Section 506 Great Lakes Fishery and Ecosystem Restoration
Preliminary Restoration Plan for
the Boardman River Mainstem
Grand Traverse County, Michigan

November 2005

U.S. Army Corps of Engineers

Preliminary Restoration Plan
Boardman River
Section 506 Great Lakes Fishery and Ecosystem Restoration

1. PROJECT: Boardman River: Great Lakes Fishery and Ecosystem Restoration

Congressional District: MI-4, Camp
Senators Stabenow and Levin

Authority: Section 506 (Great Lakes Fishery and Ecosystem Restoration) of the Water Resources Development Act of 2000 (PL 106-541), which states in paragraph c(2):

> "The Secretary shall plan, design, and construct projects to support the restoration of the fishery, ecosystem, and beneficial uses of the Great Lakes".

2. LOCATION:

State: Michigan
County: Grand Traverse

The Boardman River is located in the northwestern portion of Michigan's Lower Peninsula. The river originates in central Kalkaska County, flows southwest into Grand Traverse County where it turns north and flows into West Grand Traverse Bay, Lake Michigan in Traverse City, Michigan (Figures 1 and 2). The Boardman River watershed drains a surface area of approximately 291 square miles and includes 179 lineal stream miles and 12 natural lakes. The project area is a 20-mile plus section of the Boardman River's main stem, located in Grand Traverse County, which empties into the bay and contains four dams (Figure 3): Union Street Dam, located at river mile 1.5, Sabin Dam at 5.3, Boardman Dam at 6.1, and Brown Bridge Dam at 18.5. The project area spans from upstream of Brown Bridge Pond's inlet to the mouth of the river.

3. DESCRIPTION OF THE PROPOSED PROJECT

The Boardman River

The Boardman River is a designated Natural River under the State of Michigan Natural Rivers Program. Outside of the project area, the Boardman River is a top-quality trout stream with 36 lineal miles of Blue Ribbon Trout Stream designated by the Michigan Department of Natural Resources (MDNR) Fisheries Division. The Boardman River is considered one of the top ten best trout streams in Michigan (Huggler and Barfknecht 1995). The Boardman River supports self-sustaining populations of brown (*Salmo trutta*), brook (*Salvelinus fontinalis*), and rainbow trout (*Oncorhynchus mykiss*). Steelhead (*O. mykiss*), coho salmon (*O. kisutch*), and Chinook salmon (*O. tshawytscha*) are stocked into the Boardman River watershed to supplement the Lake Michigan fishery and provide potamodromous angling opportunities downstream of Sabin Dam. MDNR

Fisheries Division also operates a salmon trap and transfer facility approximately ¼ mile upstream of the mouth to control upstream salmon migration.

Mitigating the ecosystem disruption to the project area caused by the Boardman Dams would add approximately 20 miles of top quality trout stream.

The Boardman Dams

Table 3-1
Boardman Dams' Dimensions

	Structural Height	Head	Length	Size of Impoundment
Union Street	10 ft	9 ft	200 ft	339 acres
Sabin	32 ft	20 ft	921 ft	40 acres
Boardman	56 ft	41 ft	900 ft	103 acres
Brown Bridge	46 ft	33 ft	2,400 ft	191 acres

Union Street Dam. The Union Street Dam was constructed in 1867 to supply power for a now defunct flourmill. It is owned by the City of Traverse City (referred to as Traverse City from this point on) and its current purpose is to maintain the water level in Boardman Lake. The dam is composed of earthen materials and steel sheet pile. The dam has a fish ladder, constructed to allow migration of potomadromous salmon and trout while blocking upstream sea lamprey (*Petromyzon marinus*) migration.

The dam's impoundment, Boardman Lake, is a natural lake that was originally 259 acres in size and increased to 339 acres after the Union Street Dam was constructed. There are approximately 40 privately owned parcels and two parks, one with a boat ramp, on Boardman Lake.

.

Sabin Dam. Sabin Dam (Figure 4) was constructed in 1906 and was rebuilt to its current configuration in 1930. It is an earthen and concrete dam with a powerhouse capable of generating 500 kilowatts (0.5 megawatt). The dam's impoundment, Sabin Pond, has a drainage area of 269 sq. miles.

Sabin Dam is owned by Grand Traverse County and generates hydropower for Traverse City Light and Power Department (TCLPD is a community-owned, municipal utility). By agreement between Grand Traverse County and TCLPD, the Sabin Dam was retrofitted to produce hydropower and began generating in 1986. Sabin Dam is currently operated as a run-of-river dam. A run-of-river dam is a hydroelectric dam lacking a large reservoir and, therefore, with only a limited capacity for water storage. This means a run-of-river dam has limited control over its outflow and power generation.

Boardman Dam. Also locally referred to as Keystone Dam, Boardman Dam (Figure 5) was constructed in 1894 and rebuilt to its current configuration in 1930. It is an earthen and concrete dam with a powerhouse capable of generating 1,000 kilowatts (1.0

megawatt). It is owned by Grand Traverse County and generates hydropower for TCLPD. The Boardman Dam is currently operated as a run-of-river dam.

The Boardman Dam spillway is crossed over by a one-lane bridge connecting two sections of Cass Road, a county road.

Like the dam, this impoundment is known locally as both Boardman Pond and Keystone Pond. Boardman Pond has a drainage area of 267 sq. miles. Twenty-seven private parcels either border or have deeded access to Boardman Pond.

Brown Bridge Dam. Brown Bridge Dam (Figure 6) was constructed in 1921 and is an earthen and concrete dam with a powerhouse capable of generating 725 kilowatts (0.725 megawatt). It is also owned by Traverse City and generates hydropower for TCLPD. Brown Bridge Dam is operated as a run-of-river dam. Its impoundment, Brown Bridge Pond has a drainage area of 151 sq. miles.

The three hydro dams, Sabin, Boardman and Brown Bridge, produce an approximate total 10,784 megawatt hours of energy per year, which accounts for only 3.4% of the electricity needs for TCLPD's rate payers. On May 31, 2005 a settlement agreement was executed among the TCLPD, Traverse City, Grand Traverse County, the Federal Energy Regulatory Commission (FERC) the Michigan Department of Environmental Quality (MDEQ) and others that transferred regulatory jurisdiction of these three dams from FERC to the MDEQ. As FERC no longer retains jurisdiction over these three dams, the responsibility for their maintenance, decommissioning and potential removal falls on TCLPD, Traverse City and Grand Traverse County. TCLPD is now in the process of decommissioning these dams in preparation for their removal.

Description of the Problem

The four dams on the Boardman River, collectively referred to as the Boardman Dams, are damaging the ecosystem of the project area, thereby reducing trout populations. The degrading effects of impoundments on fisheries habitat and populations are well documented (Morita and Yamamoto 2001, Pejchar and Warner 2001, Taylor et al. 2001, Kanehl et al. 1997). The specific adverse effects these dams have on trout populations and habitat in the Boardman River are: habitat fragmentation, habitat degradation, thermal disruptions and induced species disruptions.

Habitat Fragmentation

The Boardman Dams fragment the Boardman River mainstem into four discontinuous segments: downstream of Sabin Dam, downstream of Boardman Dam, downstream of Brown Bridge Dam, and upstream of Brown Bridge Dam. This fragmentation of the Boardman River's fish populations, specifically resident brown and brook trout, increases their vulnerability to environmental degradation (pollution, habitat degradation, and wetland filling) and decreases their genetic diversity. Genetically distinct populations are less capable of evolving with changing environmental conditions since their genetic

diversity is geographically limited (Morita and Yamamoto 2001, Neraas and Spruell 2001).

In addition, discontinuous passage throughout most of the Boardman River mainstem inhibits fish populations from searching for optimal sediment sizes (gravel and cobble) and water levels for spawning, locating areas of optimal food availability and locating areas with minimal predation risk (Bednarek 2001, Regal 1992, and Clapp et. al 1990).

Habitat Degradation

The Boardman Dams limit the downstream transport of woody debris, vegetation and sediment throughout the river in the project area. Limiting these materials degrades trout fisheries and aquatic invertebrate habitat. Woody debris is an important habitat component providing food, refuge, cover and channel diversity to a variety of aquatic invertebrate and fish species (Johnson et al. 2003, Zika and Peter 2002). Woody debris also protects banks from excessive erosion.

Riparian vegetation is an important habitat component providing food, refuge and shade to trout and other aquatic species. Riparian vegetation reduces the erosive potential of flowing water by stabilizing banks and decreases the influx of pollutants and excess nutrients to the Boardman River. The Boardman Dams decrease the diversity of riparian vegetation in the project area by disrupting downstream dispersal of reproductive materials (Andersson et al. 2000). Seeds and/or plant fragments settle out in the impoundments preventing further dispersal downstream.

Sediment is also an important habitat component of the Boardman River because it determines channel form (Kondolf 1997). Water discharged from the dams carries less sediment than a free flowing system would. Therefore, the Boardman River must compensate for decreased sediment load by eroding its banks and bed downstream of the dams, which degrades fish habitat (Kondolf 1997). The impoundments these dams create also decrease natural flow velocities, which cause sediment to be deposited within and upstream of the impoundments. Sediment accrual fills boulder, cobble and gravel habitat interstices which are used by numerous invertebrate and fish species as spawning, rearing, feeding habitat and refuge from predators (Mundie and Crabtree 1997). The inlets to Boardman Lake, Brown Bridge, Boardman and Sabin Ponds are filling with sediment since natural flow velocities have decreased. Sediment is being deposited upstream of these inlets at increasing rates, which widens the Boardman River making it shallower, wider, warmer and less hospitable for aquatic invertebrates and fish. Fisheries habitat and populations in these impoundments will continue to degrade over time due to the continuous influx of sediment.

It is also noteworthy that heavy sediment accrual limits hydropower generation capability. For example, excessive sediment accrual led to the failure of the generating equipment and eventual removal of the Stronach Dam from the Pine River in northern Michigan (Mistak et al. 2003).

Thermal Disruptions

The Boardman Dams all draw water from the top of the water column, adversely affecting water temperature and directly impacting coldwater fish species. The MDNR Fisheries Division collected water temperatures at hourly intervals two miles upstream of the Brown Bridge Pond inlet (Sheck's campground) and 0.20 miles downstream from the Brown Bridge Dam (canoe launch) throughout 2002. Water discharged out of Brown Bridge Dam averaged six degrees Fahrenheit warmer than water in the upstream channel from June-August 2002, which does not meet the requirements of Rule 75 of Part 4, Water Quality Standards, of the Natural Resources and Environmental Protection Act, 1994 PA 451. This rule states that rivers, streams and impoundments naturally capable of supporting coldwater fish shall not receive a heat load which would increase the temperature of the receiving waters at the edge of the mixing zone more than two degrees Fahrenheit above the existing natural water temperature.

In July of 2002, water temperature was recorded at 75° F below Brown Bridge Dam. Mid to high 70° F water temperatures are considered lethal to a variety of coldwater fish species, including brook and brown trout (Cushing and Allan 2001). Brook trout exhibit neutral to negative growth at or above 66° F; maximum growth for brook and brown trout occurs from 54-57° F (Dodds 2002). The average water temperature (June 1-August 31, 2002) was 66° F below Brown Bridge Dam and 60° F upstream of the impoundment. Therefore, the Brown Bridge Dam warm water discharge is negatively affecting brook and brown trout growth rates.

Although temperatures were only measured downstream and upstream of the Brown Bridge Pond, it is reasonable to assume that measurements taken near the other impoundments would reveal similar thermal disruptions.

The Boardman Dams also reduce diurnal water temperature fluctuations (lower water temperature at night and higher water temperature during the day). This unnatural temperature regime alters metabolism rates and timing of fish spawning and hatching. The lack of fluctuating temperatures also unnaturally stresses coldwater fish populations by diminishing coldwater peaks at night, which normally serve as thermal refuges during the summer. MDNR Fisheries Division collected water temperatures at hourly intervals from May 4-July 20, 2004 at six locations downstream of Brown Bridge Dam. Water temperatures were relatively static close to the dam. However, as distance from the dam increased, the frequency and amplitude of temperature fluctuations increased. In addition, as distance from the dam increased, water temperature decreased and prolonged periods of warm water temperatures (above 66° F) decreased, indicating natural thermal fluctuation was restored. The suppression of water temperature fluctuations was also observed below Boardman and Sabin Dams.

The negative effects of warm water discharge on coldwater fish species in the Boardman River were documented by Lessard and Hayes (Lessard and Hayes 2003). Lessard and

Hayes sampled the Boardman River fish population at six randomly selected 300-foot sample sites (three sites were located within a three mile stretch downstream of Brown Bridge Dam, and three sites were located within a three mile stretch upstream of the inlet). Lessard and Hayes document significant differences among population abundances of slimy sculpin (*Cottus bairdii*), brook, and brown trout upstream of Brown Bridge Pond versus downstream of the dam (Table 4-2). Lessard and Hayes attribute this discrepancy to the adverse effect the Brown Bridge Dam warm water discharge has on coldwater fish populations, since water temperature was the only habitat variable that was significantly different between the upstream and downstream sample sites.
A map showing the location of testing sites and graphs of the observed temperatures and fluctuations at these locations are presented in Appendix A.

Table 3-2. Coldwater Fish Abundance Upstream and Downstream of Brown Bridge Dam.

Fish species	**Fish Density (fish/hectare)**	
	Upstream of Brown Bridge Pond inlet	Downstream of dam
Brown trout	585	342
Brook trout	234	18
Slimy sculpin	1124	277
Total	1943	637

Induced Species Disruptions

The unnaturally warm temperatures in sections of the Boardman River also disrupt the ecosystem by inducing competition from coolwater fish species that would otherwise not compete for the same habitat as the coldwater trout and sculpin species. The MDNR found that the impoundments on Boardman River are inhabited by self-sustaining species populations typical of cool water environments (Table 4-3).

Table 3-3
Coolwater Fish Species in Boardman Impoundments

Genus species	**Common name**	**Genus species**	**Common name**
Esox lucius[1234]	Northern pike	*Sander vitreus*[1]	Walleye
Esox americanus vermiculatus[1]	Grass pickerel	*Pomoxis nigromaculatus*[1]	Black crappie
Lepomis gibbosus[1234]	Pumpkinseed-sunfish	*Ameiurus nebulosus*[13]	Brown bullhead
Lepomis macrochirus[134]	Bluegill	*Ameiurus melas*[134]	Black bullhead

Ambloplites rupestris[1234]	Rock bass	*Catostomus commersonii*[1234]	Common white sucker
Micropterus salmoides[14]	Largemouth bass	*Luxilus cornutus*[14]	Common shiner
Micropterus dolomieu[134]	Smallmouth bass	*Notropis stramineus*[1]	Sand shiner
Perca flavescens[1234]	Yellow perch	*Etheostoma nugrum*[1]	Johnny darter
		Notemigonus crysoleucas[24]	Golden shiner

Boardman Lake[1], Sabin Pond[2] , Boardman Pond[3], and Brown Bridge Pond[4]
Source: Michigan Department of Natural Resources, Fisheries Division, unpublished data.

These coolwater fish species thrive at temperatures detrimental to coldwater species. The unnatural warming of habitat downstream of the dams induces these coolwater species to migrate out of the impoundments, thereby forcing the already threatened coldwater species to endure increased competition for resources and predation.

Damming the Boardman River has also allowed the exotic zebra mussel (*Dreissena polymorpha*) to inhabit Boardman Lake and Brown Bridge Pond. The zebra mussel is notorious for disrupting the food web of an ecosystem, thereby negatively impacting native fish populations. If these dams were removed, zebra mussel colonization of the project area would likely be limited to Boardman Lake since the Boardman River mainstem would not provide optimal habitat (Griffiths et al. 1989).

Cumulative Effects

The cumulative effects of disturbed habitat, introduction of coolwater species and zebra mussels, disruption of natural flow and thermal regimes and habitat fragmentation have contributed to decreased abundance of trout populations immediately upstream and downstream of the Boardman Dams. MDNR Fisheries Division assessed brown and brook trout populations in 1987, 1988, 1989, and 1994 at Shumsky's canoe launch, Brown Bridge Road crossing, Sheck's State campground, Ranch Rudolf campground, the Fork's State campground, Broomhead Road crossing on the South Branch of the Boardman River, and the Broomhead Road crossing on the North Branch of the Boardman River. Population estimates were generated by MDNR Fisheries Division using the Chapman-Peterson model (Ricker 1975). The population estimates for brown and brook trout were lower downstream of Brown Bridge Dam than upstream. The degrading effects of unnatural impoundments on coldwater fish species and habitat are a major factor contributing to the decreased abundance of brown and brook trout downstream of Brown Bridge Dam. Evidence suggests that the remaining Boardman Dams are causing similar declines in coldwater fish populations.

Restoration Alternatives Considered

1. No Action:

The No Action alternative entails leaving the Boardman Dams in place and constructing no modifications to those dams. This alternative would not address issues related to habitat fragmentation, habitat degradation, thermal disruptions or induced species disruptions.

2. Breaching/Removing Brown Bridge, Boardman and Sabin Dams and Reconstructing the Fish Ladder at Union Street Dam:

This alternative entails breaching/removing the Brown Bridge, Boardman and Sabin Dams and reconstructing the fish ladder at Union Street Dam to allow the upstream migration of trout and other desirable fish species, such as the lake sturgeon. The reconstructed fish ladder would continue to block migration of nuisance and exotic species. This alternative addresses all of the water quality issues for the riverine reaches upstream of Boardman Lake. It reconnects the system and restores stream function to the Boardman River watershed upstream of Boardman Lake.

The Boardman, Sabin and Brown Bridge Dams would be breached to the extent necessary to redirect the stream into its historic channel. Further investigation and engineering design would be conducted during feasibility to determine location and size of the breach. Such analysis would also determine if it would be necessary to remove the concrete sections of the dams or their powerhouses to properly redirect the stream. This analysis would maximize benefits while maximizing cost effectiveness.

Steps would be taken to promote safety and to minimize effects downstream. Before any breaching or removal of dams, the impoundments would be lowered as much as possible through the spillways or spill facilities. When/if necessary to remove powerhouses, cofferdams would be constructed to allow for safe and effective removal.

Further investigation would be conducted during feasibility to determine the amount of accumulated sediment behind the dams that would need to be removed to promote proper streamflow. During construction, this sediment would be removed and deposited in the former impoundment locations.

Further investigation and engineering design would be conducted during feasibility to address Cass Road in the Boardman Dam spillway. Because this road crosses the historic channel, restoring the stream in that location would potentially flood or destabilize the road. This analysis would determine if it was possible to alter the stream to negate or minimize any adverse effects. This analysis would also determine what improvements would be necessary to protect the road. Finally, a decision would be made regarding the extent of the Federal responsibility in protecting this road.

Appropriate erosion control and bank stabilization would be constructed wherever necessary at sites to prevent bank collapse and unnatural sediment loading of the stream.

The fish ladder at Union Street Dam would be reconstructed to have wider, shallower steps to allow passage to larger fish species, such as the lake sturgeon, which historically lived in the Boardman River.

Further investigation would be conducted during the feasibility phase to ascertain the structural stability of the Boardman Dams. This analysis would determine if, and at what costs, repairs to the dams would be needed to ensure their long-term stability. The feasibility study would identify the potential short and long term economic costs and environmental effects of upgrading, maintaining, and repairing the dams.

A flood plain map of the project area will be created or updated (if one already exist) that determines dwellings within the flood plain if any or all dams was removed.

3. Breaching/Removing Union Street, Brown Bridge, Boardman and Sabin Dams:

This alternative addresses all of the water quality issues for the projects upstream of Boardman Lake and restores complete connectivity of the Boardman River to Lake Michigan. In addition to trout species, breach/removal of these dams would allow for potential restoration of lake sturgeon to the Boardman River watershed (Whelan and Hay-Chmielewski 1997). However, there are concerns with contaminated sediments in Boardman Lake that would likely be mobilized and transported to Grand Traverse Bay and Lake Michigan if the Union Street Dam were removed. Another negative consequence of removing this dam would be the allowance of upstream migration by undesirable fish and nuisance exotic species such as sea lamprey. Removal of the Union Street Dam would require large real estate expenditures as this dam is located in a highly commercial and beach resort area.

4. Installing Fish Ladders/Bottom Draws:

This alternative involves modifying the Boardman Dams by installing fish ladders and water withdrawal structures. Fish ladders would allow the trout to move throughout the system, lessening the adverse impacts of habitat fragmentation. Bottom draw intakes can address some of the water quality issues related to temperature, but would not restore the diurnal temperature fluctuation in the riverine system needed to maintain healthy metabolism rates of coldwater species and the proper timing of these species' spawning and hatching cycles.

This alternative, while addressing some issues, does not address all of the environmental concerns regarding aquatic habitat in the Boardman River project area. The issues relating to habitat degradation, zebra mussel infiltration and high maintenance costs would remain.

Recommended Action

Sufficient Federal interest exists to recommend that the Boardman River Mainstem Restoration Project continue into the Feasibility Phase under Section 506, Great Lakes Fishery and Ecosystem Restoration, of the WRDA of 2000.

Future Without Project Condition

The Without Project Condition assumes that Traverse City and Grand Traverse County would not remove the Union Street, Sabin, Boardman and Brown Bridge Dams. The Boardman Dams would continue to fragment the Boardman River into four discontinuous segments, leading to more loss of genetic diversity in the trout populations. Also, trout species would continue to face the problems of habitat degradation and thermal disruptions. In all likelihood, trout populations would remain artificially low.

Coolwater fish populations would also experience negative effects. As silt accumulates in the impoundments, these fish species would face loss of habitat. The MDNR finds it likely that coolwater species populations would not be able to sustain themselves.

Traverse City and Grand Traverse County would most likely only make repairs to these four dams when such repairs become necessary.

Future With Project Condition

The Future With Project Condition assumes that the Corps pursues alternative plan two, the removal of Brown Bridge, Boardman and Sabin Dams and the reconstruction of the fish ladder at Union Street Dam. With Corps participation, the Sabin, Boardman and Brown Bridge Dams would be breeched or removed, reconnecting the Boardman River trout populations with Lake Michigan. The Sabin, Boardman and Brown Bridge Ponds would be converted to free-flowing channel. Many acres of retained river habitat would be transformed to the free river habitat that better suits the trout species. The amount of riparian habitat would also increase. Table 8-2 presents quantified estimates for these habitat units.

The free river restored in the project area would be high gradient. This fast-flowing water would correct the ecosystem problems associated with habitat degradation and thermal disruptions. A fuller discussion of these ecosystem benefits is included in paragraph 8.

The MDNR believes that with dam removal, the zebra mussel infestation would be confined to Boardman Lake as the river would not provide optimal habitat for this invasive species. Also, because the high gradient river would be cold water, the coolwater species that have been competing with the coldwater trout species would most likely migrate from the river or be confined to Boardman Lake.

All streambanks in the area of the removed dams, and in any other necessary area, would have erosion control and bank stabilizing measures applied to prevent erosion or the caving in of streambanks.

4. REAL ESTATE INFORMATION

The proposed plan, consisting of removal of three hydroelectric dams, restoration of the historic channel of the Boardman River and reconstruction of the fish passage way at the Union Street Dam, requires the non-federal sponsors to provide lands, easements, rights-of-way, relocations and disposal areas (LERRD's). The current impoundments created by the dams are 40 acres for the Sabin Dam, 103 acres for the Boardman Dam and 191 acres for the Brown Bridge Dam. Restoring the Boardman River channel in these impoundments is currently estimated to require a strip of land five miles long and 100 feet wide. This totals 60 acres of land. The non-federal sponsors need to have, at a minimum, a permanent channel improvement easement on this land for project construction and future operation and maintenance.

The removal of the three dams requires work and staging areas. These areas total 20 acres. The sponsors need to have two-year temporary work area easements over the 20 acres of staging areas. Access to the dams is from public roads. Thus, temporary access easements are not required. The reconstruction of the fish ladder at the Union Street dam will, also, require a two-year temporary work area easement of one acre. The disposal of sediment is planned to take place within the 60 acres permanent easement area. The construction debris will be disposed in a commercial landfill. Total land required for the Project is estimated at 81 acres.

The three dams, as well as most of the land around the impoundments, are owned in fee by the non-Federal sponsors. The City of Traverse City, Michigan owns the Brown Bridge Dam plus all the land around the impoundment. The Sabin and Boardman dams are owned by Grand Traverse County. The County also owns all the land around the Sabin impoundment. Around the Boardman Dam impoundment, there are an estimated 27 privately owned parcels plus an additional four parcels with access rights to the impoundment.

During the Project's feasibility phase, it is important to determine whether the private owners possess riparian rights over the Boardman impoundment. Although land abutting natural and man made lakes generally include riparian rights, these rights may not exist depending on the real estate interests conveyed to the owners abutting the lake. This is especially true with regard to man made lakes, since the ownership of the submerged land may not have been conveyed to the abutting land owners. This determination is important for calculating the value of the land needed for the Project. If the abutting owners possess riparian rights, the elimination or impairment of these rights by the Project will negatively impact the value of the portion of the remaining land not acquired for the Project. [1]

[1] The statutory authority and project cooperation agreement obligate the local sponsors to determine legal title of any land needed for the project except land owned by the federal government. To prevent possible

The land around the impoundments is classified as either forest reserve or residential with all the land around the Brown Bridge Pond Dam classified as forest reserve. Approximately 80% of the land needed for the Project is forest reserve land owned by the non-federal sponsors. Until it is determined the abutting private owners do not have riparian rights, the remaining 20% of the project land will be considered zoned residential and privately owned.

The value of the land needed for the Project varies depending on which impoundment it abuts. Residential land around Boardman Pond is valued at $62,000 per acre. On Sabin Pond residential land is valued at $21,000 per acre. Brown Bridge Pond does not have any residential land abutting it, but residential land in the area without lake access is valued at $6,450 per acre. Using these estimates and adjusting for duration and use, the 60 acres of permanent channel improvement easement has an estimated fair market value of $411,100 and the temporary work area easements $24,515. This provides an estimate land value of $435,615. A Corps appraiser has reviewed this cost estimate and concurs in its use in this report based upon review of available data. The non-federal sponsors incidental costs are estimated at $60,000. Thus, the total LERRD's cost is $495,615.

This amount is based upon a very broad calculation of land values determined by review of GIS data of recent sales, current assessment values and tax assessment of land parcels in the immediate area. All the data is found on the Grand Traverse County's web site. The value of vacant residential land was partially determined by the land residual technique of valuation. It is likely this amount will significantly change based upon a gross appraisal from a qualified appraiser performed during the Project's planning and design phase.

During the planning & design phase, Real Estate Division will develop detail information on the Project's real estate requirements, participate in developing Project alternatives, determine the non-Federal sponsors' legal and financial capabilities, prepare a real estate cost estimate based on a gross appraisal and create a Real Estate Plan for the decision document.

5. VIEW OF THE SPONSOR

The Grand Traverse County Board of Commissioners and the Traverse City Board of Commissioners have signed Letters of Intent to proceed with the Section 206 process. The sponsors are currently drafting new Letters of Intent and have expressed willingness now that this project is being pursued under the Section 506 program. Both non-Federal sponsors are dedicated to exploring all the options involved with potential removal of Union Street, Sabin, Boardman, and Brown Bridge Dams.

---

schedule delays, the local sponsors are encouraged to determine legal title to the project land during the feasibility phase of project development. This determination is especially crucial to the submerged land of Boardman Dam impoundment.

6. VIEWS OF FEDERAL, STATE, AND REGIONAL AGENCIES

The proposed project is consistent with the mission of the MDNR and the Grand Traverse Band of Ottawa and Chippewa Indians. These two agencies strongly support the proposed project and have a desire to provide appropriate assistance and resources during the study, construction and project implementation. The MDNR has provided much assistance to the Corps in preparing the draft PRP.

7. ENVIRONMENTAL COMPLIANCE REQUIREMENTS

Alternatives would be evaluated pursuant to all appropriate statutes, executive orders, and memoranda including: Fish and Wildlife Act of 1956; Fish and Wildlife Coordination Act of 1958; National Historic Preservation Act of 1966; National Environmental Policy Act of 1969; Clean Air Act of 1970; Executive Order 11593, Protection and Enhancement of the Cultural Environment, May 1971; Endangered Species Act of 1973; Clean Water Act of 1977; Executive Order 11988, Flood Plain Management, May 1977; and Executive Order 11990, Wetland Protection, May 1977. Project alternatives would be coordinated with the appropriate Federal and State agencies for review under each of the appropriate statutes, executive orders, and memoranda.

The District will complete an Environmental Assessment (EA) to address environmental impacts of the proposed project. The District Engineer will issue a Finding of No Significant Impact (FONSI) or perform an Environmental Impact Statement (and issue a Record of Decision), as appropriate, during the feasibility phase. Several issues that will be investigated during the feasibility phase are:

1) Boardman and Brown Bridge Ponds provide nesting habitat for the common loon (*Gavia immer*). The common loon is a State of Michigan listed threatened species. Therefore, strict precautions should be taken to assure no loons are adversely affected during the dam removal process. The EA (or EIS) that will be completed (pending approval of this document) will detail specific precautions that would need to be implemented to assure no or minimal adverse affects to the common loon if the dams are removed. There are numerous lakes in the Boardman River watershed that provide suitable habitat for the relocation of common loon nests from Brown Bridge and Boardman Ponds including Boardman, Arbutus, Spring and Spider Lakes. There is also a bald eagle (*Haliaeetus leucocephalus*) nest near Brown Bridge Pond. The bald eagle is a federally listed threatened species and protected under the federal Endangered Species Act. The EA (or EIS) that will be completed (pending approval of this document) will also detail specific precautions that would need to be implemented to assure no or minimal adverse affects to the bald eagle if during the dam removal process.

2) There may be a loss of wetland habitat due to the dam removal process, particularly in the inlet areas of Boardman Lake, Sabin Pond, Boardman Pond and Brown Bridge Pond. However, new wetland areas will be created as the channel reconnects with its natural floodplain and new riparian areas are established. A wetland delineation will be completed prior to dam removal by Grand Traverse County and Traverse City, in

conjunction with MDNR Fisheries Division. The wetland delineation will assess wetland loss versus wetlands gained as a result of dam removal. The Sponsor would be required to complete a wetland assessment to obtain a dam removal permit from the MDEQ.

3) Removal of Union Street, Sabin, Boardman and/or Brown Bridge Dams will re-suspend and transport sediments that have the potential to be contaminated. Therefore, sediments in Boardman Lake, Sabin, Boardman and Brown Bridge Ponds will be tested. If there is significant contamination, special handling of sediments, such as deposition in an appropriate upland site prior may be required. If necessary, changes to the final recommended plan could be made to address sediment quality issues.

4) Based on the available information, all four dams meet the age criteria for eligibility for listing on the National Register of Historic Places (NRHP). Consultation with the State Historical Preservation Office (SHPO) will be conducted regarding the dams' eligibility. If the dams have been modified to the extent that they no longer retain their historic integrity, then potentially they would be ineligible for the NRHP.

8. BENEFITS

The long and short-term ecological benefits of removing dams are well documented (Burrows 2003, Born et al. 1998, Kanehl and Lyons 1997). The Boardman River suffered a major loss of natural habitat when the current dams were constructed. These dams were constructed in high gradient reaches in order to maximize hydropower output. These high gradient reaches provided very productive habitat to brown, brook and rainbow trout within the Boardman River watershed. High gradient reaches also provided optimal invertebrate habitat due to high oxygen concentrations and preferable substrate composition within the Boardman River watershed.

The removal of Sabin, Boardman, and Brown Bridge Dams will restore five lineal miles of unnatural reservoir habitat to high gradient river habitat and reconnect the Boardman River fish populations with Lake Michigan. This project will allow fish unobstructed access to 26 lineal mainstream miles and 160 total lineal river miles in the watershed, increasing the genetic integrity of fisheries populations in the Boardman River. Increased genetic integrity renders fish more resistant to disease, pollution and habitat degradation.

Dam removal will also restore the natural flow regime of the Boardman River, allowing for natural transport of nutrients, vegetation, woody debris and invertebrates throughout the watershed. The restored flow regime will benefit brown trout, brook trout, rainbow trout and other coldwater species by restoring natural riverine habitat such as riffle-pool sequences, natural transport and deposition of woody debris throughout the mainstem, decreased sedimentation and river widening at the inlets of the impoundments and decreased streambed degradation downstream of the dams.

Reconstructing the fish ladder at union Street Dam potentially provides for the restoration of the lake sturgeon (*Acipenser fluvescens*) population that was extirpated from the Boardman River when the Union Street Dam was built. Lake sturgeon migration into the

Boardman River was blocked after the Union Street Dam was constructed in 1867. The lake sturgeon is a State of Michigan listed threatened species.

Table 8-1
Estimated Habitat Units and Ecosystem Outputs
For the Without Project Condition

Habitat	Acres	Quality (1-10)	Importance (1-5)	Ecosystem Output
Retained river (mouth to Brown Bridge Pond inlet)	786	4	2	6,288
Riparian habitat	56	7	3	1,176
Wetlands	112	6	4	2,688
Free river (upstream of Brown Bridge Pond inlet)	288	8	3	6,912
Total	1,242			17,064

Table 8-1 presents the estimated habitat units and ecosystem outputs of the without project condition. The measure for retained river habitat units represents the cumulative acreage of the four impoundments and 15.5 miles of river (from the mouth to Brown Bridge Dam) with an average width of 60 feet.

Riparian habitat without the project was calculated by multiplying 50 ft. (typical riparian corridor width) by the cumulative perimeter value of Boardman, Sabin, and Brown Bridge Ponds (48,935 ft.). Riparian habitat surrounding Boardman Lake was not included in this analysis because it would not change after implementation of this alternative.

Table 8-2
Estimated Habitat Units and Ecosystem Outputs
For the Proposed Project:
Removal of Sabin, Boardman and Brown Bridge Dams
With Reconstruction of the Union Street Dam Fish Ladder

Habitat	Acres	Quality (1-10)	Importance (1-5)	Ecosystem Output
Free river, (inlet of Boardman Lake to inlet of Brown Bridge Pond)	138	8	4	4,416
Retained river (mouth to inlet of	350	6	2	4,200

Boardman Lake)				
Riparian habitat	60	8	3	1,440
Upland high floodplain	294	7	2	4,116
Wetlands	112	8	4	3,584
Free river (upstream of Brown Bridge Pond inlet)	288	9	4	10,368
Total	1,242			28,124
Net benefit				11,060

For the proposed project, the measure of retained river habitat units represents the acreage of Boardman Lake and 1.5 miles of retained river (downstream of Union Street Dam) with an average width of 60 feet.

The measure for free river downstream of the Brown Bridge Pond inlet for the proposed project represents 14 miles of current free-flowing river from the inlet of Boardman Lake to the inlet of Brown Bridge Pond and five miles of restored river that is currently impounded (one mile in Sabin, two miles in Boardman, and two miles in Brown Bridge Pond).

The quality of retained river for the proposed project is significantly higher than without the project due to restoration of coldwater fisheries habitat, i.e., restoration of natural flow and thermal regimes; restored sediment, vegetative, woody debris and nutrient transport, enhanced genetic diversity and reduction of unnatural coolwater species and exotic zebra mussels. The importance of retained river for the proposed project is significantly higher than without the project since dam removal will restore extremely high gradient and quality spawning habitat that currently only occurs in the Keystone Rapids area (historic hydro-power impoundment) of the Boardman River watershed.

Riparian habitat for the proposed project was calculated by multiplying 100 ft. (to include both the north and south banks) by the length of restored channel that is currently impounded (26,400 ft.). Acres of riparian habitat are greater for the proposed project due to restoration of the natural sinuosity of the Boardman River. Riparian habitat quality is greater for the proposed project due to the unnatural sedimentation upstream of the impoundment inlets, sediment degradation downstream of the dams and discontinuous dispersal of vegetation due to the impoundments in the without project condition.

The measure for wetland represents all the wetlands that are contiguous with Sabin, Boardman and Brown Bridge Ponds, and was determined from a 24k National Wetlands Inventory Arc-view shapefile. No net loss of wetlands is predicted after dam removal based on the Changes in Wetland, 1800s-1900s publication (Michigan Natural Features

Inventory), which indicates wetlands were lost when the reservoirs were created. Therefore, if the dams are removed it is likely that wetland habitat will be restored over time and there will not be a net loss of wetlands. The quality of the without project wetlands is lower than the wetlands with the proposed project because the current wetlands are filling in with sediment since natural flow dynamics and sediment transport capability of the Boardman River is compromised by the dams.

The measure of free river upstream of the Brown Bridge pond inlet was determined by subtracting 20.5 miles (108,240 feet) of the Boardman River downstream of the Brown Bridge inlet from the total lineal feet of perennial river (945,120 feet) and multiplying that by an average river width of 15 feet. The importance of this free river is higher for the proposed project because potomadromous steelhead, brown trout and, potentially, lake sturgeon species would be able to access this stretch of free river.

The measure for upland high floodplain represents land that will be exposed after Sabin, Boardman and Brown Bridge Dams are removed.

Table 8-3
Estimated Habitat Units and Ecosystem Outputs
For Alternative Three:
Removal of Sabin, Boardman, Brown Bridge and Union Street Dam

Habitat	Acres	Quality (1-10)	Importance (1-5)	Ecosystem Output
Free river (Boardman River)	151	7	4	4,228
Natural lake (Boardman Lake)	259	6	3	4,662
Riparian habitat	92	8	3	2,208
Wetlands	112	8	4	3,584
Upland high floodplain	340	7	2	5,166
Free river (upstream of Brown Bridge Pond inslet)	288	7	4	8,064
Total	1,242			27,912
Net benefit				10,848

Removal of Union Street Dam would restore approximately 0.3 miles of river and Boardman Lake would recede to approximately 259 acres. The measure for riparian habitat for alternative three calculated by multiplying 100 ft., including both the north and south banks, by the length of restored channel that is currently impounded (28,150

ft.), and adding that value to the product of the perimeter of Boardman Lake, after removal of Union Street Dam and a 50 feet riparian corridor.

The wetland values were obtained in the same manner as Table 8-2. The measure for free river downstream of the Brown Bridge Pond inlet for alternative three represents 15.5 miles of current free-flowing river from the Boardman River mouth to the inlet of Brown Bridge Pond and 5.3 miles of restored river that is currently impounded (one mile in Sabin Pond, two miles in Boardman Pond, two miles in Brown Bridge Pond and 0.3 miles in Boardman Lake).

The quality of the free river, both up and downstream of the Brown Bridge Pond inlet, and Boardman Lake would be reduced because removing the Union Street Dam would allow exotic fish species, such as sea lamprey, access to these habitats. Non-native fish species would compete with native trout species for breeding and feeding habitat, thereby adversely affecting trout populations. Also, an invasion of the predatory sea lamprey species would greatly reduce the trout population of the Boardman River habitat.

Table 8-4
Estimated Habitat Units and Ecosystem Outputs
For Alternative Four:
Installing Fish Ladders/Bottom Draws

Habitat	Acres	Quality (1-10)	Importance (1-5)	Ecosystem Output
Retained river (mouth to Brown Bridge Pond inlet)	786	6	2	9,432
Riparian habitat	56	7	3	1,176
Wetlands	112	6	4	2,688
Free river (upstream of Brown Bridge Pond inlet)	288	8	3	6,912
Total	1,242			20,208
Net benefit				3,144

The quality of retained river for alternative four is higher than that in the without project condition as fish ladders would allow trout species to move throughout the system, lessening the adverse impacts of habitat fragmentation. Also, bottom draw intakes can address some of the water quality issues related to temperature.

In the feasibility phase of the project study, incremental benefit analysis will be performed to determine the most cost effective benefit level among the viable alternative plans.

9. GENERAL SCHEDULE

Description	Duration	Completion Date
PRP Submittal to LRD	2 months	September 30, 2005
PRP submitted to County and City	2 months	November 28, 2005
Feasibility Analysis Phase	12-18 months	March 2007
City and County Review and Acceptance of Feasibility Analysis	3 months	June 2007
Plans and Specifications Phase	6 months	December 2007
City and County Acceptance of Plans and Specifications Stage	3 months	June 2007
Project Implementation	5-7 years	June 2014

10. SUPPLEMENTAL INFORMATION:

It is also noteworthy that maintaining the Boardman Dams represents an economic burden to the citizens of Traverse City and Grand Traverse County. Removing the dams will alleviate much of this burden.

The Sabin and Boardman Dams are owned by Grand Traverse County while the Union Street and Brown Bridge Dams are owned by Traverse City. Historically, the maintenance costs of the Sabin, Boardman and Brown Bridge Dams are borne by TCLPD. Under the settlement agreement, responsibility for maintenance of the Sabin and Boardman Dams will now revert to Grand Traverse County while responsibility for maintenance of the Brown Bridge and Union Street Dams will revert to Traverse City.

Under Federal Energy Regulatory Commission (FERC) guidelines, if these dams are not removed, various repairs and updates will be necessary. For example, the Brown Bridge Dam is not capable of withstanding the probable maximum flood event (PMF), therefore reconstructing the spillway would be necessary. It is questionable whether Boardman Dam would need similar work to meet FERC requirements. TCLPB estimated the reconstruction of the Brown Bridge Dam spillway to be approximately $2,000,000 based on prior experience. TCLPB believes it is likely that the required work for Boardman Dam would bear a similar cost. Once the spillway improvements are completed, additional funding may be required to revise the current PMF study, inundation maps, and Emergency Action Plans. FERC would also require that a leak in the Boardman

Dam be properly repaired at an estimated cost of $600,000 to $800,000, once again based on prior experience of maintenance costs born by TCLPB. It is probable that once jurisdiction of the four Boardman Dams transfers to MDEQ, similar repairs would still be required.

11. FINANCIAL DATA

The cost estimates provided below are based on the assumption that the Corps pursues Alternative 2, the removal of Brown Bridge, Boardman and Sabin Dams and the reconstruction of the fish ladder at Union Street Dam. The cost of removing the Sabin, Boardman and Brown Bridge Dams is a preliminary estimate based on several assumptions. Among them are: 1) The powerhouses on all three dams would need to be removed, 2) A bridge would need to be constructed over the proposed river channel in the Boardman Dam spillway to protect Cass Road. Figure 7 lists the assumed steps to be taken at each dam and provides an estimate for each step.

During feasibility, these assumptions will be more fully addressed to determine their necessity, resulting in a more accurate and reliable cost estimate. An estimate for annual OMRR&R costs will also be developed during feasibility

a. Estimated Project Costs (in Thousands):

Description	Estimated Costs	Federal	Non- Federal
Recon Study (PRP)[1]	$ 25	$ 25	$ 0
Feasibility Study	$ 863	$ 863	$ 0
Plans and Specs	$ 227	$ 227	$ 0
PCA negotiations	$ 28	$ 28	$ 0
LERRD's	$ 496	$ 0	$ 496
Construction[2]	$ 5,458	$ 3,737	$ 1,721
Total Costs	**$ 7,097**	**$ 4,880**	**$ 2,217**

[1] Although costs for the PRP, feasibility study and plans and specs are cost shared 65% Federal/ 35% non-Federal, the non-Federal sponsors provide their shares of these costs during construction.

[2] Includes contract preparation, estimated contract ($4.5M), 10% contingency, S&A, and E&D during construction.

b. Non-Federal Requirements (in Thousands):

LERRD's	$ 496
Cash	$1,721
Work-in-kind	$ 0
OMRR&R	TBD

12. FEDERAL ALLOCATIONS TO DATE

To date, $25,000 has been allocated to this study to prepare the PRP.

13. CONCLUSIONS AND RECOMMENDATIONS

Recommended Action

Sufficient Federal interest exists to recommend that the Boardman River Dam Mainstem Restoration Project continue into the Feasibility Phase under Section 506, Great Lakes Fishery and Ecosystem Restoration, of the WRDA of 2000.

The proposed project would reconnect the stream habitats within the project area, restore the habitat by allowing woody debris and sediment materials to flow throughout the Boardman River, negate the thermal disruption, restore the natural balance between coldwater and coolwater species and likely limit the zebra mussel infestation to Boardman Lake. The cumulative result of these improvements would be the rebounding of the trout populations in the Boardman River project area. The sculpin population would also rebound. These ends would be accomplished without transporting pollutants into Grand Traverse Bay and Lake Michigan or allowing upstream migration of undesirable and exotic fish species.

The proposed project restores tributary habitat for Great Lakes fish by increasing the diversity of species moving between the Lakes and Boardman River and by making more tributaries available to these species. Restoration of tributary habitat was indicated in the Great Lakes Fisheries and Ecosystem Restoration support plan as a high basin-wide priority.

14. REFERENCES

Andersson, E., C. Nilsson, and M. E. Johansson. 2000. Effects of river fragmentation on plant dispersal and riparian flora. Regulated Rivers: Research and Management. 16: 83-89.

Bednarek, A. T. 2001. Undamming rivers: A review of the ecological impacts of dam removal. Environmental Management. 27: 803-814.

Born, S. M., K. D. Genskow, T. L. Filbert, N. Hernandez-Mora, M. L. Keefer, and K. A. White. 1998. Socioeconomic and institutional dimensions of dam removals: the Wisconsin experience. Environmental Management. 22: 359-370.

Burrows, B. A. 2003. The effects of Stronach dam removal on habitat and fisheries resources in the Pine River, Manistee County, Michigan. Michigan State University, Masters Thesis.

Clapp, D. F., R. D. Clark, Jr., and J. S. Diana. 1990. Range, activity, and habitat of large, free-ranging brown trout in a Michigan stream. Transactions of the American Fisheries Society. 119: 1022-1034.

Cushing, C. E. and J. D. Allan. 2001. Streams: Their Ecology and Life. Academic Press. San Diego.

Dodds, W. K. 2002. Freshwater Ecology-Concepts and Environmental Applications. Academic Press. San Diego. pp. 436.

Griffiths, R. W., W. P. Kovalak, and D. W. Schloesser. 1989. The zebra mussel, *Dreissena polymorpha* (Pallas, 1771). *In* North America: impact on raw water users. *In* Symposium: Service water system problems affecting sagety-related equipment. Charlotte, NC, November 6-8.

Hay-Chmielewski, E. and G. Whelan. 1997. Lake sturgeon rehabilitation strategy. Michigan Department of Natural Resources Fisheries Special Report No. 18.

Huggler, T. and G. Barfknecht. 1995. Fifty rivers: how to, when to, and where to. Davison, MI. pp. 46-47.

Johnson, B. L., D. H. Breneman, and C. Richards. 2003. Macroinvertaebrate community structure and function associated with large wood in low gradient streams. River Research and Applications. 19: 199-218.

Kanehl, P. D., J. Lyons, and J. E. Nelson. 1997. Changes in the habitat and fish community of the Milwaukee River, Wisconsin, following removal of the Wollen Mills dam. North American Journal of Fisheries Management. 17: 387-400.

Kondolf, G. M. 1997. Hungry water: Effects of dams and gravel mining on river channels. Environmental Management. 21: 533-551.

Lessard, J. L. and D. B. Hayes. 2003. Effects of elevated water temperature on fish and macroinvertebrate communities below small dams. River Research and Applications.

Michigan Department of Environmental Quality. 2002. The collection and analysis of sediment samples from the Boardman Lake/River, Grand Traverse County, MI. Report MI/DEQ/SWQ-02/108.

Mistak, J. L., D. B. Hayes, and M. T. Bremigan. 2003. Food habits of coexisting salmonines above and below Stronach Dam in the Pine River, Michigan. Environmental Biology of Fishes. 67: 179-190.

Morita, K and S. Yamamoto. Effects of habitat fragmentation by damming on the persistence of stream-swelling charr populations. Conservation Biology. 16: 1318-1323.

Mundie, J. H. and D. G. Crabtree. 1997. Effects on sediments and biota of cleaning a salmonids spawning channel. Fisheries Management and Ecology. 4: 111-126.

Neraas, L. P. and P. Spruell. 2001. Fragmentation of riverine systems: the genetic effects of dams on bull trout (*Salvelinus confluentus*) in the Clark Fork River system. Molecular Ecology. 10: 1153-1164.

Pejchar, L and K. Warner. 2001. A river might run through it again: criteria for consideration of dam removal and interim lessons from California. Environmental Management. 28: 561-575.

Regal, G. E. 1992. Range of movement and daily activity of wild brown trout in the South Branch Au Sable River, Michigan. Michigan Department of Natural Resources Fisheries Research Report No. 1988.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Department of the Environment, Fisheries and Marine Service Bulletin 191. Ottawa, Canada.

Taylor, C. A., J. H. Knouft, and T. M. Hiland. 2001. Consequences of stream impoundment on fish communities in a small North American drainage. Regulated Rivers: Research and Management. 17: 687-698.

Zika, U. and A. Peter. 2002. The introduction of woody debris into a channelized stream: effect on trout populations and habitat. River Research and Applications. 18: 355-366.