences

A. General

The proposed installation of fish passage at the Wiley Russell, Mill Street, Swimming Pool and Water Supply Dams on the Green River in Greenfield Massachusetts, is not expected to have any long-term adverse effects on the existing environment of the Green River. It will provide fish passage to sections of the river upstream from the four dams and restore the historical riverine habitat in the downstream section between its confluence with the Deerfield River and the Water supply dam. The provision of fish passage on the Green River is expected to have an overall positive effect on the river ecology, as well as the town of Greenfield. The passage of anadromous fish beyond the dam will provide an additional recreational benefit to the town of Greenfield, (*i.e.,* observation of fish migration), which already has several large parks and recreational areas.

B. Terrestrial Environment

1. Topography

The removal of the Wiley & Russell and Mill Street Dams, and the construction of fish ladders at the Swimming Pool and Water Supply Dams, on the Green River are not expected to have any significant effects on the topography in the vicinity of the project. The project will involve some alteration of the stream banks in the areas of the two lower dams, (planned for removal), and in the upstream areas, some minor excavation in of the existing streambed downstream from the dams. However, this will not significantly alter the overall bank and/or river configurations in these areas. Most of the grade and bank will be untouched, and whatever changes are made will not have any significant adverse effects to the overall stream/river morphology. No blasting of bedrock features in the vicinity of the four dams is anticipated.

2. Geology and Soils

The proposed project is not expected to have any significant adverse effects on the existing geology of the site. The Wiley Russell and Mill Street Dams are constructed on bedrock ledge which forms the stream-bed downstream from the dam. Removal of these dams will re-expose this rock allowing it either to scour or become modified and covered with gravel according to the localized fluvial characteristics at each dam. At the Swimming Pool and Water Supply dams, small sections of the stream bank may be excavated in order to create the proper discharge elevation depths for the fish ladders, however, only a small amount of topsoil and area of the riverbed will be removed. Generally short-term effects from all the construction activities will be potential erosion and runoff of loosened excavated material into the Green River; however, this impact will be minimized by the placement of silt curtains and the use of other erosion control features. Upon completion of construction activities, all excavated areas, including the riparian edges of the areas where

the dams were removed as well as those where fish ladders have been constructed, will be stabilized and re-vegetated.

2.a Prime Farmland Soils

The FPPA applies to farmland with soil types as prime, unique, or of statewide or local importance, but not to farmland already in or committed to urban development or water storage. As noted, soils of local farmland importance exist on the site, and a "Farmland Conversion Impact Rating Form" will be completed in coordination with the Franklin County Conservation District and the Greenfield Office of the U.S. Department of Agriculture (USDA) if determined to be necessary. Generally, the amount of impact is considered not significant, but will be documented in compliance with the FPPA. A copy of the completed EA will be sent to the Department of Agriculture agencies. Minimal impacts if any are expected to occur with this project. The proposed work will be done along the river bank with minimal disturbance to the banks themselves. Dam removal will result in an overall increase of riparian zone due to the loss of the impoundments, and fish ladder construction will involve work along the existing dam structures.

3. Vegetation

The proposed project of the removal of the Wiley & Russell and Mill Street Dams, and the construction of fish ladders at the Swimming Pool and Water Supply Dams, is not expected to have any significant long-term negative effect on the existing vegetation in the vicinities of the project area. Riparian areas in the immediate vicinities of each dam will be temporarily affected by the construction equipment and associated activities, however upon completion of the project these areas will be restored and replanted with native vegetation. The removal of the Wiley & Russell Dam will eliminate the impoundments behind them exposing the historic banks of the Green River channel. These will become re-vegetated with native vegetation and will provide an increased riparian zone in this section of the river. In addition, there is expected to be some unavoidable drainage of the wetlands in the oxbow area upstream from the Mill Street Dam due to the impoundment loss, with the result that the existing wetland plant species will be replaced by upland species (further discussion of this can be found in the Wetlands section and the Incremental Analysis section of this Environmental Assessment).

At the two upstream dams, any vegetated areas that had been disturbed by the construction activities will be restored at the completion of the project, including any that may have occurred by the construction of the access road at the Water Supply Dam.

4. Wildlife

a. Mammals

The proposed project is generally not expected to have any long-term negative effects on terrestrial wildlife inhabiting the riparian areas of the Green River. The actual construction footprints (for both dam removal and fish ladder construction) will be limited to the areas immediately abutting each of the dams. These areas have been previously disturbed, and in the case of the Wiley & Russell and Mill Street Dams, (proposed for removal), are in urban settings adjacent to paved parking areas, roadways, and concrete bridges which are habitat impediments. Temporary construction access structures and roadways (as described for the Water Supply Dam) are planned to traverse the previously disturbed sections and/or existing components of the dams as much as possible in order to minimize any habitat disturbances. Most terrestrial wildlife species that may inhabit the immediate project footprint areas are expected to temporarily relocate. Any impacts that may occur will be temporary, and of short duration, lasting only until the project is completed.

The passage of migratory fish beyond the four Dams into the upper sections of the Green River is expected to have an overall positive effect upon the wildlife population in these areas. Both the upstream migration of pre-spawning adult alewives and shad, as well as the downstream migration of the juveniles, will provide beneficial forage to resident wildlife species, to include birds, as well as other predatory terrestrial wildlife. Many avian species including, herons, loons, and raptor species are pisciverous, as well as terrestrial mammals such as river otter and to a lesser extent raccoons, and black bear, all of which have previously been found in the areas of the Green River watershed.

b. Avian Species

The proposed project is not expected to have any long-term negative effects on avian species inhabiting the riparian areas of the Green River, with the exception of the possible displacement of those wetland/waterfowl species that are associated with the Mill Street Dam impoundment. As discussed above, the construction footprints for the activities proposed at each location are expected to have minimal habitat impact affecting relatively small areas most of which have been previously disturbed. These effects will also be short term and temporary. However, at Mill Street, the removal of the dam will cause the impoundment and associated wetlands and “Donut Pond” to drain, which would eliminate the aquatic bird habitat in that location. As noted, water birds observed in that location included great blue heron, snowy egret, mallard duck and common merganser. These species would be forced to relocate to other nearby wetlands along the Green River or its vicinity in the Connecticut River corridor. Additional habitat that could be used by these bird species is located approximately 0.5 miles upstream from the Swimming Pool dam near a bend in the river in an area of scrub shrub wetland. Another area of wetland habitat is located in the Green River upstream from the Leyden Woods apartments near the confluence of Punch and Hinsdale Brooks.

The habitat behind the Mill Street Dam will be replaced by upland, and with it associated upland avian species. It should also be reiterated that the restoration of anadromous fish to the Green River upstream from the Wiley & Russell Dam is expected

to benefit the avian population, by providing additional forage to those pisciverous species which include, herons, loons and raptors, all of which have been observed in the vicinities of the Green and Connecticut River corridors.

C. Aquatic Environment

1. Hydrology

a. Surface Water

The proposed fish passage project is not expected to have any long-term negative effects on the overall hydrology of the Green River, however it will alter the local hydrology at the Wiley Russell and Mill Street Dams by the removal of their respective impoundments and restoration of historic river channel. The dam removal at Wiley & Russell Dam will cause the impoundment to drain with the loss of approximately 2.24 acres of water surface, and the dam removal at Mill Street would eliminate approximately 3.74 acres of open water habitat. These areas would be restored to free flowing riverine habitat, with the elimination of the backwatering caused by the dam structures. This would increase the frequency and intensity of flushing flows during storm events in the section of the Green River between the Mill Street Dam and its confluence with the Deerfield River. This will benefit the river by restoring a more natural flow regime which will helps to maintain sediment transport maintaining benthic habitat suitable for riverine fish species, having an overall positive effect on the hydrology of the Green River.

The construction of the two fish ladders at the Town Swimming Pool and Water Supply Dam is not expected to have any long-term negative effects to the existing flows in the upstream section of the Green River. The fish ladders will be notched into the existing spillways, and flow will be diverted into each of them during the anadromous fish migration season (spring to early summer). There will be no alteration or regulation in the amount of water retained by each of the dams, and therefore no flow changes will occur which could negatively affect downstream aquatic life.

b. Groundwater

The loss of the impoundments behind the Wiley Russell and Mill Street Dams may influence the hydrology of the surrounding riparian areas by locally lowering the groundwater levels. At Wiley Russell, the existing bank is steeply sided with minimal fringing wetlands, and therefore the effects of a lower groundwater level will be limited to the bank areas within the defined channel. However at Mill Street, the hydrology of the adjacent wetlands upstream from the impoundment would be affected by the lowering of the groundwater level to approximately 3 feet below the level of the Donut Pond. This would modify approximately 15 acres of mixed wetlands and uplands, by reducing the total amount of wetlands, as well as potentially reducing areas of standing water.

Therefore, the removal of the Mill Street impoundment may have a negative effect upon the associated wetlands upstream, with the potential loss of the Donut Pond as well as the wetlands in the oxbow. Although there is the potential that the existing springs which emerge from the base of the adjacent hillside will help to support these wetlands (in the absence of the river level), for the purpose of this study, it will be

assumed that these wetlands will be significantly reduced, with a resulting impacts to associated resources. In addition, the removal of the Mill Street Dam will reduce the frequency of flooding in the oxbow area, since the flow impediments will be eliminated. Although there may be negative effects to these wetlands, it should be realized that the hydraulic effect of the impoundment on these wetlands is artificial in that it did not historically influence them, but occurs as a result of the Mill Street Dam being in place, and with its removal a more historical habitat and riparian zone will be restored (See Incremental Analysis for further discussion).

2. Water Quality

The proposed restoration project consisting of the removal of Wiley & Russell and Mill Street Dams, as well as the construction of fish ladders at the Swimming Pool and Water Supply Dams, is not expected to have any significant long-term adverse effects on the water quality of the Green River downstream or upstream. There will be short-term increases in turbidity at each of the four dams during construction operations, however these will be minimized by the use of silt curtains and other erosion control structures and will be only for the duration of the construction. After dam removal at Wiley Russell and Mill Street, the sediment behind these dams will be washed downstream. This would create temporary increases in turbidity, which could affect water quality and fill in benthic habitat. However this is expected to be temporary, and scouring will occur as the river flows through these previously impounded areas, and continues its downstream flow. As noted, the increased intensity and frequency of higher flows (flushing flows) due to the elimination of these impoundments is expected to remove sediment that was washed out of the dams to downstream areas. With the exception of Wiley & Russell, the sediments behind the impoundments have been found to be clean, with any detected contaminant levels being below the concentrations where adverse affects to aquatic life would be expected. In the area behind the Wiley & Russell Dam, the sediments that had higher levels of contaminants would need to be removed or capped in order to prevent the spread of contaminants to downstream areas, prior to dam removal. It should be noted that work to clean up these sediments is ongoing.

At the Water Supply Dam, temporary increases in turbidity may occur from the construction of the temporary access road across the bottom of the spillway. This will be constructed during the low flow season and using erosion control structures (i.e. coffer dams) in order to minimize associated water quality impacts. In addition, the placement of the road will temporarily cover approximately 0.2 acres of benthic habitat at the base of the dam. The road will be removed at the completion of the project, and the benthic habitat restored to its former condition. The organisms are expected to re-colonize from the adjacent substrate within several seasons. Prior to construction, a water quality certificate will be obtained from the Commonwealth of Massachusetts, pursuant to Section 401 of the clean Water Act.

The removal of the two downstream dams is expected to have a long term positive effect on the water quality of the Green River in the section downstream from them, by the

removal of their impoundments. Generally impoundments can cause negative effects to water quality in coldwater rivers, by slowing the water and allowing it to warm, with subsequent reductions in dissolved oxygen concentrations resulting from the reduced aeration and the increased temperature (decreased holding capacity of the water). In addition, depending on the depth and flows through these impoundments, thermal stratification of the water column can develop during the summer months, with the deeper layers becoming anoxic precluding the survival of aquatic organisms. The elimination of these impoundments will restore faster flows with higher aeration, and reduce solar warming and potential thermal stratification. The increased flows in the formerly impounded areas will improve aeration, and reduce warming; helping to maintain suitable coldwater fish habitat.

3. Riverine Processes

The construction of fish ladders at both the Swimming Pool and Water Supply Dams are not expected to have any long-term negative impacts on sediment transport and/or sediment deposition in the areas downstream or upstream from them. However, as discussed in the Water Quality Section of this EA, the proposed removal of both the Wiley & Russell and Mill Street dams will wash the accumulated sediments from their impoundments downstream, to quieter depositional areas along the course of the Green, Deerfield and Connecticut Rivers. This may have temporary negative effects to the benthic habitat, however this sediment transport will stabilize overtime as the river reaches equilibrium between flow, sediment size, and gradient. The long-term effects will be the restoration of the historic benthic habitat in the former impoundments with the re-exposure of the historical gravel/cobble substrate.

4. Sediment Chemistry

As noted, sediment collected from one of the locations in the Wiley Russell impoundment was found to contain levels of Pyrene, Benz[a]anthracene, Chrysene and Benzo[a]pyrene that were above the Commonwealth of Massachusetts Threshold Effects levels for benthic organisms. These contaminated sediments will be either immobilized or removed from the impoundment prior to dam removal in order to prevent the spread of contaminants to downstream areas of the river. Other locations where elevated levels of contaminants were found (discussed in C.4 of this EA) are within the existing river channel and are not expected to move from the flow changes associated with dam removal and resulting scouring of the impoundment(s).

D. Biological Resources

1. Aquatic Vegetation/Wetlands

As noted, the removal of both the Wiley & Russell and Mill Street Dam will cause the impoundments to drain, with resulting effects to the associated wetland vegetation. The minimal fringing wetland vegetation along the banks at Wiley Russell will revert to more upland species, however much of the vegetation types will be unchanged, due to the existing steep sided banks which descend into the channel. At the Mill Street Dam, the wetland vegetation associated with the oxbow upstream of the impoundment is expected to change as a result its drainage from dam removal. As noted in the hydrology section of this EA, areas of standing water will be reduced, with the result that the aquatic bed vegetation may be replaced by emergent wetland vegetation types, with a general succession of changes in hydrophyte communities as the wet areas become less saturated and revert to upland. It should be reiterated that the wetlands under the influence of the impoundment are artificially created and maintained, and the hydrology and wetland habitats will be reverting back to a more historical condition with the dam and associated impoundment removed. The construction of fish ladders at the Town Swimming Pool and Water Supply Dams are not expected to have any long-term negative effects on wetland vegetation. Temporary construction impacts may occur in fringing bank areas, which will be used for construction access (primarily the access road at the Water Supply Dam), however these areas will be restored to their former condition when the project has been completed. Permanent bank excavation over a short distance may also affect small areas of wetland vegetation, however this will be minimal, involving a small area adjacent to each fish ladder structure.

2. Fisheries

The proposed project will have an overall positive effect upon the fisheries of the Green River. The provision of fish passage by the removal of the Wiley & Russell and Mill Street Dams, and the construction of fish ladders at the Swimming Pool and Water Supply Dams is expected to open approximately 21 additional river miles of anadromous fish migratory and spawning habitat on the Green River alone, as well as additional miles of coldwater tributary streams. Several of these streams currently support juvenile Atlantic salmon as well other salmonid species. As mentioned previously, Hinsdale Brook, which joins the Green River upstream from the Swimming Pool Dam supports multiple age classes of Atlantic salmon (from previous stocking) as well as brook and brown trout. This stream (as well as the numerous streams along the Green River with similar habitat) may provide suitable Atlantic salmon spawning habitat for returning adults once they are able to migrate beyond the existing dams. Additional spawning habitat for blueback herring is expected to become available along the restored migratory corridor as well as in the impoundments behind the Swimming Pool and Water Supply Dams. Additionally, passage for existing potomadromous fish will become available, along the entire stretch of reconnected river.

The restoration of andromous blueback herring to the Green River will not only benefit the ecosystem by the restoration of a historic species, but also by the influx of

additional forage for the existing fish populations. Generally, in freshwater areas where river herring (i.e. alewives and blueback herring) have been restored, studies show that resident fish populations have been enhanced. The juvenile herring produced in the spawning run serve as food supply for bass and other resident and/or migratory species. All life stages of anadromous herrings are important forage for many freshwater and marine fish (i.e. striped bass) that may occur in the Connecticut River estuary. In addition, the mortality of anadromous alewives provides an important source of nutrients for headwater ponds (Loesch, 1987).

Restoration of Atlantic salmon to this section of the river will not only enhance the quality of the fishery by restoration of an historic native species, but also have an economic and/or recreational benefit to the downstream areas of the Connecticut River estuary. Restoration efforts for this species have been ongoing throughout New England since the since the 1960's, and represent efforts by the Federal and State governments, as well as numerous local non-profit river associations. In order for these fish to be restored to the Connecticut River and its tributaries (including the Deerfield and Green Rivers), access to their spawning habitat needs to be provided. The Green River and its tributaries represent historic spawning habitat, and the success and survival and return of the stocked juveniles indicates the presence of sufficient habitat and water quality for these fish to survive and reproduce. Therefore, the provision of fish passage will allow these fish to access this historic habitat and allow for the continued progress of their restoration to these rivers.

The removal of the two downstream dams, as well as the construction of fish ladders on the two upstream dams in the Green River, in addition to allowing fish passage, will also be expected to restore additional riverine habitat used by resident fish in the Green River. Trout, largemouth and smallmouth bass, white sucker as well as smaller species (i.e. dace) will be able to move through the channel unimpeded, both upstream and downstream. This will allow these fish to utilize habitat both upstream and downstream from the former dams for feeding, spawning, or riverine refuge (i.e. trout). In addition, the restored stream bed of cobbles, gravel, and sand in the riffle, pool, and run areas, will provide suitable substrate for colonization by benthic invertebrates which could provide a food supply for fish inhabiting that section of the river. The opening of this area will reconnect the benthic habitat, allowing re-colonization and migration of these organisms through this section of the river.

The loss of the two impoundments may have a negative effect on the existing lacustrine/warmwater fish currently inhabiting the Green River. In addition to the riverine species noted above, the Green River also provides habitat for largemouth bass, smallmouth bass, bluegill, yellow perch, pumpkinseed, red-breasted sunfish, common shiner, and brown bullhead. All of these fish, with the exception of smallmouth bass, are generally associated with slower moving water as would occur in the impoundments behind the dams, rather than in the open areas of the Green River. The removal of the two dams will reduce the amount of artificially created lacustrine habitat associated with their impoundments. However, similar habitat will remain intact behind the Swimming Pool and Water Supply Dams. It should be noted the quality of the lacustrine habitat which currently exists behind both the Wiley Russell and Mill Street Dams is marginal due to the large amounts of sediment that has accumulated there, as well as the lack of cover and apparent spawning areas. This is

particularly true at Wiley Russell, where the substrate consisted of fine silt, and very little cover was present in the impoundment.

E. Threatened and Endangered Species

It is expected that the proposed fish passage project consisting of dam removal and fish ladder construction on the Green River, will not have any negative impact on any Federally listed endangered species. As noted, coordination with the U.S. Fish and Wildlife Service has indicated that no Federally-listed threatened of endangered species under the jurisdiction of the U.S. Fish and Wildlife Service occur in the vicinity of the proposed project area with the exception of occasional transient bald eagles (*Haliaeetus leucocephalus*). Coordination with the National Marine Fisheries Service has also indicated that there are no threatened or endangered species expected to be present within that region of the Connecticut River Watershed. Although shortnose sturgeon occupy the more sections of the Connecticut River in the latitude of the Green River, they have not been documented in the Green River (see letters dated February 19, 2003 and February 11, 2003, Appendix A).

As noted in the Affected Environment section of this EA, coordination with the Commonwealth of Massachusetts Division of fisheries and Wildlife Natural Heritage and Endangered Species Program (NHESP) has indicated that several plant fish and reptile species listed by the state as endangered and/or Special Concern occur within the study area. The plant species include Barren Strawberry (*Waldsteinia fragariodes*), Black Maple (*Acer nigrum*), both considered to be species of Special Concern; the fish species is Northern Redbelly dace (*Phoxinus eos*), listed as Endangered; and reptile species, Wood Turtle (*Glyptemys insculpta*). In order to avoid any potential impacts to these species, coordination with the NHESP will be continued. When possible, construction activities will be conducted during seasons that would present the least risk to these species (i.e. low flow season for the endangered dace). In order to protect the plant species, a survey would be done prior to construction to determine their presence in the actual footprint. If present, then the construction activities will be modified to avoid these species (when possible), or they will be transplanted outside of the project footprint prior to beginning. For the endangered turtle, a turtle survey would be conducted prior to construction, and any wood turtles in the project area will be collected and transported to another location. Therefore given that the above noted conditions are complied with, the proposed project on the Green Rivers not expected to have any long term negative affects on any of the state-listed species of concern and/or threatened or endangered species noted above which have been observed in the project area.

F. Essential Fish Habitat Assessment

The proposed provision of fish passage on the Green River is not expected to have any significant negative impacts on EFH for the designated life stages of Atlantic salmon (noted previously), as well as the noted life stages of the species listed in section VIII F

of this EA, which occur in the Connecticut River estuary. During construction, erosion control measures will be in place to minimize negative effects to water quality resulting from silt/sediment runoff. Cofferdams will also be employed in order to isolate the actual areas of in-river work both upstream and downstream of the dam (i.e. the entrance and exit channels). Work will be timed in order to avoid interference with either up-migrating or down-migrating anadromous blueback herring as well as any Atlantic salmon that may be in the area.

The proposed project is expected to have an overall positive effect on EFH for the designated life stages of Atlantic salmon in the Connecticut River. The provision of fish passage on the Green River (a tributary of the Deerfield and Connecticut River) will enable anadromous Atlantic salmon as well as blueback herring to access an additional 21 miles of river with potential spawning and nursery habitat upstream from the Wiley Russell, Mill Street, Swimming Pool, and Water Supply Dams. Although recent returns of Atlantic salmon to the Connecticut River and its tributaries have been low, the potential spawning habitat exists in the Green River and its tributaries for restoration of this species to the river, where these species have been stocked. The removal of the two lower dams and the construction of fish passage at the two upper dams will provide both upstream and downstream passage for pre/post spawning adults as well as down-migrating smolts.

The proposed project is also expected to have a positive effect on many of the EFH species that inhabit the Connecticut River estuary as well as Long Island Sound. The provision of fish passage will open up additional spawning habitat for anadromous blueback herring, which are preyed upon by several of the listed EFH species such as bluefish and Atlantic salmon (Scott and Crossman, 1973). In addition, many other larger marine predator species prey on Alewives and/or blueback herring, including striped bass. The additional blueback herring spawning habitat that will become available to these fish on the Green River is expected to increase their numbers in the Connecticut River estuary as well as in Long Island Sound, thereby having a positive effect on these ecosystems, including the EFH species inhabiting these areas.

G. Historical and Archeological Resources

The Green River is considered archaeologically sensitive for the presence of prehistoric archaeological sites dating from the Middle Archaic to the Contact Periods. The Wiley & Russell Dam was determined to be a contributing element to the Greenfield Tap and Die Plant No. 1, a district eligible for the NR. The Green River was used for hydropower for other industries during Greenfield's history, however, the other three dams being considered in this study are not eligible for the NR. The Greenfield Historical Commission in correspondence dated 28 November 2005, notes that the Town of Greenfield is working on a Green River Heritage Area walking trail along Mead Street. "The trail will include interpretation of the landscape along this segment of the Green River corridor, considered an internationally significant source for development of precision metalworking technology. Dams are obviously crucial parts of this

interpretation." The Town of Greenfield is fulfilling the provisions of a Memorandum of Agreement (MOA) with the Massachusetts State Historic Preservation Office (MA SHPO) to mitigate the recent demolition of the Greenfield Tap and Die Plant #1. The letter goes on to state that the construction of the trail is considered mitigation for this demolition, and that the Wiley & Russell Dam was considered a contributing element to the NR district. The Historical Commission asks the Corps to consider alternatives to demolition of the Wiley & Russell Dam. The MA SHPO notes in a 14 November 2005 letter that they look forward to receiving additional information once design, staging, and construction areas have been conclusively selected before they will concur with the no effect determination made by the Corps. In further correspondence on 6 December 2005, they request that alternatives to the proposed demolition of the Wiley & Russell Dam be considered The MA SHPO requests the opportunity to review scaled project plans and specifications if the project changes to include impact areas outside areas that have been already substantially altered. A no effect determination was sent in correspondence to the Stockbridge-Munsee Tribal Historic Preservation Officer (THPO). We received no response from the Stockbridge-Munsee THPO. It is recommended that the Wampanoag THPO and the Narragansett THPO be provided with plans and specifications, along with the MA SHPO, and Greenfield Historic Commission, when available, so that the effect of the project on historic properties can be determined. Normally, this effects determination is made as part of the Environmental Assessment, however, the sketchy nature of the project plans, with no preferred alternative, scaled drawings, or location of staging or construction areas that were available during this process were inadequate to make a determination of effect that was acceptable to the SHPO and Historical Commission.

A determination of no effect was made, based on the assumption that demolition of the Greenfield Tap and Die Plant No. 1, rendered the Wiley & Russell Dam no longer eligible for the NR, since it was a contributing element to the historic district, and not individually eligible. The possibility of future archaeological investigations was noted based on the location of construction, access, and staging areas. The MA SHPO replied that they would wait to see plans before concurring with the no effect determination. Information was not available at that time concerning the mitigation agreement the Town of Greenfield had made with the MA SHPO, which includes the development of a walking trail as part of a public education component of Greenfield's industrial past. However, upon receipt of the town's letter, the SHPO noted that the Corps should look at alternatives other than demolition of the Wiley & Russell Dam.

Additional correspondence will be sent to the MA SHPO and THPOs to consult on our current views of the non-eligibility of the Wiley and Russell dam, and to make a determination of effect for the project as a whole. Consultation with the MA SHPO and the THPOs will be completed before a final decision is made on the project.

H. Cultural and Economic Resources

The provision of fish passage beyond the four dams on the Green is expected to have an overall benefit to the cultural and economic resources of the town of Greenfield. The restoration of anadromous fish to the Green River is expected to enhance recreational

and/or cultural activities in several ways. These include fish viewing, since the up migrating fish will be visible in the restored river channel at Wiley Russell and Mill Street, and in the fish ladders at Swimming Pool and Water Supply Dams, as well as improved recreational fishing, since the influx of blueback herring into the system can improve the overall productivity of the existing fisheries in the river. Additional value will be added to the Deerfield and Connecticut River Ecosystems, and the Natural Heritage Status of the Connecticut River, as well as the as to the productivity of the Connecticut River estuary, by the restoration (i.e. return) of blueback herring to the ecosystem.

I. Environmental Justice

The proposed project is not expected to pose impacts upon any minority or low income populations adjacent to or in the vicinity of the project pursuant to Executive Order No. 12898. The project involves removal of both the Wiley & Russell and Mill Street Dams, and the construction of fish ladders on both the Swimming Pool and Water Supply Dams. This will reconnect the stretch of the Green River through the town of Greenfield allowing passage of historic anadromous, catadromous and potomadromous fish to historic habitat along the Green River. This will benefit the ecosystem and have a positive effect upon the fisheries. It will also provide benefits to the recreational fishing community in general, including any recreational fisher that may be using the river for subsistence fishing. As noted earlier, a population segment meeting the criteria to be classified as an Environmental Justice Population exists near the center of the Town of Greenfield. However, the proposed project is not expected to have a long-term disproportionate negative effect on this population. Construction activities will be limited to the actual footprints of the project, with truck traffic routes along existing roadways suitable for that type of traffic. Standard safety protocols will be employed for all construction activities, with necessary permits acquired prior to the work being accomplished. Short-term activities may limit access to the river in the actual footprints of the project, however, this will be short term and temporary, with the end result being restoration of anadromous fish to the system.

J. Protection of Children

Executive Order 13045 requires federal agencies to examine proposed actions to determine whether they will have disproportionately high human health or safety risks on children. During the construction phase of the proposed project, heavy construction equipment and vehicles will be transported to each of the dam sites. However, the actual sites will be fenced off to prevent unauthorized personnel from entering the work area (including children). In addition, there will be a temporary increase in truck traffic transporting materials to and from the sites. These trucks will be limited to the public roadways, and the existing project access road (right of way), and are therefore not expected to cause any disproportionate direct, indirect or cumulative impact to children associated with environmental health or safety risks. Construction itself is expected to

last for approximately 4 months. Therefore, this increased traffic will be for a short duration and temporary. Public access to the project is not expected to disproportionately impact children, since any hazardous areas will be fenced to prevent access. Although there are schools and playgrounds within the vicinities of the proposed project (see section VII I of this EA), they are not located in the actual footprints of the project and therefore would not be affected disproportionately by the project.

K. Air Quality

1. Air Quality Statement of Conformity Requirements

U.S. Army Corps of Engineers guidance on air quality compliance is summarized in Appendix C of the Corps Planning Guidance Notebook (ER1105-2-100, Appendix C, Section C-7, pg. C-47). Section 176 (c) of the Clean Air Act (CAA) requires that Federal agencies assure that their activities are in conformance with Federally-approved CAA state implementation plans for geographic areas designated as non-attainment and maintenance areas under the CAA. The EPA General Conformity Rule to implement Section 176 (c) is found at 40 CFR Part 93.

Clean Air Act compliance, specifically with EPA's General Conformity Rule, requires that all Federal agencies, including Department of the Army, to review new actions and decide whether the actions would worsen an existing NAAQS violation, cause a new NAAQS violation, delay the SIP attainment schedule of the NAAQS, or otherwise contradict the State's SIP.

The Commonwealth of Massachusetts is authorized by the EPA to administer its own air emissions permit program, which is shaped by its State Implementation Plan (SIP). The SIP sets the basic strategies for implementation, maintenance, and enforcement of the National Ambient Air Quality Standards (NAAQS). The SIP is the federally enforceable plan that identifies how that state will attain and/or maintain the primary and secondary National Ambient Air Quality Standards (NAAQS) established by the EPA (U.S. Environmental Protection Agency, 2004b). In Massachusetts, Federal actions must conform to the Massachusetts state implementation plan or Federal implementation plan. The Corps must evaluate and determine if the proposed action (construction and operation) will generate air pollution emissions that aggravate a non-attainment problem or jeopardize the maintenance status of the area for ozone. When the total direct and indirect emissions caused by the operation of the Federal action/facility are less than threshold levels established in the rule (40 C.F.R. § 93.153), a Record of Non-applicability (RONA) is prepared and signed by the facility environmental coordinator.

2. Construction and Operation

Construction would occur over a total period of about 12 months, with work being done seasonally. Construction activity at the proposed project site would require bulldozers, dump trucks, pick-up trucks, front-end loaders, dredges and other construction equipment, including small generators and graders.

During construction, equipment operating at the four sites on the Green River would emit pollutants including nitrogen oxides that can lead to the formation of ozone. The dam removals at Wiley Russell and Mill Street Dams, as well as the construction of fish ladders at Swimming Pool and Water Supply Dams, would involve vehicles transporting gravel (dump trucks) and other construction equipment to and from the site. These vehicles will be in compliance with the state's vehicle emission program.

Equipment operating on the construction site (non-road construction equipment) will emit pollutants that contribute to increased levels of criteria pollutants such as carbon monoxide, nitrogen oxides, and ozone. The emissions for construction vehicles and related equipment will have an insignificant impact to local air quality.

Construction of the proposed project could cause a temporary reduction in local ambient air quality because of fugitive dust and emissions generated by construction equipment. The extent of dust generated would depend on the level of construction activity and dryness. Proper dust suppression techniques would be employed to avoid creating a nuisance for nearby residents during dry and windy weather.

In order to minimize air quality effects during construction, all construction operations would comply with applicable provisions of the Commonwealth of Massachusetts air quality control regulations pertaining to dust, odors, construction, noise, and motor vehicle emissions. No direct or indirect increases or other changes in local or regional air quality are likely to occur with the construction and operation of the proposed project.

3. General Conformity

The general conformity rule was designed to ensure that Federal actions do not impede local efforts to control air pollution. It is called a conformity rule because Federal agencies are required to demonstrate that their actions "conform with" (i.e., do not undermine) the approved SIP for their geographic area. Federal agencies make this demonstration by performing a conformity review. The conformity review is the process used to evaluate and document project-related air pollutant emissions, local air quality impacts and the potential need for emission mitigation (Polyak, K and Webber, L. 2002). A conformity review must be performed when a Federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. Non-attainment areas are geographic regions where the air quality fails to meet the NAAQS.

The project is located in Franklin County, Greenfield Massachusetts. Franklin County is considered to be non-attainment for ozone, receiving a "moderate" classification under the new 8-hour ozone air quality classification. The General Conformity thresholds for ozone in a moderate non-attainment area have an emission rate threshold of 50 tons per year (tons/year) of VOC (volatile organic compounds) and100 tons/year of NO_x (nitrogen oxides) (Polyak, K and Webber, L. 2002). (40 CFR 51.853, 7-1-03).

To conduct a general conformity review and emission inventory for the proposed dam removal and fish ladder construction, a list of construction equipment was identified using the project construction cost estimate. The first column of the emissions calculations table (Appendix E) provides a summary equipment list. The New England District prepared calculations of the worst-case project specific emissions of NOx and VOCs to determine whether project emissions would be under the General Conformity Trigger Levels. Because of the small scale of the project, several simplifying assumptions were applied in performing the calculations to prepare a worst-case analysis. The actual emissions would most likely be much lower, but in no case above the calculated values. For instance, the load factor is the average percentage of rated horsepower used during a source's operational profile. To simplify the calculations, we used a worst-case estimate of 1.0, or 100 percent, for all equipment. We used 12 hours per day as worst-case hours of operation for most equipment. We used the total construction duration minus non-work days (i.e. holidays, weekends, and weather days) to estimate days of operation, rather than the specific days of operation for each piece of equipment. Based on these calculations, the worst-case NOx emissions were 87.79 tons and the worst-case VOC emissions were 12.41 tons. In both cases, the total construction emissions were below the General Conformity Trigger Levels.

Detailed calculations (i.e. not worst case) for several projects of similar scale in the Corps of Engineers, Philadelphia District (small navigation, emergency streambank stabilization, and ecosystem restoration projects in New Jersey, and a road maintenance project in Delaware) had calculated emissions well below the 100 tons per year threshold. Table 6.8-1 summarizes the emissions estimates for these 4 projects. Detailed calculations for the Green River fish ladder construction project would be likely to have values closer to this range. Appendix E contains the equipment list for the Green River Project, and the calculations and listing of equipment for it and the 4 projects in the Philadelphia District.

Table 6.8-1
Estimated Project Emissions for Ozone at 4 Corps of Engineers Projects located in Severe Non-Attainment Areas

Project	Location	Type	Maximum Pollutant (tons) NOx	VOCs
Wills Hole Thorofare	New Jersey	Small Navigation-Dredging	9.80	0.25
Barnegat Bay Dredged Hole #6	New Jersey	Ecosystem Restoration	19.90	0.36
Manasquan River at Bergerville Rd	New Jersey	Streambank Stabilization	0.69	0.10
Summit Bridge Road Maintenance	Delaware	Road Maintenance	5.01	0.71
		Combined totals:	35.40	1.42
		Multiple of 2 combined totals (tons):	70.80	2.84

The total estimated direct and indirect emissions that would result from the removal of two dams and the construction of two fish ladders on the Green River are below the General Conformity trigger levels of 100 tons per year of NOx and 50 tons per year of VOCs. General Conformity under the Clean Air Act, Section 176 has been evaluated for the project according to the requirements of 40 CFR 93, Subpart B. The requirements of this rule are not applicable to this project because the total direct and indirect emissions from the project are below the conformity threshold values established at 40 CFR 93.153 (b) for ozone (NOx and VOCs) in a moderate attainment area.

The determination of whether or not a project is regionally significant is if its emissions exceed 10% of the state's total emissions budget for the criteria pollutants (40 CFR 93.153 (i)). Table IV – 1 of the 2002 Eastern Massachusetts Supplement to the July 1998 Ozone Attainment State Implementation Plan Submittal (MADEP, 2002), lists the total emissions inventories for emissions sources in the state for various years, and predicts estimated inventories for 2007. These inventories are calculated as tons per summer day (tpsd) and show that for mobile sources alone, total values of 117.118 tpsd of VOCs and 243.328 tpsd of NOx are predicted for 2007. As noted, the emissions for the Green River fish passage project are estimated to be 87.79 and 12.41 tons *per year* for both VOCs and NOx respectively (broken down by dredging season). These values show that *in less than one day*, mobile sources alone within the area of Eastern Massachusetts would exceed the yearly estimated emissions for both VOCs and NOx for the proposed Milford Pond Dredging Project. Therefore the estimated emissions for the proposed project are below 10% of the total emissions inventory for the Commonwealth of Massachusetts. The Army activity does not reach the threshold levels established by the EPA rule, and is not regionally significant, and therefore the conformity rule is inapplicable here.

IX. Cumulative Effects

Cumulative impacts are those resulting from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions. The past and current activities in the Green River in the vicinity of the Wiley & Russell, Mill Street, Swimming Pool and Water Supply Dams include and have included

maintenance and repair of the spillway and floodgates of each of the dams as well as repair of the bridge abutments and re-surfacing of the pavement of the roads that access and cross the river in close proximity to these dams (i.e. the Mill Street Bridge directly over the Mill Street Dam). These activities could potentially affect water and habitat quality in the Green River, by involving in-river work (even though minimal) which could be factored into the cumulative impacts to the environment. Additional impacts to the habitat occur seasonally at the Swimming Pool Dam from periodic beach maintenance, which involves the placement of sand, and the resulting washing of this sand into areas of the river downstream during the winter months. Also, at the Water Supply Dam, normal usage of water from the town may reduce flows during times of greater use. All of these activities would potentially effect the habitat of the Green River, and could be considered cumulative when added to the proposed construction activities for fish passage. However, the proposed dam removal at Wiley & Russell and Mill Street will eliminate the need for any future dam maintenance, once the construction activities have been completed therefore eliminating that future impact. In addition, the proposed construction activities at the Swimming Pool and Water Supply Dams are not expected to have any long-term negative effects on the Green River habitat, and any negative effects will be short term and temporary. The end result will be a long-term positive effect on the environment by the restoration of anadromous fish to their historic habitat. It is also expected that any construction activities would be accomplished during construction windows established to minimize negative effects to the existing aquatic and/or wetland habitat. The proposed construction activities are one-time events, and therefore the effects of these and previous activities would not be expected to significantly affect water quality, air quality, hydrology, and other biological resources.

This project is expected to benefit the overall ecological health the Green River by restoring anadromous fisheries and connectivity of the riverine habitat. The direct effects of this project are not anticipated to add to any adverse impacts from other actions in the area (i.e. those noted above). Therefore, no adverse cumulative impacts are projected as a result of this project.

Beneficial cumulative effects include those which when added to this project will further improve the Green River ecosystem. The provision of fish passage beyond the four Dams cumulatively increases the overall available anadromous fish habitat in the Green River. Without this project, these fish are only able to pass to the base of the Wiley & Russell Dam (from the Deerfield and Connecticut Rivers). With this project in place, approximately 21 additional river miles are available for spawning and migratory habitat. The proposed fish passage project at the Green River would allow this increased number of fish to continue migrating upstream of the four Dams, providing cumulatively positive benefits to the fisheries in the river.

Although there will be reversion of wetlands to upland habitat in the area of the impoundment upstream from Mill Street Dam, this will be a gradual reversion to historic riparian habitat.

X. Actions Taken to Minimize Impacts

The proposed removal of the Wiley & Russell and Mill Street Dams, and construction of fish ladders on the Swimming Pool and Water Supply Dams is proposed to occur during the summer low flow season outside of the times of any existing anadromous fisheries downstream migration. A Water Quality Certificate will be obtained prior to construction pursuant to Section 401 of the Clean Water Act, and any construction windows and/or time restrictions that may be noted in it would be followed in order to minimize potential impacts to existing or migrating fish species. During construction, flows will be diverted around the construction areas with proper erosion control measures utilized. Temporary cofferdams will be used to divert the water around the areas of active construction, and silt fences will be installed around any excavation areas. These measures will minimize any potential water quality impacts to the river from silt runoff. Access of construction equipment to the area of the Water Supply Dam will be accomplished by the construction of the access road (noted previously) along the base of the dam, which will be removed upon completion of the project.

The completed project will restore connectivity to the river by restoring riverine habitat along the stretch between the Wiley Russell and Mill Street Dams, extending to the Swimming Pool Dam, and allowing anadromous fish passage beyond both the Swimming Pool and Water Supply Dams. Flows downstream from the two upstream dams will not be altered by the fish ladders, and flows downstream from the Wiley & Russell and Mill Street Dams will be restored to their historic hydrological patterns, no longer held back by the dam spillways. As noted in the Endangered and Threatened Species Section of the Environmental Consequences of this EA, surveys may be done to ensure that any of the state listed plant, fish and/or reptile species are not impacted. Methods to avoid and/or minimize impacts to these species include by relocation/transplanting of any plants or reptiles that may be in the area prior to construction, or by working during construction windows established to protect these species. Upon completion of the project, all of the construction footprints will be re-stabilized and replanted with native vegetation.

XI. Coordination

A. Personal Communication

- The following persons were coordinated with in the preparation of this report.
- Ms. Christine Duerring, Commonwealth of Massachusetts EOEA.
- Dr. Alex Haro, USGS, Conte Anadromous Fisheries Research Laboratory, Turners Falls, MA.
- Dr. Caleb Slater, Massachusetts Division of Fisheries and

Wildlife,Westborough, MA

- Ms. Karen Pelto, DFW, Riverways Program
  251 Causeway Street, Suite 400, Boston, Massachusetts 02114

- Mr. Richard Quinn, U.S. Fish and Wildlife Service, Newton Corner, Massachusetts

- Mr. Peter Conway, Resident, Greenfield MA

- Ms. Patricia Conway, Resident, Greenfield MA

B. Informational Meeting

The Commonwealth of Massachusetts EOEA and the U.S. Army Corps of Engineers, New England District conducted a public informational meeting on June 14, 2001, at Greenfield Community College. The following people were in attendance (see list in Appendix A).

C. Correspondence

Project coordination Letters were mailed to the following people prior to the preparation of this report pursuant to the Federal Fish and Wildlife Coordination Act, Federal Endangered Species Act, and the National Historic Preservation Act (See Appendix A).

Mr. Michael Bartlett
U.S. Fish and Wildlife Service
70 Commercial Street
Suite 300
Concord N.H. 03301-5087

Mr. Jack Terrill
Asst. Regional Admin. for Habitat Conservation
National Marine Fisheries Service
One Blackburn Drive
Gloucester, Massachusetts 01930

Mr. David Webster
Director, Massachusetts Office of Ecosystem Protection
EPA – New England, Region 1
One Congress Street, Suite 1100 (CMA)

Boston, Massachusetts 02114-2023

Mark Tisa Ph.D.
Commonwealth of Massachusetts
Division of Fisheries and Wildlife
One Rabbit Hill Road
Westborough, Massachusetts 01581

Ms. Patricia Huckery
Massachusetts Natural Heritage
and Endangered Species Program
Division of Fish and Wildlife
One Rabbit Hill Road
Westborough, Massachusetts 01581

Caleb Slater Ph.D.
Anadromous Fish Project Leader
Massachusetts Division of Fisheries and Wildlife
Field Headquarters
One Rabbit Hill Road
Westborough, Massachusetts 01581

Mr. Robert W. Varney, Regional Administrator
United States Environmental Protection Agency
Region I, New England
One Congress Street, Suite 1100
Boston, Massachusetts 02114-2023

Mr. David Webster
Director, Massachusetts Office of Ecosystem Protection
EPA – New England, Region 1
One Congress Street, Suite 1100 (CMA)
Boston, Massachusetts 02114-2023

Robert Deblinger, Ph.D.
Assistant Director Wildlife
Division of Fish and Wildlife
One Rabbit Hill Road
Westborough, Massachusetts 01581

Mr. Richard Thibedeau, Director
Bureau of Resource Protection
Massachusetts Department
of Environmental Management
251 Causeway Street, Suite 600

Boston, Massachusetts 02114-2104

Ms. Ellen Roy Herzfelder, Secretary
Executive Office of Environmental Affairs
MEPA Office
251 Causeway Street, 9th Floor
Boston, Massachusetts 02114

Mr. Dave Basler
Commonwealth of Massachusetts
Division of Fisheries and Wildlife
Connecticut Valley District
East Street
Belchertown, Massachusetts 01007

Ms. Cynthia Giles, Director
Bureau of Resource Protection
Massachusetts Department of Environmental Protection
One Winter Street, Floor 5
Boston, Massachusetts 02108

Ms. Karen Pelto
DFW, Riverways Program
251 Causeway Street, Suite 400
Boston, Massachusetts 02114

Coordination Letters

The Commonwealth of Massachusetts

William Francis Galvin, Secretary of the Commonwealth
Massachusetts Historical Commission

December 6, 2005

John R. Kennelly
Chief of Planning
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742

Attn.: Kate Atwood

RE: Wiley and Russell Dam (Greenfield Tap and Die Plant #1 Wood Crib Dam), Greenfield, MA. MHC #RC.38113.

Dear Mr. Kennelly:

MHC has received the copy of the letter submitted by Greenfield Historical Commission concerning the project referenced above. The Greenfield Historical Commission should be included as a consulting party (36 CFR 800.2 (c)(3)) in this review, and please provide them with the project information in your letter of October 11, 2005.

The Wiley and Russell Dam (Greenfield Tap and Die Plant #1 Wood Crib Dam) is a component of the Greenfield Tap and Die Complex. In 2001 the MHC determined that the complex was determined to be eligible for listing in the National Register of Historic Places under Criteria A and C on the local level. The information submitted by the Greenfield Historical Commission indicates that the Wiley and Russell Dam is a crucial component of the city's proposed Green River Heritage Area walking trail. Please consider alternatives (e.g., installation of a fish ladder) to the proposed demolition of the Wiley and Russell Dam.

MHC looks forward to further consultation with the Corps and the Greenfield Historical Commission. These comments are offered to assist in compliance with Section 106 of the National Historic Preservation Act of 1966 (36 CFR 800). Please feel free to contact Gregory R. Dubell if you have any questions or need additional information.

Sincerely,

Brona Simon

Brona Simon
State Archaeologist
Deputy Historic Preservation Officer
Massachusetts Historical Commission

xc: Marcia Starkey, Greenfield Historical Commission
Patrice Kish, DCR, Cultural Resources
William Salomaa, DCR, Office of Dam Safety
DEP-WERO

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Field Office
70 Commercial Street, Suite 300
Concord, New Hampshire 03301-5087

February 19, 2003

John R. Kennelly
Deputy Chief, Engineering/Planning
New England District, Corps of Engineers
696 Virginia Road
Concord, MA 01742

Dear Mr. Kennelly:

This responds to your January 15, 2003 letter describing the General Investigation of the Green River in Greenfield, Massachusetts. The purpose of the investigation is to identify measures for anadromous fish passage beyond four dams along an approximate 10-mile section of the Green River. We support this project and will work closely with the Corps to evaluate the alternatives and environmental benefits of this project. Please provide close cooperation with this office. These comments are provided in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543).

Based on information currently available to us, no federally-listed or proposed, threatened or endangered species under the jurisdiction of the U.S. Fish and Wildlife Service are known to occur in the project area, with the exception of occasional transient bald eagles (*Haliaeetus leucocephalus*). Preparation of a Biological Assessment or further consultation with us under Section 7 of the Endangered Species Act is not required. Should project plans change, or additional information on listed or proposed species becomes available, this determination may be reconsidered.

Thank you for the opportunity to comment on this project. We look forward to working with you as this investigation develops. Until further notice I will be your principal contact for this project.

Sincerely yours,

William J. Neidermyer

William J. Neidermyer
Assistant Supervisor
Federal Activities
New England Field Office

Fish Species of the Green River

Species	Common Name	Native/Introduced/Hatchery	Life History	Passage
Petromyzon marinus	sea lamprey	N	Anadromous	X
Acipenser brevirostrum	shortnose sturgeon	N	Anadromous	X
Anguilla rostrata	American eel	N	Catadromous	X
Alosa aestivalis	blueback herring	N (range expansion)	Anadromous	X
Alosa sapidissima	American shad	N	Anadromous	X
Dorosoma cepedianum	gizzard shad	N	Anadromous	X
Salmo salar	Atlantic salmon	(N, H)	Anadromous	X
Salmo trutta	brown trout	I (H)		X
Onchorhynchus mykiss	rainbow trout	I (H)		X
Salvelinus fontinalis	brook trout	N		X
Esox niger	chain pickerel	N		
Cyprinus carpio	common carp	I		X
Notropis cornutus	common shiner	N		
Notropis hudsonius	spottail shiner	N		
Phoxinus eos	northern redbelly dace	N		
Rhinichthys atratulus	blacknose dace	N		
Rhinichthys cataractae	longnose dace	N		
Semotilus corporalis	fallfish	N		
Catostomus commersoni	white sucker	N	Potamodromous	X
Ictalurus melas	brown bullhead	N		
Morone americana	white perch	N	Anadromous	X
Ambloplites rupestris	rock bass	N		
Lepomis auritis	redbreast sunfish	N		X
Lepomis gibbosus	pumpkinseed	N		
Lepomis macrochirus	bluegill	N		X
Micropterus dolomieui	smallmouth bass	I	Potamodromous	X
Micropterus salmoides	largemouth bass	I		X
Etheostoma olstedi	tesselated darter	N		
Perca flavescens	yellow perch	N		X
Stizostedion vitreum	walleye	N	Potamodromous	X
Cottus cognatus	slimy sculpin	N		

The Commonwealth of Massachusetts

William Francis Galvin, Secretary of the Commonwealth
Massachusetts Historical Commission

November 14, 2005

John R. Kennelly
Chief of Planning
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742

Attn.: Kate Atwood

RE: Wiley and Russell Dam, Mill Street Dam, Town Swimming Pool Dam, and Town Water Supply Dam, Greenfield, MA. MHC #RC.38113.

Dear Mr. Kennelly:

Staff of the Massachusetts Historical Commission have reviewed the information you submitted concerning the proposed project referenced above. The proposed project involves the demolition of the Wiley and Russell and Mill Street Dams and the construction of fish ladders at the Swimming Pool and Town Water Supply Dams. The Corps has determined that the dams are not historic and have no significant construction features, and that no historic properties will be affected by the implementation of the project.

MHC looks forward to receiving the additional information once the design, staging, and construction areas have been conclusively selected. MHC requests the opportunity to review scaled project plans and specifications if the project changes to include impact areas outside areas that have been already substantially altered.

Review of the Inventory of Historic and Archaeological Assets of the Commonwealth determined that the Greenfield Tap and Die Plant #1 Wood Crib Dam (MHC #GRE.936) is located within the proposed project area. MHC is not able to determine if the Greenfield Tap and Die Plant #1 Wood Crib Dam is the same structure as the Wiley and Russell Dam.

These comments are offered to assist in compliance with Section 106 of the National Historic Preservation Act of 1966 (36 CFR 800). Please feel free to contact Gregory R. Dubell if you have any questions or need additional information.

Sincerely,

Edward L. Bell
Senior Archaeologist
Massachusetts Historical Commission

xc: Patrice Kish, DCR
William Salomaa, Office of Dam Safety
DEP-WERO
Greenfield Historical Commission

220 Morrissey Boulevard. Boston, Massachusetts 02125
(617) 727-8470 • Fax: (617) 727-5128
www.sec.state.ma.us/mhc

October 4, 2005

Engineering/Planning Division
Evaluation Branch

Ms. Brona Simon, Deputy State Historic Preservation Officer
Massachusetts Historical Commission
Massachusetts Archives Building
220 Morrissey Boulevard
Boston, Massachusetts 02125

Dear Ms. Simon:

The U.S. Army Corps of Engineers, New England District (NAE), has prepared a draft Environmental Assessment for fish passage at four dams on the Green River in order to provide unobstructed access for anadromous and catadromous fish to habitat upstream from the dams, all in Greenfield, Massachusetts. We would like your comments on this proposed undertaking.

The reconnaissance and feasibility studies were initially authorized by a recommendation by the United State's Senate in the 1998 Appropriations Bill, to monitor operational changes on the Deerfield River in Searsburg and Somerset Vermont resulting from the conveyance of two Dams to the Corps to enhance ecosystem restoration. The study was originally proposed by the State of Vermont. However, shortly after the study's initiation the two dams of interest were sold to private interests along with their associated land as part of a deregulation plan. As a result the State of Vermont was no longer interested in Corps involvement with these dams, and the study was no longer considered necessary. However, both the Commonwealth of Massachusetts and the State of Vermont requested an expanded scope of the study to include the remainder of the Deerfield River. The expanded scope was authorized under a United States Senate Resolution Committee on Public works adopted on May 11, 1962, requesting that the Board of Engineers for Rivers and Harbors, created under the Rivers and Harbors Act of June 12, 1902, review the reports of the Connecticut River in Connecticut, Vermont, New Hampshire and Massachusetts, "…with a view to determining the advisability of modifying the existing project at the present time, with particular reference to developing a comprehensive plan of improvement for the basin in the interests of flood control, navigation, hydroelectric power development, water supply, and other purposes, coordinated with related land resources." Therefore the study was expanded to the entire Deerfield River, including the Green River, which is a significant tributary to it.

During the last two decades, various state and federal government agencies have been working cooperatively to restore anadromous fish to their historic habitat in the Connecticut River and its tributaries, including the Deerfield and Green Rivers. Restoration efforts have included identification of specific restoration locations, stocking of anadromous fish to historical upstream spawning and nursery habitats, and provision of fish passage beyond dams, by either dam removal, or creating by-pass structures as fish ladders, lifts, and/or partial dam breaching.

In 1999, the NAE completed the Deerfield River Ecosystem Restoration Reconnaissance Report to determine the need for aquatic habitat restoration on the Deerfield River and its tributaries, and to identify potential restoration alternatives.

The proposed project would involve provision of fish passage at each of the four dams on the approximate 8-mile section of the Green River in the Town of Greenfield. This will be accomplished by the removal of both the Wiley & Russell and Mill Street Dams, and the construction of fish ladders at the Swimming Pool and Water Supply Dams (see enclosed photographs). These proposed activities are described below for each dam.

Wiley & Russell Dam: This is the most downstream dam on the Green River, located approximately 1.2 miles above the confluence with the Deerfield River. It is approximately 14 ft. high and 165 ft. long, constructed of timber crib and concrete (most likely re-constructed after the 1938 flood). It was originally used for water supply for the Greenfield Tap and Die Company complex adjacent to the dam. The factory closed in 1992, and all of the associated buildings were demolished sometime after 2001. The dam is in need of repairs, with the two low-level gates being inoperable. The Town of Greenfield currently owns the Wiley & Russell Dam.

The proposed project would involve the demolition of the timber crib structure, which would cause the impoundment behind the dam to drain and revert to riverine habitat. The sediment behind the dam would scour and revert to historical gravel/cobble substrate. The construction activities would be done during the low-flow season, and would be expected to take approximately 3 months to complete (see enclosed plans). Upon completion, the area would be stabilized and replanted with native riparian vegetation.

Mill Street Dam: This dam is located approximately 0.5 miles upstream from the Wiley & Russell Dam, below the Mill Street Bridge. It is a concrete dam about 12 ft. high that was used by the Greenfield Electric Light and Power Company to generate hydroelectric power. It is now also owned by the Town of Greenfield, and is no longer used for its original purpose.

The proposed project would involve the demolition of the concrete structure, which would cause the impoundment behind the dam to drain and revert to its historical riverine habitat, consisting of riffle/pools and runs (see enclosed plans). As with the Wiley & Russell Dam, the sediment would scour and revert to gravel and cobble substrate more suitable for riverine/coldwater fish and invertebrates. Upon completion, the area would be stabilized and replanted with native riparian vegetation.

Town Swimming Pool Dam: This dam is located approximately 3 miles upstream from the Mill Street Dam. It is a concrete dam approximately 2 feet high and used to provide a recreational swimming pool by seasonally raising the water level on the Green River with flashboards. A shallow winter pool is also maintained by the existing, two foot tall concrete weir. The Town of Greenfield also owns this dam.

The proposed project would be the construction of an approximately four foot wide

aluminum Alaska steep-pass Denil fish ladder on the right bank (looking downstream) of the Green River (see enclosed plans). The fish ladder would notch into the existing concrete spillway structure and descend for approximately 25 ft. to the entrance channel in the river. Flow will be controlled by stop-logs at the top of the fish ladder in the exit pool, and diverted into it during anadromous fish migration/spawning season. Access to this section of the river will be along the right bank of the river, which is currently part of the Town of Greenfield's recreation area (i.e., public beach). Construction would be during the low flow season and is expected to take approximately three months.

Town Water Supply Dam: This is the last dam on the Green River in Massachusetts (also known as the Pumping Station Dam), located approximately 4 miles upstream from the Town Swimming Pool Dam. It is approximately 14 ft. high, and was constructed in 1972 by the Town of Greenfield as a backup municipal water supply. It is still used for that purpose.

The proposed project would be the construction of a four foot concrete, Denil fish ladder on the right bank (looking downstream) of the town water supply dam. The fish ladder would notch into the existing concrete spillway and descend along the right bank of the Green River for a distance of approximately 45 ft., to a 180-degree turning pool. It would then continue in the opposite direction for a distance of approximately 35 ft. to another 180-degree turning/resting pool at its entrance below the dam in the Green River. A temporary access road will be constructed at the base of the dam on the downstream side of the dam across the river, with culverts in order to convey the river flow. Upon completion, the temporary access road will be removed, and the area restored to its previous condition.

Background research completed by NAE determined that the Green River is archaeologically sensitive for prehistoric sites. Information collected from sites in the vicinity of Greenfield suggests that Native American groups inhabited the area continuously from the Middle Archaic to the Contact Periods. The river systems served as transportation corridors for the area's earliest inhabitants. In 2001, the Greenfield Tap and Die Company was determined eligible for the National Register of Historic Places "under Criteria A and C at the local level as the well-preserved factory complex of a world-renowned precision machine tool manufacturer that was the major local employer through much of the twentieth century." However, sometime after this date, all the buildings in the complex were demolished. All that remains are the dam and a partially blocked underground canal (possible raceway).

We believe that demolition of the Wiley & Russell and Mill Street Dams and the construction of fish ladders at the Swimming Pool and Town Water Supply Dams should have no effect on historic properties. While the Wiley & Russell Dam was associated with an NR eligible industrial complex, the structures have been demolished. The Mill Street, Swimming Pool, and Town Water Supply Dams are not historic, and have no significant construction features. In addition, it appears at this stage of design that all work and staging areas will take place in previously disturbed areas (parking lots, existing recreational facilities, in the stream channel, or areas disturbed during dam construction). At this level of design, staging and construction areas have not been conclusively selected. NAE is proposing to include in the Finding of No Significant Impact and project plans and specifications, that the proposed project will have no effect on historic properties provided all work takes place in areas already altered

by ground disturbance. If that is not possible, then any archaeological or historic surveys will be undertaken by NAE. We will provide these stipulations in a Memorandum of Agreement (MOA), prepared in consultation with your office. We will also provide the plans and specifications to your office, when available, for review. We would appreciate your concurrence.

If you have any questions, please contact Ms. Kate Atwood, NAE Archaeologist at (978) 318-8537.

Sincerely,

H. Farrell McMillan, P.E
Chief, Engineering/Planning Division

Enclosures

Similar letter sent to:
Ms. Sherry White, Tribal Historic Preservation Officer
c/o Stockbridge Munsee Community
Post Office Box 70
Bowler, Wisconsin 54416

CF:
Ms. Atwood
Reading File

Mr. Levitt

January 15, 2003

Levitt/sa/114

Engineering/Planning Division
Evaluation Branch

Mr. Michael Bartlett, Supervisor
U.S. Fish and Wildlife Service
70 Commercial Street, Suite 300
Concord, New Hampshire 03301-5087

Dear Mr. Bartlett:

The U.S. Army Corps of Engineers, New England District is conducting a General Investigation of the Green River in Greenfield, Massachusetts under the authority contained in the 1998 U.S. Senate Appropriations Bill. The Green River is a tributary to the Deerfield River in the Connecticut River Basin. The purpose of the investigation is to identify alternative measures for anadromous fish passage beyond four dams along an approximate 10-mile section of the Green River. These are the Wiley and Russell Dam on Meridian Street in downtown Greenfield; the Mill Street Dam located approximately one mile upstream from the Wiley and Russell Dam; the Town Swimming Pool Dam on Nash's Mill Road; and the most upstream, the Pumping Station Dam, located near the covered bridge on Eunice Williams Drive. In addition, the study will identify potential riverine and/or riparian habitat restoration areas along this section of the river. The purpose of this letter is to obtain your comments on this project pursuant to the Fish and Wildlife Coordination Act, as amended, and to request a list of endangered and threatened species for the project area pursuant to Section 7(c) of the Endangered Species Act of 1973 as amended. A map is included to assist you with your work.

The Green River historically provided an anadromous fisheries migration corridor for Atlantic salmon, and may also provide passage for anadromous American shad and blueback herring, which are currently found in the Green and Deerfield rivers. Other species that would benefit from fish passage beyond the dams include brook trout, brown trout, rainbow trout, white sucker and smallmouth bass. Currently, Atlantic salmon restoration efforts on the Green River include spring fry stocking in the river as well as in major tributaries upstream. These fry will eventually become smolts and migrate to sea, and return to their release areas in order to spawn.

Possible fish passage alternatives at the Wiley and Russell Dam include either dam removal or construction of a fish ladder or a rock ramp fishway; and at the Mill Street Dam, either removal or fish ladder construction. For the upper two dams, construction of a fish ladder at each is proposed. Potential habitat restoration opportunities exist in the impoundments and/or riverine corridors behind both the Wiley and Russell and the Mill Street dams. These include the placement of instream cover and bank structures (i.e. artificial undercuts), scour boulders, rock weirs etc. The exact locations and configurations of these habitat restoration features would depend upon the selected alternative of either dam removal or construction of fish passage structures. Additional habitat restoration opportunities exist in the Green River upstream from the swimming pool dam. These include bank stabilization, possibly using either a geotextile fabric and/or plantings, as well as placement of instream structures designed to create pool and riffle complexes and/or scour holes in that section of the river. Additional habitat restoration opportunities will be explored in the study and could include the restoration of riparian canopy in some areas in order to increase connectivity along the river corridor and restore vegetated buffer zones where necessary.

We look forward to your contribution towards the development of an appropriate alternative(s) for this aquatic restoration project. Any questions or comments can be directed to Mr. Ken Levitt, Environmental Resources Section, at (978)-318-8114, or Mr. Dave Larsen, Study Manager, at (978) 318-8113.

Sincerely,

John R. Kennelly
Deputy Chief, Engineering/Planning Division

Enclosures

cc:
Mr. Levitt
Mr. Larsen

C/ ERS

C/ EVAL

DEP C/ ENG/PLNG

C/ ENG/PLNG

Historical Commission

4711
tel. (413) 774-7441

Town of GREENFIELD, MASSACHUSETTS

Town Hall, Greenfield, Mass. 01301

28 November 2005

Kate Atwood
U.S. Army Corps of Engineers
696 Virginia Road
Concord MA 01742

Dear Ms. Atwood;

I am writing to you in regard to a November 14th letter from Edward L. Bell at the Massachusetts Historical Commission (MHC) concerning possible demolition of two river dams and construction of two fish passages on the Green River in Greenfield. As a consulting party to this Section 106 review, the Historical Commission requests the opportunity to review information presently available on the project. The following provides some background on our involvement with this site.

In 2005, the Town of Greenfield began work on a Green River Heritage Area walking trail along Mead Street. The trail will include interpretation of the landscape along this segment of the Green River corridor, considered an internationally significant source for development of precision metalworking technology. Dams are obviously crucial parts of this interpretation.

The trail is also intended to fulfill the provisions of a Memorandum of Agreement the Town concluded with the MHC to mitigate recent demolition of the Greenfield Tap & Die Plant #1. Most importantly, the trail is intended to build and sustain community pride and spirit through a permanent reminder to Greenfield's citizens of their lengthy and important achievements at this place. Of course, it is also potentially a lesson in our uses of natural resources.

Thank you for your cooperation and we will continue to work with state and local river advocates toward a plan which will serve these related interests. Please contact me if you have questions.

Sincerely,
Marcia Starkey
Marcia Starkey, chair

c/ Ed Bell, MHC
Patrice Kish, DCR

Commonwealth of Massachusetts

Division of Fisheries & Wildlife

MassWildlife

Wayne F. MacCallum, *Director*

February 24, 2003

John R. Kennelly
Department of the Army
New England District, Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

Re: Green River Investigation
Greenfield, MA
NHESP File: 03-11523

Dear Mr. Kennelly,

Thank you for contacting the Division of Fisheries and Wildlife for information regarding the general investigation of the Green River. I have reviewed the site and would like to offer the following comments.

The Natural Heritage and Endangered Species Program's database indicates that the following Priority/Estimated Habitats exist along the Green River in the area you have indicated and have been delineated for the following species:

Species	Taxon	Status
PH 130		
Barren Strawberry (*Waldsteinia fragarioides*)	plant	Special Concern
Black Maple (*Acer nigrum*)	plant	Special Concern
Northern Redbelly Dace (*Phoxinus eos*)	fish	Endangered
Wood Turtle (*Clemmys insculpta*)	reptile	Special Concern
PH 235/WH 7310		
Barren Strawberry (*Waldesteinia fragarioides*)	plant	Special Concern
Wood Turtle (*Clemmys insculpta*)	reptile	Special Concern

These species are protected under the Massachusetts Endangered Species Act (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00) as well as the state's Wetlands Protection Act (M.G.L. c. 131, s. 40) and its implementing regulations (310 CMR 10.00). Fact sheets for these species can be found on our website at www.state.ma.us/dfwele/dfw.

The Fisheries section indicates that fisheries surveys on the Green River have yielded 21 fish species: brown trout (*Salmo trutta*), slimy sculpin (*Cottus cognatus*), longnose dace (*Rhinicthys cataractae*), Atlantic salmon (*Salmo salar*), brook trout (*Salvelinus fontinalis*), creek chub (*Semotilus atromaculatus*), spottail shiner (*Notropis hudsonius*), white sucker (*Catastomus*

Division of Fisheries and Wildlife
Field Headquarters, One Rabbit Hill Road, Westborough, MA 01581 (508) 792-7270 Fax (508) 792-7275
An Agency of the Department of Fisheries, Wildlife & Environmental Law Enforcement

commersoni), blacknose dace (*Rhinichthys atratulus*), tessellated darter (*Etheostoma olmstedi*), fallfish (*Semotilus corporalis*), common shiner (*Notropis cornutus*), American eel (*Anguilla rostrata*), smallmouth bass (*Micropterus dolomieu*), brown bullhead (*Ameiurus nebulosus*), bluegill (*Lepomis macrochirus*), rainbow trout (*Oncorhynchus mykiss*), pumpkinseed (*Lepomis gibbosus*), largemouth bass (*Micropterus salmoides*) and rock bass (*Ambloplites rupestris*).

This evaluation is based on the most recent information available from the Division of Fisheries and Wildlife. Should your site plans change, or new information become available, this evaluation may be reconsidered.

If you have any questions regarding rare species, please contact Christine Vaccaro, Environmental Review Assistant, at ext. 154. If you have any questions regarding fisheries, please contact Richard Hartley, Aquatic Biologist, at ext. 132.

Sincerely,

Thomas W. French

Thomas W. French, Ph.D
Assistant Director

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

FEB 11 2003

John R. Kennelly
Deputy Chief, Engineering/Planning Division
U.S. Army Corps of Engineers
696 Virginia Road
Concord, Massachusetts 01742

Re: ACOE General Investigation of anadromous fish passage in the Green River

Dear Mr. Kennelly:

This letter is in response to your request for comments on the "General Investigation of the Green River" you submitted to us in accordance with the Fish and Wildlife Coordination Act, and Endangered Species Act. We appreciate the Army Corps of Engineers (ACOE) contacting us during the early stages of this project and welcome the opportunity to provide comments under the above-cited authorities. Please note that these comments are considered preliminary in nature due to the minimal amount of information available at this time. Once we receive more detailed construction plans describing the preferred alternative for fish passage, we will kindly offer our official recommendations on this project.

As you correctly pointed out in your letter, the Green River historically provided migratory corridors for Atlantic salmon, American shad, and blueback herring. Unfortunately, the building of various dams along this river has been detrimental to these species' habitat, and has likely contributed to the decline in population numbers for these anadromous fish. As such, the National Marine Fisheries Service supports the ACOE's investigation into the potential alternatives that may be available for increasing fish passage around the specified dams in the Green River.

With respect to selecting a preferred alternative for fish passage at the Wiley and Russell and Mill Street Dams, we encourage the ACOE to consider dam removal as an appropriate alternative for fish passage. Removal of these dams will help to restore the natural flows to this region of the river and allow for unobstructed fish passage. It may also create an opportunity for habitat restoration within the riverbed. We also support the restoration opportunities that may be available upstream of the swimming pool dam and encourage the ACOE to review the bioengineering technologies available for bank stabilization.

In regard to endangered or threatened species that may be present within the Green River, our Protected Resources Division has indicated that no species are expected to inhabit this region of the Connecticut River watershed. Shortnose sturgeon do inhabit the waters of the Connecticut River at this latitude; however, they have not been documented at th

proposed project sites. Please keep in mind that if additional information on listed or proposed species becomes available, this determination may be reconsidered.

Again, we appreciate the opportunity to comment on this project and support your efforts in restoring fish passage within the Green River. If you have any questions or comments on the information provided, please contact David MacDuffee (978-281-9319) for Fish and Wildlife Coordination Act issues, and Kim Damon-Randall (978-281-9112) for Endangered Species Act concerns.

Sincerely,

Peter Colosi, Jr.

Peter D. Colosi, Jr.
Assistant Regional Administrator
for Habitat Conservation

cc: Kim Damon-Randall, F/NER3

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XIII. Compliance With Environmental Statutes and Executive Orders (*Still needs some cultural resources and Farmland Protection Act coordination*)

A. Federal Statutes

1. Archaeological Resources Protection Act of 1979, as amended, 16 USC 470 et seq.

Compliance: Not Applicable as issuance of a permit from the Federal land manager to excavate or remove archaeological resources located on public or Indian is not required.

2. Preservation of Historic and Archeological Data Act of 1974, as amended, 16 U.S.C. 469 et seq.

Compliance: Project is being coordinated with the State Historic Preservation officer. Impacts to archaeological resources, if applicable, will be properly mitigated.

3. American Indian Religious Freedom Act of 1978, 42 U.S.C. 1996.

Compliance: Must ensure access by Native Americans to sacred sites, possession of sacred objects, and the freedom to worship through ceremonials and traditional rites.

4. Clean Air Act, as amended, 42 U.S.C. 7401 et seq.

Compliance: Public notice of the availability of this report to the Environmental Protection Agency is required for compliance pursuant to Sections 176c and 309 of the Clean Air Act.

5. Clean Water Act of 1977 (Federal Water Pollution Control Act Amendments of 1972) 33 U.S.C. 1251 et seq.

Compliance: A Section 404(b)(1) Evaluation and Compliance Review is incorporated into the project report. An application shall be filed for State Water Quality Certification pursuant to Section 401 of the Clean Water Act.

6. Coastal Zone Management Act of 1972, as amended, 16 U.S.C. 1451 et seq.

Compliance: Not Applicable. Project is not within the Coastal Zone.

7. Endangered Species Act of 1973, as amended, 16 U.S.C. 1531 et seq.

Compliance: Coordination with the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) has determined no formal consultation requirements are necessary pursuant to Section 7 of the Endangered Species Act.

8. Estuarine Areas Act, 16 U.S.C. 1221 et seq.

Compliance: Applicable only if report is being submitted to Congress. Report is not being submitted to Congress, therefore, Not Applicable.

9. Federal Farmland Protection Policy Act (FPPA) of 1981 7 U.S.C. 4201 et seq.

Compliance: Coordination with District Soils Conservation Office has occurred. Completed Farmland Conversion Impact Rating Form will be included with this EA.

10. Federal Water Project Recreation Act, as amended, 16 U.S.C. 4601-12 et seq.

Compliance: Public notice of availability of the project report to the National Park Service (NPS) and Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.

11. Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661 et seq.

Compliance: Coordination with the FWS, NMFS, and State fish and wildlife agencies signifies compliance with the Fish and Wildlife Coordination Act.

12. Land and Water Conservation Fund Act of 1965, as amended, 16 U.S.C. 4601-4 et seq.

Compliance: Public notice of the availability of this report to the National Park Service (NPS) and the Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.

13. Marine Protection, Research, and Sanctuaries Act of 1971, as amended, 33 U.S.C. 1401 et seq.

Compliance: Not applicable, the project does not involve the transportation or disposal of dredged material in ocean waters pursuant to Sections 102 and 103 of the Act, respectively.

14. National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470 et seq.

Compliance: Coordination with the State Historic Preservation Office signifies compliance.

15. Native American Graves Protection and Repatriation Act (NAGPRA), 25 U.S.C. 3000-3013, 18 U.S.C. 1170

Compliance: Regulations implementing NAGPRA will be followed if discovery of human remains and/or funerary items occur during implementation of this project.

16. National Environmental Policy Act of 1969, as amended, 42 U.S.C 4321 et seq.

Compliance: Preparation of an Environmental Assessment signifies partial compliance with NEPA. Full compliance shall be noted at the time the Finding of No Significant Impact is signed.

17. Rivers and Harbors Act of 1899, as amended, 33 U.S.C. 401 et seq.

Compliance: Not Applicable. No requirements for projects or programs authorized by Congress. The proposed aquatic ecosystem restoration project is being conducted pursuant to the Congressionally-approved authority.

18. Watershed Protection and Flood Prevention Act as amended, 16 U.S.C 1001 et seq.

Compliance: Floodplain impacts were considered in project planning.

19. Wild and Scenic Rivers Act, as amended, 16 U.S.C 1271 et seq.

Compliance: The Green River in the study area is not designated as a Wild and Scenic River under the Wild and Scenic Rivers Act.

20. Magnuson-Stevens Act, as amended, 16 U.S.C. 1801 et seq.

Compliance: Coordination with the National Marine Fisheries Service and preparation of an Essential Fish Habitat (EFH) Assessment signify compliance with the EFH provisions of the Magnuson-Stevens Act.

B. Executive Orders

1. Executive Order 11593, Protection and Enhancement of the Cultural Environment, 13 May 1971.

Compliance: Coordination with the State Historic Preservation Officer signifies compliance.

2. Executive Order 11988, Floodplain Management, 24 May 1977 amended by Executive Order 12148, 20 July 1979.

Compliance: Public notice of the availability of this report or public review fulfills the requirements of Executive Order 11988, Section 2(a) (2).

3. Executive Order 11990, Protection of Wetlands, 24 May 1977.

Compliance: Public notice of the availability of this report for public review fulfills the requirements of Executive Order 11990, Section 2 (b).

4. Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, 4 January 1979.

Compliance: Not applicable to projects located within the United States.

5. Executive Order 12898, Environmental Justice, 11 February 1994.

Compliance: The project is not expected to have a significant impact on minority or low-income population, or any other population in the project area.

6. Executive Order 13007, Accommodation of Sacred Sites, 24 May 1996.

Compliance: Not applicable. Project is not located on Federal Lands.

7. Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks. 21 April 1997.

Compliance: The project would not create a disproportionate environmental health or safety risk for children.

8. Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, 6 November 2000.

Compliance: This project has been coordinated with the Stockbridge-Munsee Tribal Historic Preservation Officer.

C. Executive Memorandum

Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing NEPA, 11 August 1980.

Compliance: Coordination with local NRCS and USDA has occurred. Farmland Conversion Impact Rating Form is included with EA

White House Memorandum, Government-to-Government Relations with Indian Tribes, 29 April 1994.

Compliance: Consultation with Federally Recognized Indian Tribes, where appropriate, signifies compliance. This project has been coordinated with the Stockbridge-Munsee Tribal Historic Preservation Officer.

Deerfield River General Investigation
Green River Dam Fish Passage Restoration Project
Greenfield, Massachusetts

Finding of No Significant Impact

The proposed Federal action involves the restoration of fish passage to the Green River by the removal of the Wiley Russell and Mill Street Dams; and the construction of Denil fish ladders at the town Swimming Pool and Water Supply Dams, in Greenfield Massachusetts. This will open an additional 21 miles of spawning and nursery habitat for up-migrating anadromous fish. In addition, upstream and downstream passage will be provided for catadromous fish (i.e. American eel) as well as resident river species that were previously unable to pass to areas upstream of the dams. Andromous species expected to benefit from the project include Atlantic salmon, blueback herring, American shad; and potamadromous species expected to benefit include smallmouth bass, white sucker, and brook trout.

The fish ladder at the Swimming Pool Dam will be constructed on the right bank of the river and will tie into the existing spillway and descend adjacent to the existing downstream abutment to its downstream entrance in the Green River. At the Water Supply Dam, the fish ladder will be also be constructed on the right bank of the river, tying into the right side of the spillway and having its entrance channel along the downstream bank. At Mill Street and Wiley Russell Dams, the existing structures will be removed in order to allow the Green River to flow freely. Minimal vegetated wetland habitat exists in the footprints of the proposed projects. At Mill Street, the existing upstream wetlands supported by the Dam are expected to revert to more historical riparian habitat consisting of a mixture of uplands and wetlands, with the existing areas of aquatic bed and emergent wetlands being reduced due to drainage of the impoundment. No significant long term or short-term adverse impacts to the environment are anticipated. Construction will begin on or after August 2007 when river conditions permit minimum impact to migratory fish species.

My determination of a Finding of No Significant Impact is based on the Environmental Assessment and the following considerations:

a. The project will restore a historic anadromous fisheries corridor and increase the fisheries carrying capacity of the Green River.

b. The project will have no known negative impacts on any State or Federal rare or endangered species.

c. Additional consultation will be completed with the MA SHPO and the Stockbridge-Munsee, Wampanoag, and Narragansett THPO's concerning whether there are prudent or feasible alternatives to the adverse effect of demolition of the Wiley and Russell Dam, and what the possible effects the project may have on archaeological resources. A Memorandum of Agreement (MOA) may need to be

executed to mitigate for adverse effects on significant cultural resources. The MOA and any ensuing mitigation must be completed prior to the conclusion of the Plans and Specifications phase of the project.

c. This project conforms with the Clean Air Act, Massachusetts State Implementation Plan.

d. Sediment loading would be minimized by employing erosion control plans, temporary cofferdams and by scheduling the construction during the seasonal low flow period. Detailed erosion control measures will be in place prior to construction activities.

Based on my review and evaluation of the environmental effects as presented in the Environmental Assessment, I have determined that the Green River Fish Passage Restoration Project is not a major Federal action significantly affecting the quality of the human environment. Therefore, I have determined that this project is exempt from requirements to prepare an Environmental Impact Statement.

11 March 08
Date

Curtis L. Thalken
Colonel, Corps of Engineers
District Engineer

CLEAN WATER ACT SECTION 404 (b)(1) EVALUATION

NEW ENGLAND DISTRICT
US ARMY CORPS OF ENGINEERS, CONCORD, MA
CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

PROJECT: Green River Fish Passage Restoration Project, Greenfield, MA, Conducted under the Authority of the Rivers and Harbors Act of 1902.

PROJECT MANAGER:	Mr. David Larsen	tel. 978-318-8113
FORM COMPLETED BY:	Mr. Ken Levitt	tel. 978-318-8114

DESCRIPTION: The selected plan consists of the construction of Denil fish ladders at two dams on the upper Green River in Greenfield Massachusetts; and the removal of two dams on the lower Green River in Greenfield Massachusetts; to provide migratory fish passage for a distance of 21 miles along River into Vermont. Removal of the two dams will involve excavation of sections of the timber crib spillway structure at the Wiley Russell Dam, with subsequent bank stabilization, and removal of the concrete spillway structure at the Mill Street Dam, with subsequent bank stabilization. Construction of the fish ladders will involve excavation of the right bank and the stream bed of the Green River at the town Swimming Pool Dam and the right bank and the stream bed at the Town Water Supply Dam. This will be necessary to provide support footings for the concrete channels, and create temporary access to the work areas. Less than 100 cubic yards of bank material will be excavated at each location and it will either be replaced or disposed of at an approved upland site. In addition, clean material will be placed into the river at the base of the Water Supply Dam, in order to create a temporary access road for the construction activities. This road will be removed upon completion of construction activities. Temporary cofferdams and proper erosion control measures will be employed during the construction period. Upon completion of the project, the banks will be stabilized and replanted with native vegetation.

NEW ENGLAND DISTRICT
US ARMY CORPS OF ENGINEERS, CONCORD, MA

PROJECT: Green River Ecosystem Restoration Project-Conducted under the US Army Corps of Engineers Authority contained in Section 206 of the 1996 Water Resources Development Act, as amended.

CLEAN WATER ACT
Evaluation of Section 404(b)(1) Guidelines

1. Review of Compliance (Section 230.10(a)-(d)).

A review of the permit application indicated that:

a. The discharge represents the least environmentally damaging practicable alternative and if in a special aquatic site, the activity associated with the discharge must have direct access or proximity to, or be located in the aquatic ecosystem to fulfill its basic purpose.

X
YES NO

b. The activity does not appear to:

1) violate applicable state water quality standards or effluent standards prohibited under Section 307 of the CWA;

2) jeopardize the existence of Federally listed threatened and endangered species or their habitat; and

3) violate requirements of any Federally designated marine sanctuary.

X
YES NO

c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values.

X
YES NO

d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem.

YES	NO
X	

2. Technical Evaluation Factors (Subparts C-F).

	N/A	Not Signi-ficant	Signi-ficant
a. Potential Impacts on Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C).			
1) Substrate.		X	
2) Suspended particles/turbidity.		X	
3) Water column impacts.		X	
4) Current patterns and water circulation.		X	
5) Normal water fluctuations.	X		
6) Salinity gradients.	X		
b. Potential Impacts on Biological Characteristics of the Aquatic Ecosystem (Subpart D).			
1) Threatened and endangered species		X	
2) Fish, crustaceans, mollusks, and other organisms in the aquatic food web.		X	
3) Other wildlife (mammals, birds, reptiles and amphibians).		X	
c. Potential Impacts on Special Aquatic Sites (Subpart E)			
1) Sanctuaries and refuges.	X		
2) Wetlands.		X	
3) Mud flats.		X	
4) Vegetated shallows.		X	
5) Coral reefs.	X		
6) Riffle and pool complexes.		X	
d. Potential Effects on Human Use Characteristics (Subpart F).			
1) Municipal and private water supplies.		X	

2)	Recreational and commercial fisheries.		X	
3)	Water-related recreation.		X	
4)	Aesthetics impacts.		X	
5)	Parks, national and historic monuments, national seashores, wilderness areas, research sites and similar preserves.		X	

Remarks: Explanation of identified significant impacts: See also Environmental Assessment and reference to coordination with State Historic and Preservation Office.

3. Evaluation and Testing (Subpart G).

a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material. (Check only those appropriate.)

1) Physical characteristics.....X

2) Hydrography in relation to known or anticipated sources of contaminants.....X

3) Results from previous testing of the material or similar material in the vicinity of the project.....X

4) Known, significant sources of persistent pesticides from land runoff or percolation.....__

5) Spill records for petroleum products or designated hazardous substances (Section 311 of CWA)..... __

6) Public records of significant introduction of contaminants from industries, municipalities, or other sources..__

7) Known existence of substantial material deposits of substances

which could be released in harmful quantities to the aquatic environment by man-induced discharge activities..... X

8) Other sources (specify).....

List appropriate references
See Environmental Assessment

b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredge or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and disposal sites and not likely to require constraints. The material meets the testing exclusion criteria.

X YES ___ NO

4. Disposal Site Delineation (Section 230.11(f)).

a. The following factors, as appropriate, have been considered in evaluating the disposal site.

1) Depth of water at disposal site..... NA
2) Current velocity, direction, and variability at disposal site..... NA
3) Degree of turbulence..... NA
4) Water column stratification..... NA
5) Discharge vessel speed and direction..... NA
6) Rate of discharge..... NA
7) Dredged material characteristics (constituents, amount, and type of material, settling velocities)..... NA
8) Number of discharges per unit of time..... NA
9) Other factors affecting rates and patterns of mixing (specify)..... NA

List appropriate references.
See Environmental Assessment, Not applicable. Work involves construction of temporary coffer dams consisting of either portable dams, earth or sandbags.

b. An evaluation of the appropriate factors in 4a above indicated that our disposal sites and/or size of mixing zone are acceptable.

X YES _ NO

5. Actions To Minimize Adverse Effects (Subpart H).

All appropriate and practicable steps have been taken, through application of recommendation of Section 230.70-230.77 to ensure minimal adverse effects of the proposed discharge. X YES ___ NO

List actions taken.

See Environmental Assessment

6. Factual Determination (Section 230.11).

All review of appropriate information, as identified in items 2-5 above; indicate there is minimal potential for short or long term environmental effects of the proposed discharge as related to:

a. Physical substrate at the disposal site (review sections 2a, 3,4, and 5 above). YES X NO__

b. Water circulation, fluctuation and salinity (review sections 2a, 3, 4, and 5). YES X NO___

c. Suspended particles/turbidity (review sections 2a, 3, 4, and 5). YES X NO___

d. Contaminant availability (review sections 2a, 3, and 4). YES X NO___

e. Aquatic ecosystem structure, function and organisms (review sections 2b and c, 3, and 5) YES X NO___

f. Proposed disposal site (review sections 2, 4, and 5). YES X NO___

g. Cumulative effects on the aquatic ecosystem. YES X NO____

h. Secondary effects on the aquatic ecosystem. YES X NO____

7. **Findings**

The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines.....YES X NO____

11 March 08

DATE

Curtis L. Thalken
Colonel, Corps of Engineers
District Engineer