Peninsular Paper Dam Impoundment Restoration Plan

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1. Summary

This plan is intended to guide the restoration effort in the Peninsular Paper Dam Impoundment and nearby areas before, during, and after the removal of Peninsular Paper Dam (Pen Dam) on the Huron River in Ypsilanti.

The impoundment stretches from Pen Dam upriver to just below Superior Dam. Peninsular Park (Pen Park) is immediately adjacent to the actual dam structure on the north side of the river and provides the only public access point intended for recreational use. There is public access to a portage at Superior Dam, but the limited access there is intended only for maintenance and emergency service.

The City of Ypsilanti owns the dam and is responsible for its maintenance or its safe decommissioning and removal. Pen Park is the only public land area adjacent to the current impoundment that is likely to be affected by removal of Pen Dam and is therefore the focus of restoration efforts. The remainder of the impoundment is under private land ownership and restoration activities of any recovered private lands in the impoundment will require private owner permission.

Prior to dam removal, treatment and removal of invasive species around the impoundment will be a priority. Invasive exotic species are present in the area and could negatively affect the development of native vegetation. Invasive species found at Pen Park are likely representative of those found on adjacent lands around the entire impoundment. No aquatic invasive species have been identified and confirmed in the impoundment, but a few wetland species, particularly Phragmites, Purple Loosestrife and Flowering Rush, are present throughout the entire Huron River watershed and will require attention in the impoundment area. Following dam removal, management of invasive species will be required for many years, just as with any other stretch of the Huron River.

Revegetating the impoundment after dam removal is essential to ecosystem restoration. Draining the impoundment is anticipated to expose approximately 40 acres of recovered lands within the former impoundment. Approximately 270,000 cubic yards of sediment have accumulated in the impoundment. Approximately 70,000 to 130,000 cubic yards are deposited within the boundaries of what is likely to be the restored river channel. That sediment will either require removal or will be naturally redistributed downstream after the dam is removed. The stretch of river below Leforge Road, downstream of the dam, will likely see little change, though transient sediment deposition in some locations is expected, especially in the first two high-flow seasons following the dam removal. The dewatered impoundment will have some legacy biological assets for restoration: soil microbes, remnant tree stumps, or residual live plants. The soil nutrient level and moisture availability of the newly recovered land is uncertain, but given proximity to agricultural drainage, may be high. Evaporation could be high due to sun and wind exposure. Nearby forested areas and urban tree canopies will be an asset that could provide seeds, spores, and detritus to speed succession. Natural succession of the dewatered reservoirs will be slow to moderate and can’t be relied upon as a central restoration strategy.

The goals for revegetating the impoundment are to minimize invasive species establishment, facilitate ecosystem processes and, where possible in the long term (multiple decades), establish a native forested riparian buffer. To achieve these goals, revegetation crews should plan to actively revegetate exposed areas where feasible, where landowners grant permission, and where landowners agree to follow best

riparian restoration practices for ecological health. Areas close to native forests should be allowed to regenerate as naturally as possible.

The key strategy to prevent invasive species spread throughout the impoundment is to control populations before, during, and after dam removal. To further minimize the establishment of invasive species, biologists and revegetation crews should plant a diversity of native plant species over a period of several years, employing multiple types of plant materials representing various life-stages (seeds, seedlings, and live-stakes). Actively introducing a variety of plants into the dewatered impoundment will help stabilize ecosystem processes. Seeding dewatered banks with grasses and forbs will limit erosion of fine sediments and hasten the development of new soil through the capture and deposition of organic materials like decomposing plants. The fortification and creation of soft shorelines will be considered as well using appropriate materials and approaches for the area. The immediate objective of planting will avoid ecological stress to the river and alleviate physical stress to the surrounding landscape. The primary long-term objective is to facilitate diverse ecological communities and robust fisheries habitat.

2. Goals and Objectives of the Restoration Planning Process

The City of Ypsilanti and the Huron River Watershed Council are coordinating this Impoundment Restoration Plan for the impoundment currently above Pen Dam with the following objectives:

1) Provide the City of Ypsilanti, Superior Charter Township, Ypsilanti Charter Township, the Huron River Watershed Council, the Washtenaw County Water Resources Commission, the Michigan Department of Natural Resources, and the U.S. Fish and Wildlife Service with information needed to restore the impoundment to a freely flowing river system.
2) Identify wetland areas, connected streams, and upland areas that may be restored to benefit native species.
3) Identify potentially threatened, endangered, or at-risk, sensitive native species that will require protective actions or intervention before, during, or after removal of Pen Dam.
4) Identify any additional inventories required to fully inform the Restoration Plan, the Removal Design Plan, and subsequent local, state, and federal assessment processes.
5) Identify best practices for restoring natural wetland flood attenuation in the current impoundment along the Huron River.
6) Identify actions that will enhance connected ecosystems following removal of Pen Dam.
7) Identify estimated budgets for restoring wetlands, streams, and natural floodplains along the Huron River within the impoundment area.

A Restoration Subcommittee was established in 2020 following the award of grant funds to the Huron River Watershed Council and the City of Ypsilanti from the Michigan Department of Natural Resources Fisheries Habitat Grant Program. The Restoration Subcommittee reports to the Steering Committee and accepts community input through the Community Advisory Subcommittee. Intentionally, the chairperson of the Restoration Subcommittee is an Ypsilanti resident and not a staff person of HRWC. This provides independent oversight of subcommittee efforts.

HRWC is the coordinating body preparing this plan. HRWC has been involved with assessment and planning regarding the impoundment for several decades. The Restoration Subcommittee has oversight regarding the content and objectives, and specific actions described in the plan.

3. Restoration Subcommittee

The purpose of the Restoration Subcommittee is to advance the safe, ecological restoration of the Pen Dam impoundment area using best available science, strategic planning, and restoration activities.

3.1 Organizations and Groups Represented on the Restoration Subcommittee

Individual members of this committee agreed to volunteer their time and expertise to inform the restoration process that will accompany the removal of Pen Dam. The names and contact information of individuals are not available at this time, as public engagement was outside of the scope of work they agreed to provide for this project. Recommendations made by the subcommittee will be made public, will

be non-binding, and recommendations will be subject to municipal, county, state, and federal review before implementation.

- City of Ypsilanti
  - Ypsilanti City Council
  - Ypsilanti City Staff
  - Ypsilanti Parks and Recreation Commission
- Waterfront property owners
- Eastern Michigan University
- Huron River Watershed Council
- Michigan Department of Natural Resources
  - Natural Rivers District Program[1]
  - Fisheries Division
- University of Michigan
- U.S. Fish and Wildlife Service
- Washtenaw County Water Resources Commission

3.2 Relation to Steering Committee

The Steering Committee is composed of representatives from each municipal body with boundaries overlapping the project area: Superior Charter Township, Ypsilanti Charter Township, the City of Ypsilanti, and Washtenaw County. The Huron River Watershed Council serves the Steering Committee in a technical advisory and administrative role.

The purpose of the Steering Committee is to provide broad oversight over the entire project of dam removal and restoration. The Restoration Subcommittee advises the Steering Committee and project administrators on best practices that will ensure the safety and ecological health of the restored river channel.

3.3 Relation to Community Advisory Subcommittee

The City of Ypsilanti is leading community engagement efforts and has authority over the Community Advisory Subcommittee. Through 2021, the Community Advisory Subcommittee was comprised of Ypsilanti-area residents and stakeholders. The Huron River Watershed Council serves the subcommittee in a technical advisory role at the request of the city. The City of Ypsilanti will continue to adapt and refine community engagement strategies to keep area residents informed and to effectively collect community input on the project. As such, the structure and goals of the Community Advisory Subcommittee may change over time.

The city works with independent facilitators to ensure that the full range of resident perspectives are considered regarding future uses of the river and of Pen Park. Since the community vision of Pen Park will affect the details of restoration actions to be completed on the parcel, communication between the Restoration Subcommittee and the Community Advisory Subcommittee is crucial. City staff and other community members actively exchange relevant information between the two subcommittees.

[1] While the project area described in this plan does not fall within any Natural Rivers District, this restoration project intends to follow the high standards and practices for riparian protection when possible.

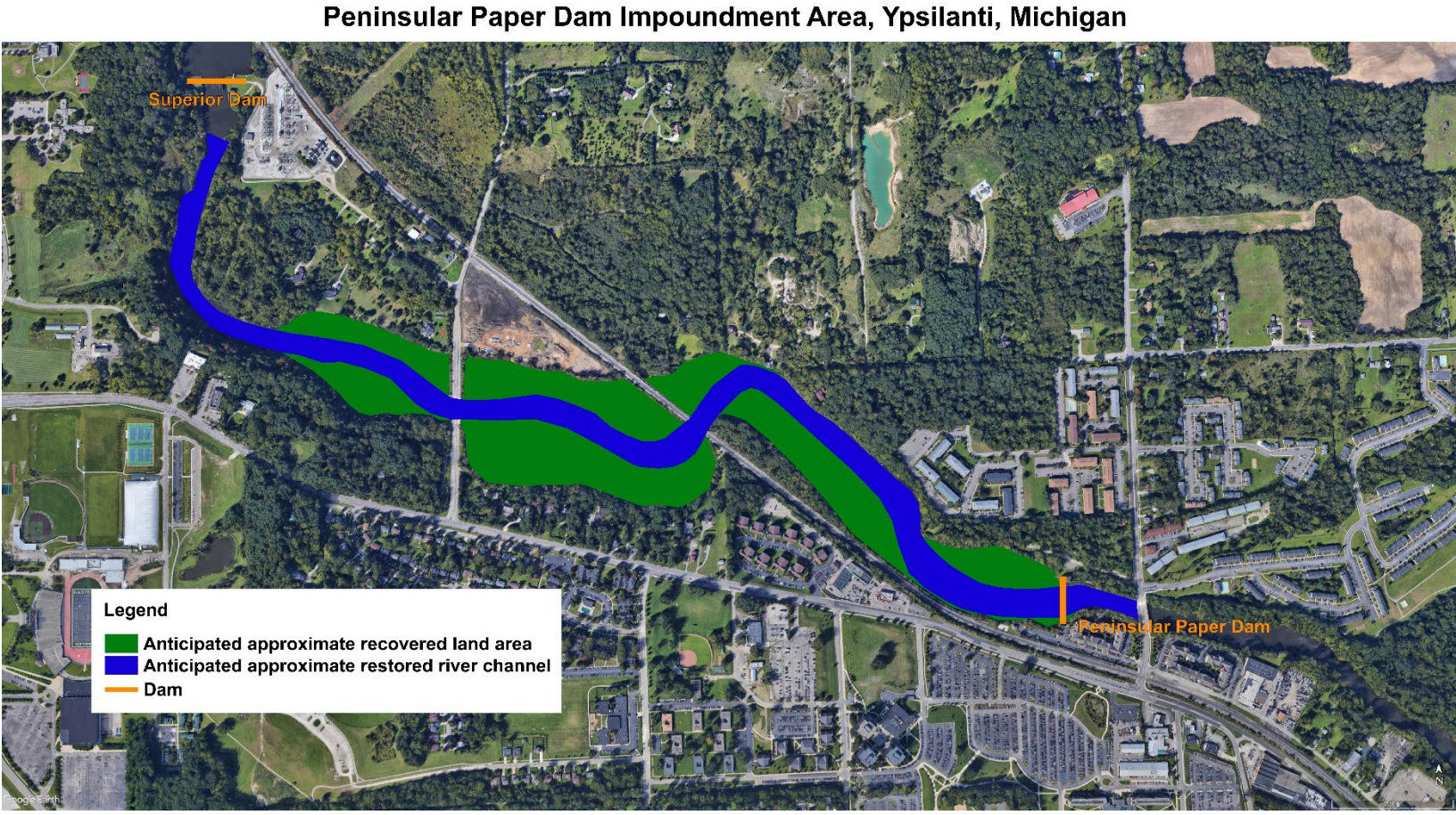

Figure 1. *This map shows the general project area. Peninsular Paper Dam (Pen Dam) is marked in orange at the lower right. The impoundment extends west and northwest up toward Superior Dam, also marked in orange. The effective project area extends from Leforge Road, just below Pen Dam, to the stretch of river just below Superior Dam. Areas downriver from Pen Dam and Leforge Road are not expected to be directly affected.*

The deep blue river channel indicates the approximate anticipated future river channel following dam removal based on the best information available. The green areas indicate where recovered land area is expected to be above water under average river flow conditions.

4. Site Description and History

4.1 Peninsular Paper Dam

Pen Dam is located on the Huron River in Ypsilanti, Michigan (Washtenaw County) (latitude: 42.25605, longitude: - 83.6241). The original dam structure was constructed in 1867 to provide power for paper manufacturing. The dam failed in 1918 and was rebuilt two years later. The dam is classified as a concrete gravity dam that measures 16 feet high with crest length of 290 feet; of which 250 feet is the concrete spillway. The area physically altered by the structure of the dam and dam retaining walls extends from about 70 feet upstream to 170 feet downstream of the spillway. The dam no longer generates power, and all electricity-generating equipment has been removed from the powerhouse. The City of Ypsilanti now owns the dam and powerhouse. The dam has a “high” hazard potential classification, as classified by the US Army Corps of Engineers. Hazard classification relates to the degree of adverse incremental

consequences resulting from a failure or incorrect operation of a dam. Figure 1 provides a map showing the location of Pen Dam and the impoundment area relative to Ypsilanti.

4.2 The Impoundment

The impoundment measures 177 acres in size and extends approximately 6,575 feet upstream of the spillway. The upstream end of the impoundment is 1,722 feet downstream of the Superior Dam, the next upstream dam. Approximately 39 parcel properties about the impoundment. The impoundment is crossed by two causeways/bridges. The Conrail Railroad Bridge crosses the impoundment approximately 3,210 feet upstream of the Pen Dam; the Superior Road Bridge crosses the impoundment approximately 4,910 feet upstream of the dam. The dam site is accessible from Peninsular Park (Pen Park) which is owned and maintained by the City of Ypsilanti. Pen Park is on the north side of the river, accessible from Leforge Road. Leforge Rd crosses the Huron River approximately 450 feet downstream of the dam. The dam structure, Pen Park, and the lower portion of the impoundment lies within the City of Ypsilanti; a central portion of the impoundment lies within Ypsilanti Township; the upper portion of the impoundment lies within Superior Township.

4.3 Site History

The City of Ypsilanti, contracted engineering firms, and the Huron River Watershed Council have compiled and reviewed dozens of files including plans, reports, and historic photos. An inventory of files is available in the Feasibility Study and appendices, completed by Princeton Hydro in 2018. Many of the files are readily available for download at from HRWC at http://www.hrwc.org/pendam or from Ypsilanti at http://cityofypsilanti.com/pendam. Digital copies of additional technical and high-resolution documents can be provided upon request.

4.4 Pre-Colonial Site History

The Huron River Watershed Council has reviewed the pre-colonial (pre-settlement) maps and land cover data for the entire impoundment area and adjacent upland areas. The area was found to be dominated almost entirely by Oak-Hickory forests common to southeast Michigan and this part of the Midwest before significant landscape alterations occurred through agricultural drainage and industrialization. Riparian wetlands were not identified as a significant landscape type near the historic river channel though the reasons for that are unclear.

5. Huron River Watershed Council Dam and Impoundments Program Summary

In 1995, a Michigan Department of Natural Resources “Fisheries Research Report” recommended removing select dams on the Huron River to improve fisheries.[1] The MDNR identified several dams for which removal would provide ecological benefits with specific priority on three dams: 1) Argo in Ann Arbor, 2) Mill Pond in Dexter (this dam is now removed), and 3) Peninsular Paper Dam in Ypsilanti.

At that time and since 1995, HRWC has supported the communities in which these dams are located with technical assistance related to stream flows, the impacts of dams and other flow alterations, and options

for dam management. Working with climatologists and water resource professionals throughout the watershed, HRWC led the Climate Resilient Communities Project from 2012 through 2015. Through that project, the management of dams was confirmed to be a critical priority for improving community resilience with increasing risks and vulnerabilities due to climate change.[2]

HRWC has since compiled an inventory of all dams in the watershed and assessed the effect of the 100 known dams on the watershed. HRWC has learned more about the systematic problems caused by an entire watershed of dams, as well as problems caused by specific dams.

HRWC continually works with all communities, dam owners, and dam operators to improve the functionality and safety of their dams. While the ecological and climate resilience benefits of dam removal are well-supported by a robust and rapidly growing body of scientific literature, each dam can create unique vulnerabilities, liabilities and benefits, and must be considered individually in the context of the broader body of available scientific knowledge.

5.1 Rationale for the Removal of Pen Dam

The removal of the dam was considered for several reasons. Among these concerns were: the inability of the City to procure sufficient insurance for the dam, that the dam no longer generates power or serves an economic purpose, and that required repairs and ongoing maintenance could be substantial. Improving the ecological health of river through dam removal and restoration were also found to be beneficial to the City's interests. The removal of the spillway will (i) deregulate the dam and remove any owner obligation for repair and ongoing inspections and maintenance as per dam safety regulations; (ii) greatly reduce the public safety hazard and legal liability to the owner; (iii) likely result in improved water quality for this reach of Huron River, such as temperature moderation and increased dissolved oxygen; (iv) restore the existing impoundment to over 1-mile of free-flowing river (and associated fishery) with an adjacent vegetated floodplain; and, (v) reconnect over 2 miles of river that have been isolated for over 100 years.

6. Site Investigation, Survey, and Observations

As a part of a Feasibility Study completed in 2018, a fluvial geomorphologist and professional surveyor with Princeton Hydro completed an investigation of the site and impoundment. The investigation included manual probing and survey of sediment within the impoundment, and selected survey of the dam spillway, abutments, and the two bridges crossing within the impoundment.

A project team comprised of engineers and subject matter experts from LimnoTech, AECOM, and Inter-fluve conducted site investigations and analysis through 2020 and 2021 in progress of preliminary design and supporting analysis. Below is a summary of the relevant findings as of January 2022.

6.1 Field Investigations

Field investigations during the feasibility study and removal design studies have identified locations of features and structures that may influence restoration decisions, including valley walls, slope instability, low vegetated floodplains, maintained yards, eroding banks, banks stabilized with stone or retaining wall, and stormwater outfalls. Steep slopes, particularly about 4,000 feet upstream of the dam on river left,

show signs of slope failures above the normal water surface elevation. Such failures should be addressed regardless of dam removal.

6.2 Depth to Refusal Survey Summary

Depth to refusal and sediment analysis has established the location of a legacy thalweg and the likely former river alignment, as well as the distribution, depth and general grain size class of impounded sediments. Sediment in and around the legacy thalweg tends to be coarser in nature, including a mix of sand and gravel. Sediment outside of the historic natural river channel but within the current impoundment margin tends to be finer, including sand, silt, and clay. The historic river channel, or thalweg, generally contains the least unconsolidated sediment. At the dam, the depth of the sediment is 4 feet with the top of the sediment layer 11 feet below the crest of the spillway. Sediment depth generally decreases away from the dam upstream, becoming near-zero at approximately 6,000 feet upstream of the dam and 1,000 feet downstream of Superior Dam.

Little unconsolidated sediment has been found under either of the bridges, indicating that the bridges create hydraulic constrictions that cause scour and prevent the deposition of impounded sediments. Supporting this finding is the relatively high deposition of sediment downstream of each bridge.

6.3 Bathymetry and Hydraulic Analysis

The results of the bathymetric, hydraulic modelling, and sediment quantity analysis to date have produced several key findings and have significantly reduced uncertainty previously described in the Feasibility Study.

Bathymetric surveys were conducted by Inter-fluve in 2021to understand the submerged shape of the original river channel. Depth to refusal surveys were completed to estimate the total volume of sediment present in the impoundment and understand where in the impoundment sediment has been deposited. All methods were approved by EGLE, MDNR, and MDHHS officials prior to sample collection.

Hydraulic analysis conducted by AECOM in 2021 was consistent with recommendations in the feasibility study. AECOM identified three key locations where scour and erosion will likely need proactive management using artificial and natural structures (such as installing cobble, riprap, proactive vegetation, and soil lifts). The three locations identified specifically were near the two railroad bridges and the outside bend of the river near the Hard Right at W Clark Rd. Potential changes at these locations and the effects on wildlife habitat should be considered in restoration efforts.

Scour may also be possible near the dam location along the railroad embankment. That embankment is already fortified and the river flows straighter through that section. Significant restoration potential along the railroad embankment near the dam is unlikely.

6.4 Sediment Sampling and Analysis

To understand the quantity and quality of the sediment in the impoundment, samples were collected during the Feasibility Study and during supporting analysis in 2021. Samples were collected with vibracores using a similar method employed in the feasibility study.

6.4.1 Sediment Volume

Areas further away from the thalweg exhibited higher top of sediment elevations and greater sediment depth, commonly 4 to 5 feet, with a maximum of 7 feet. These sediment depths are markedly low compared to the spillway height of 16 feet. The low depths of sediment accumulated in this impoundment may be the result of the full dam failure and sediment release in 1918, as well as the presence of multiple large upstream dams on the river (most notably, Superior Dam, built in 1920) that serve as sediment traps and reduce the overall sediment load at this point in the river.

Sampling results and Depth to Refusal measurements completed in 2020 and 2021 indicate the volume of sediment in the impoundment is significantly less than the upper bound estimate in the Feasibility Study. The Feasibility Study indicated up to 1,000,000 cubic yards (cy) of sediment may be present. More detailed analysis and estimates indicate approximately 270,000 cy are present, with an evacuation volume of 60,000-135,000 cy. (The evacuation volume is the amount of sediment in the old river channel that would likely be moved by natural processes over time.)

The topography of the impoundment area and the bathymetry further indicate that sediments have deposited unevenly and in a pattern that lends itself to a range of strategies for management, and, where possible, restoration.

6.4.2 Sediment Quality

Sampling and laboratory analysis of sediment impounded behind Pen Dam has been conducted several times in the past. In 2013, six sediment samples were collected from throughout the impoundment and analyzed for a range of common contaminants. As a part of the Feasibility Study, Limnotech and a subcontractor completed sediment sampling using vibracores on July 17, 2018. Vibracores were completed in 10 pre-selected sampling locations, to capture the depth of impounded sediment adjacent to bridges and where the river channel is likely to reform following dam removal.

As a part of the analysis of the impoundment in preparation for the dam removal design, 33 vibracore samples were taken in 11 transects. Results from each of these sampling efforts has been broadly consistent, and more information about the methodology used during these sampling efforts can be found in the respective reports available at http://hrwc.org/pendam.

The studies have concluded that the quantity of sediment that may be mobilized by dam removal is relatively small compared to the height of the dam and size of the impoundment, and thus does not preclude dam removal. The potential effects of any sediment transport downriver will need to be considered, however. A sediment management strategy will be developed by qualified engineers and reviewed by state officials before deconstruction of the dam and dewatering of the impoundment proceeds.

Detections in a majority of impounded sediment have consistently been below ecological and human health criteria for Metals, PNAs, and PCBs. There are some exceedances of these thresholds for heavy metals, however. Specific polyaromatic hydrocarbons (PAHs) were detected in exceedance in a few locations, though the total PAH level was below ecological criteria.

The sediment sampling results show that there are only 2 out of the 33 sampled locations in the

impoundment where the pollutants exceed the sediment quality goals for public health. One of those locations is immediately adjacent to the future river channel, and that sediment will need to be removed, leaving only one future upland location with an exceedance of the arsenic background levels.

Despite that the amount of sediment and the level of contamination in that sediment is low, experts have indicated that the need for significant section dredging before removal is possible, if not likely in this case, depending on the specific ecological and human health criteria applicable through the removal design. Assessments of sediment management will likely change as more information is collected, and changes to sediment management plans could alter the implementation of specific restoration activities, such as mussel relocation.

6.5 River Profile and Flow Considerations

The anticipated water level drop varies significantly throughout the impoundment, generally with the greatest drop in water level near the location of the existing dam. Conditions and depth in the river channel after removal are expected to be very similar to conditions and depths currently downstream of the dam.

The bank profile of the restored river channel, estimated with an analysis of cross sections, shows that the landscape is more variable and slightly steeper than expected. This may reduce the area of flat wetland available throughout the year, but may also recover more consistently dry land throughout the impoundment. More geotechnical and hydraulic assessment will be needed in specific areas of the impoundment, and will be completed by qualified, contracted engineering firms prior to final removal design. In most of the specific areas identified, private landowners will need to be consulted regarding proposed actions.

Hydraulic modelling completed by AECOM shows the statistical risk of damaging floods (FEMA 100-year flood) will be significantly reduced to homes and property adjacent to the current impoundment.

6.6 Summary of Bridge Scour Analysis

AECOM conducted a preliminary scour analysis of the two bridges that cross the impoundment as a part of their hydraulic analysis in 2021. Based on that preliminary analysis, and similar to findings from the feasibility study, scour is a potential concern and counter measures may be needed. Left unmanaged, scour could result in instability at the river crossings. AECOM recommended further investigation during the final design phase and for the project team to plan for inclusion of scour counter measures in the final design. As of January 2021, the placement of cobble upriver of the bridge abutments was viewed as the most likely and cost-effective means of addressing scour, though that assessment could change as more information is collected. The engineering team also discussed the potential need to fortify bottomlands near the bridges in order to slow sediment transport and downcutting. Construction in these locations could directly affect some restoration activities and should be considered throughout and during mussel survey and relocation efforts.

6.7 Summary of Bank Scour Assessment and Bank Stabilization Needs

Once a dam is removed, natural processes of erosion and deposition can resume. If infrastructure such as

Figure 2: *(Provided by Inter-fluve) Left – A stone toe with an upper slope stabilized by biodegradeable fabrics, native grasses, shrubs and trees just 1 year after construction (Silver Creek, MN). Right – A 35 ft high bluff on the Little Miami River, Ohio stabilized with a rock toe and a combination of bioengineering treatments in the upper slope. Photo 15 years after construction.*

homes, boathouses, roads, bridges and buildings have been built in and around the impoundment,

measures must be taken to protect that infrastructure. Therefore, the assessment of potential scour and erosion of banks following a change in river channel and river flow velocity is an essential part of any dam removal and restoration effort.

As of January 2021, the findings from work completed by AECOM and Inter-fluve indicate that most of the restored river channel should be resilient to unwanted erosion or scour, with some locations requiring additional attention.

Locations immediately above and below the dam, near bridge crossings, and along the outside banks of the restored river immediately above and below the railroad bridge are locations that will warrant ongoing consideration.

6.8 Potential Restoration Treatments for Bank Stabilization

A likely treatment for stabilizing these banks will include a hard toe treatment, such as rounded river stone or riprap with a bioengineered treatment on the upper slope. Hard toe treatment is used where erosive energy is greatest, typically at the deepest parts of the river and at the outside of meander bends. Because erosive power is dependent on depth, erosive energy decreases as the water becomes shallower. In the upper banks, we can employ native vegetation treatments that feature plants with root systems that hold the soil in place. Bioengineering treatment options are commonly deployed for bank and bluff slope stabilization post-dam removal, as shown in Figure 2.

Additional geotechnical analysis will help make sure existing structures are protected by the final removal design and may inform some restoration activities in these specific locations. The river channel adjacent to the railroad causeway immediately upriver from the dam will also be an area of further scrutiny, though

due to the highly engineered nature of this part of the river channel, it's unlikely that bank stabilization efforts at this location will affect restoration plans with the exception of mussel relocation plans.

6.9 Implications of Design Removal and Supporting Analysis on Restoration Efforts

The information currently available as of March 2022, the findings of the Feasibility Study and additional analysis completed in 2021 do not suggest that planned restoration efforts and goals within the project area will be significantly affected before or after dam removal by the deconstruction of the dam, the construction of necessary structures, or the implementation of sediment management strategies. In specific locations, however, restoration plans may change as more information is collected.

Sediment management will likely include both active and passive strategies. In active sediment management, sediment is mechanically removed from the newly-formed active river channel and redistributed upland on-site or taken off-site for disposal or beneficial reuse. Passive management allows the river to remove sediment naturally in a safely managed way that avoids impacts to people, property, or wildlife. In this case, it is unlikely that only active sediment management will be possible and unlikely that only passive sediment management will be permissible or preferable.

There are specific locations within the impoundment that will require geotechnical analysis and may require additional sediment analysis. The outside banks of the impoundment and restored river channel immediately upstream and downstream of the railroad bridge are two such locations that will warrant continued focus and attention. Any changes in sediment management strategy or infrastructural changes that arise due to future findings will be incorporated into the Restoration Plan. The greatest source of remaining uncertainty relevant to restoration planning efforts is the lack of a precise topographic profile for recovered river banks. Slight variations in the expected river profile will alter which restoration strategies are deployed in specific parts of the impoundment. This will affect what efforts need to be communicated to waterfront residents that agree to collaborate with the restoration process. As such, future restoration efforts should include contingencies for variable water levels and various resulting landscapes types ranging from primarily inundated wetlands to primarily dry banks.

Any revitalization plans to restructure recovered land in Pen Park will have local implications for restoration planning within the park boundaries. The Restoration Commitee will continue to incorporate plans developed by the City of Ypsilanti for any changes to the land cover, layout, composition, or terrestrial structure inside Pen Park as the Restoration Plan is revised.

7. Expected Changes in Fish Populations

Although the number of river miles reconnected as a result of the removal of Pen Dam is relatively small compared to other dam removals, the habitat and gradient that would become available to fish in this part of the Huron River is of much higher quality than in many dam removal situations. Removal of Pen Dam would also open the door to future increased connectivity in the Huron River with potential installation of fish ladders and/or other dam removals. Game fish species, such as smallmouth bass, walleye, and white bass would benefit greatly from the increased access to prime spawning habitat, nursery areas and likely cooler water temperatures that would result from Pen Dam removal. This could increase opportunity for

fishing at public areas along this stretch of river as well as in Ford Lake, which had the third highest open water fishing effort per acre in a survey of 20 lakes during 2000-2006.

Conditions in the restored river channel is expected to be similar to stretches of the Huron River downriver from Pen Dam. More than 4,200 fish were collected representing 26 species as a part of MDNR fish survey near Heritage Park, August 2001. The data indicates that:

- The dominant species collected indicate good water quality below the existing impoundment.
- Fish communities are borderline between cool and warm water fish.
    - Coolwater fish found include: smallmouth bass, greenside and rainbow darter, rock bass, logperch, white sucker.
    - Warmwater fish found include: bluegill, largemouth bass, bullheads, bluntnose minnow.
- Multiple species sensitive to sedimentation and pollution were present (rainbow darter, stonecat, logperch, northern hogsucker), a positive indicator of river health.
- The abundance of smaller smallmouth bass indicates this stretch is an important nursery area.

Generally, experts expect a transition from a more lentic community to more lotic fish community as the dam is removed and the river restored. Panfish will still be present. Catfish and carp abundance will likely decrease, but will likely still be present in numbers to sustain local recreation activities related to those species. Anglers will likely need to change techniques from those used typically used in lakes to techniques typically used in flowing streams.

8. Macroinvertebrate Populations

The Michigan Department of Environmental Quality (Now the Michigan Department of Environment, Great Lakes, and Energy) sampled macroinvertebrates near LeForge Road in June and August 2012 using standard MDEQ non-wadable stream protocols as a part of an effort to sample habitat and macroinvertebrate communities at 32 sites in the Huron River watershed.[3]

- The stretch of the river downstream from Pen Dam was rated as excellent for both the macroinvertebrate community and habitat and was the highest scoring of the 8 mainstem sites sampled.
- Twenty-eight macroinvertebrate taxa were collected, the second highest out of 29 stations sampled for these animals.
- Mayflies, stoneflies and caddisflies, which are all known for their high water quality requirements, comprised of 33% of all individuals collected.

HRWC has a regular sampling site at Riverside Park, downstream of Peninsular Pond. Samples are taken by trained volunteers but identified by aquatic biologists per the methodology of the Michigan Clean Water Corps (MiCorps)[4].

- HRWC rates this site as Fair (out of Excellent, Good, Fair, and Poor).
- From 2013-2019, 5 fall samples and 4 spring samples were taken, with an average of 12.4 taxa found (identifying at the Family level). Approximately 33% of the taxa were mayflies, stoneflies and caddisflies.

HRWC staff sampled the shoreline of the Pen Dam impoundment Pond on October 8, 2021. While the MiCorps methodology is for wadable, lotic (flowing) ecosystems, an attempt was made to follow the same general methods for this sample by sticking to the wadable waters along the eastern shoreline of Peninsular Pond for 300 feet and 40 minutes of collection time. The results are not surprisingly indicative of a littoral ecosystem, but also indicate poor water quality and poor habitat. That being said, comparing a littoral sample to the downstream lotic samples need to be considered with the appropriate context.

- 9 taxa were found, mostly still water taxa including water striders, mosquito, and marsh beetles, and taxa typically found in lower quality waters such as narrow-winged damselfly (Coenagrionidae).
- No mayflies, stoneflies, or caddisflies were found.

HRWC will continue monitoring the macroinvertebrate populations in Peninsular Pond annually and the downstream section at Riverside Park through dam removal and at least 5 years beyond, and could add the new river section of Peninsular Pond as a permanent sample site if the conditions prove adequately safe to send volunteers here.

9. Native, Protected, Threatened, and Endangered Species

The Restoration Subcommittee will follow guidance provided by the USFWS Information for Planning and Consultation tool (IPAC) and information provided by the Michigan Natural Features Inventory (MNFI).

IPAC can be used to generate a species list and ensure that depending on the proposed type of work (in river, tree clearing etc.) the appropriate species are considered.[5]

9.1 Mussels

Freshwater mussels are imperiled throughout North America and 38 mussels are listed as species of greatest conservation need in Michigan's Wildlife Action Plan.[6] Much of the Huron mainstem is classified as a Group 3 mussel stream (state and federally listed species known to be present) and the stretch above and below Pen Dam impoundment has recent records of Elktoe, Purple Wartyback and Wavy-rayed Lampmussel, which have state special concern or threatened status. One of the primary causes of decline to mussel populations is habitat loss from dam construction. Dam removal could help improve recovery potential of these species by restoring riverine habitat and increasing water quality and suitable riffle habitat available for these mussel species as well as their host species, which are present in this stretch (such as channel catfish for Purple Wartyback and Wavy-rayed Lampmussel).

9.1.1 Mussel Survey and Relocation

This project will adhere to the Michigan Freshwater Mussel Survey Protocols and Relocation Procedures, published May 2019, Version 2.[7] Project proponents are required as part of the Threatened & Endangered Species Review Process to determine presence or absence of State and Federal Threatened or Endangered Species.

The Restoration Subcommittee has initiated communication with EGLE, MDNR, and USFWS. The MDNR and USFWS are represented on the Subcommittee to determine options and inform planning.

A mussel survey of the impoundment and downriver stretches will be required. A survey plan will need to be submitted and approved by the MDNR and/or USFWS prior to beginning the survey. Typically, the survey may only be conducted from June to October, and mussel relocation (if required) may not be conducted after September. The nature of the survey and the required procedures that follow depend on what species, if any, are found. If only state protected mussels are found, they can be relocated at the time of the survey. If during the survey, federally protected mussels are found, work on the survey must stop and a relocation plan be submitted to the USFWS for authorization. If after USFWS review, only a small number of federally protected mussels are found, the USFWS may authorize relocation under the Surveyor's Section 10(a)(1)(A) Permit. If a large number of federally protected mussels must be relocated, then a Section 10 Incidental Take Permit will be required by the USFWS along with the development of a Habitat Conservation Plan (HCP). This process may take up to 2 years. Between 30 to 45 days after the relocation has been completed, at least one monitoring visit will be necessary at the relocation site, before final approval.

The results of bathymetry studies, sediment analysis, and hydraulic analysis will help identify the potential areas with high freshwater mussel densities. Areas with larger expected degrees of changes will require additional attention. The affected areas, plus a 500-foot buffer, are recommended to be included in the survey area. Sediment transport modelling may provide additional information on potential effects down river.

Certified mussel survey experts holding a State of Michigan Endangered Species Permit will be required to be contracted to lead the survey. Under the assumption that state and federally-listed species are present, a survey can only be conducted by someone who holds a current State of Michigan Endangered Species Permit and USFWS Section 10(a)(1)(A) Recovery Permit. Mussel surveys in shallow, wadable water can be conducted with the support of trained volunteers. Surveys in the impoundment area will require teams with trained divers.

Some state listed species have been informally identified in the river below Pen Dam, suggesting the presence of state-listed and threatened species. No endangered species have as yet been positively identified within the impoundment or below the dam to Ford Lake, but the presence of endangered species is possible. State-listed and threatened species will be required to be relocated to a suitable location within the Huron River.

The results of mussel surveys are valid for federal and state review for 5 years.

In addition to pre-construction mussel relocation effort, there will likely need to be a mussel rescue and relocation effort timed with the impoundment drawdown. The procedure will follow recommendations from the Michigan Mussel Rescue and Relocation Protocols for Reservoir Drawdowns (2022, not yet published).

Mussel relocation from the impoundment, if required, will likely need to be timed with drawdown of the impoundment water level to aid in the identification and relocation of mussels, and to ensure that as many mussels are found and relocated as possible. The Restoration Subcommittee identified several mussel survey and relocation efforts as good examples to follow. This included: the Lyons Dam survey, the effort in the Kalamazoo River near Ceresco Dam, the Belle River Restoration at Columbus Township Park, and

the Grand River mussel plan. Mussel surveys have also been completed previously in other sections of the Huron River.

The pending replacement of the Cross Street Bridge in Ypsilanti may overlap in project area with this project. If possible, mussel survey work should be conducted in a manner that informs both projects.

9.2 Mammals

Two endangered or threatened mammals have been identified as relevant to southeast Michigan. The Indiana Bat (*Myotis sodalist*) is endangered. The Northern Long-eared Bat (*Myotis septentrionalis*) is threatened. Neither species has been identified as having persistent habitat in the project area, and the expected changes to the impoundment may actually increase the amount of land for viable habitat and food sources.

9.3 Reptiles

The Eastern Massasauga rattlesnake (*Sistrurus catenatus*) is present in parts of the Huron River watershed and has been found nearby. There is no record of it in the project area, but the restoration efforts may increase viable habitat for the species, and care will be taken throughout the restoration of the impoundment to identify, protect, and relocate any Eastern Massasaugas.

9.4 Insects

Two relevant species are considered endangered: the Mitchell's Satyr Butterfly (*Neonympha mitchellii*) and the Poweshiek Skipperling (*Oarisma poweshiek*). The Poweshiek Skipperling prefers native prairie and as such may not be disturbed by this project. It has, however, been found recently in Oakland and Washtenaw Counties, and there are relatively few places in the Midwest that still provide suitable, sustaining habitat for this species. While it’s unlikely that restoration efforts will disturb the Poweshiek Skipperling, trained volunteers or field staff will be vigilant to make sure the species is not affected nearby.

The Mitchell’s Satyr butterfly occurs in southern part of Michigan, where it is found in prairie fens, a natural community dominated by sedges and grasses. It has not been identified and confirmed near the project area, but a restored river channel with a more biodiverse shoreline may allow for some viable habitat for the species.

9.5 Flowering Plants

One plant species relevant to the area is considered threatened: the Eastern Prairie Fringed orchid (*Platanthera leucophaea*). *Platanthera leucophaea* has been confirmed in nearby riparian and lake shoreline areas as recently as 2020 and may be present in the project area. Water-based and land-based surveys by trained volunteers or field staff in mid- to late- July will make *Platanthera leucophaea* easy to identify, catalog, protect, and relocate, if necessary.

10. Invasive Species

The Huron River watershed has many exotic and invasive plant species that have drastically changed lake, river and riparian ecosystems. These plants grow quickly, spread quickly, alter habitat for the indigenous creatures and plants, and reduce recreational benefits for humans. Once invasive plants become established, it is often too late to eradicate them from an ecosystem. Finding the plants early is key to protection, which means both scientists and volunteers need to get boots on the ground and boats in the water to look for them.

The Midwest Invasive Species Information Network (MISIN), run by Michigan State University, is a resource for determining when invasive species arrive in a new area.[8] Users can install the MISIN app on their mobile devices to report findings, and the network also holds data collected by government employees and scientists. The breadth of the mapped data depends on where people are looking and when they choose to report their findings.

10.1 Invasive Species Detected in the Huron River

Many invasive species have been reported through the MISIN app or identified by naturalists along or near the Huron River. The invasive species detailed in this document are by no means a comprehensive assessment of the invasive species that will require consideration over several years. Restoration efforts will require addressing the invasive species discussed that are a known and immediate stress on the Huron River, but will also require adapting to newly identified invasive species in the future.

At the river's mouth at Lake Erie, the two most reported plants are European frogbit and phragmites. European frogbit is a relatively new invader to the river system. This small floating plant resembles lily pads, but the leaves are tiny; they are smaller than a fingernail. The plant forms dense mats that can impede boat traffic and alter food and habitat for waterfowl and fish. Frogbit has also been found in Novi-area detention ponds right on the Huron River watershed's eastern border, and is found in the Waterloo Recreation Area on the western border of the Huron watershed, but has not yet been found in the Huron River watershed.

Ford and Belleville Lakes suffer from Eurasian watermilfoil (*Myriophyllum spicatum*), an infamous plant that can dominate bottom cover/plant biomass in lakes and can clog up boat motors when navigating through it. Above Belleville and Ford lakes, the riparian plants phragmites and flowering rush are plentiful throughout the Huron system. Phragmites is a very tall perennial reed (8-10 feet) that spreads very easily, and its thick growth dominates areas, preventing other plants from establishing themselves. Flowering rush is another type of perennial reed that does not grow as tall (1-4 feet), but like phragmites, grows in very thick stands that prevents bird and amphibian habitat and can impede water access.

Above Ypsilanti and Ann Arbor, phragmites, flowering rush, and purple loosestrife remain the primary problems. Purple loosestrife has been reported to be spreading rapidly through private wetlands near the river. It is an aesthetically pleasing plant with purple flowers that can dominate shallow wetland or wet upland areas with sprawling monoculture stands.

European Water Clover is present in the Argo and Barton impoundments approximately 9 miles above the Pen Dam impoundment. The source of this invasive was likely the dumping or draining of a private

aquarium and it now grows in patches in these two ponds. European Water Clover looks just like four-leaf clover that floats on the surface, and again can grow very thick. It does not appear to spread in areas of freely flowing river, but rather takes hold in impounded areas above dams. HRWC and the State of Michigan have been monitoring this stand of water clover and have not yet seen it spread downstream or upstream from Argo and Barton impoundments.

The Chain of Lakes region is a series of mostly natural lakes in-line or connected to the main stem of the Huron River and major tributaries, near the boundary of Washtenaw and Livingston Counties. Starry stonewort is a problematic invasive in the Chain of Lakes. These plant-like algae are present from here up to the Huron River headwaters in all inline lakes. Similar to other invasive species, starry stonewort grows very dense and forms monoculture stands. It can grow so dense that it may impede nest construction and spawning of some native fish species. Starry stonewort is more challenging and larger threat in that there are no effective treatments to reliably remove it. Copper-based herbicides can cause a temporary die-back, but these chemicals may harm the rest of the ecosystem as they indiscriminately kill non-target plants and smaller organisms like macroinvertebrates. Starry stonewort is a relatively new invasive, and there is still much to learn about it. Scientists agree that starry stonewort thrives in low-nutrient, transparent lakes with calcium carbonate-rich sediments, which is characteristics of many lakes in Southeast Michigan.

In Kent Lake, in Island Lake State Recreation Area and Kensington Metropark, curly-leaf pondweed is present. This plant is generally not as widespread as starry stonewort or Eurasian watermilfoil, but is still problematic as it outcompetes native species and forms dense mats. Curly-leafed pondweed differs from the many native pondweeds with narrow leaves that look like the edge of lasagna noodles.

In the Upper Huron River in Oakland County, the river is extremely segmented by dams and the impoundments and connected lakes are heavily used by boat traffic. Most of the invasive species described above are known to be present in this area. Starry stonewort and invasive watermilfoil are primarily in the natural lakes and impoundments; and phragmites, flowering rush, and purple loosestrife are along the banks of the Huron River.

Most, if not all, of the above species can also be found in lakes that are not directly connected to the river. The MISIN data identifies 34 Huron River watershed lakes plagued by starry stonewort, ten afflicted with Eurasian watermilfoil, and eight infested with curly-leaf pondweed. These numbers are likely much higher due to limitations in monitoring and reporting.

It is impossible to completely eradicate invasive species currently growing in the watershed. It is very possible to prevent new ones from invading. Once invasive species arrive and establish themselves in an ecosystem, permanent eradication is nearly impossible. The phragmites, flowering rush, and purple loosestrife that make up a large portion of the Huron River's riparian zone are here to stay. It is possible yet very expensive to treat specific stands of the plants that are particularly troublesome or in places that are particularly important.

Suppressing invasive species requires vigilant isolation and decontamination policies. If any of these exotics spread to a new water body, it is important to stop the plants from colonizing immediately because once they get established, the battle is lost. It's therefore necessary to avoid contamination of ecosystems

or areas, or to act swiftly to address the spread of invasives as soon as they are identified in a new location.

Many of the invasive species found in impoundments on the Huron River and lakes in the watershed will not find ideal habitat and conditions in a restored, free-flowing river channel. Upland detection of invasive species will likely be easier than detection of aquatic species.

10.2 Points of Invasive Species Introduction

Reducing the spread of aquatic invasive species at public and private access points is critical to avoid future contamination. Local stewardship groups and ownership associations can appoint people to be vigilant at popular launch areas along a lake or river to remind boaters and recreational users to check and clean their boats and gear to avoid bringing in unwanted plants. In the Pen Dam impoundment and along the restored stretch of river, these would be activities well-suited to a group like the Friends of Peninsular Park, which tends to be made up of waterfront owners, nearby residents of the current impoundment, and frequent recreational users of Peninsular Park.

Figure 3. *An example sign design common in Michigan encouraging anglers and boaters to follow decontamination and avoidance practices.*

Conducting plant monitoring at boat launches is of primary importance and takes concerted effort. New plant invaders are almost always often first found near a boat launch, because boats are the primary vectors. Any boat, including simple canoes and kayaks, can bring in invasive plants; it is easiest for plants to hide on boat trailers.

Two important programs for lake and river residents to be aware of is the Exotic Plant Watch program through the Michigan Clean Water Corps (https://micorps.net/), which trains people to look for aquatic invasive species, and the Clean Boat Clean Waters program (http://micbcw.org), which provides training and materials to volunteers to monitor their boat launches.[9] [10]

These basic strategies are unlikely to change dramatically following removal of the dam and restoration of the river channel. Pen Park will remain the only public access location on the stretch of river between Frog Island Park and the portage at Superior Dam. Management of invasive species, in both the case of the current impoundment and a restored river will rely on awareness, education, and vigilance from nearby landowners with private waterfront access and the waterfront users.

All river users must become aware that they can easily spread invasive species from one place to another.

Inspection of boating equipment and subsequent removal of plants hanging onto to equipment is the best protection against invasive plants and is simple to do, though it is a matter of educating the public so they know to do this. Secondarily, bleach and/or Formula 409 can be used to decontaminate all gear that makes contact with the water, including waders. This is especially important if those items have been moved between disconnected water bodies. Anglers and boaters will be encouraged to follow similar decontamination and avoidance practices. Figure 3 shows an example sign design commonly found throughout Michigan. Many local areas in the Huron River watershed and throughout southeast Michigan have boat and wader wash stations. Similar amenities may be useful at Pen Park.

Paddlers on our river and stream ecosystems can get involved with the Michigan Paddle Stewards program (https://www.misin.msu.edu/projects/mipaddle/), which helps paddlers identify and map invasive species along Michigan's water trails.[11]

10.3 Focal Areas Within the Impoundment Area

Within the Impoundment, areas with higher sediment volumes away from the thalweg are more likely to revegetate rapidly and possibly with invasive plant species.

These areas are generally found immediately downriver of Superior Road and the railroad bridges, especially along the inside bends of the river. An area of the river left and downriver of the railroad bridge currently sees low water velocities.

The newly exposed lands within and adjacent to Pen Park on the north side of the river could serve as excellent plant habitat and may see invasive species move in unless proactive and ongoing measures are taken by the City of Ypsilanti and partners for the first several years of restoration. Many of the restoration actions within the park will be well-suited for volunteer efforts.

10.3 Invasive Species of Concern for Newly Exposed Lands in the Restored River Area

There are currently no invasive plant species of concern, either aquatic or terrestrial, that are known to prefer freely flowing river channels to impoundment areas. The aquatic invasive species of concern that could affect this area are similar to those that can affect the current impoundment. Moving water may limit the spread compared to current conditions, particularly for Eurasian watermilfoil, Starry stonewort, and European Water Clover.

Three terrestrial species of greatest concern that will likely vegetate the restored area rapidly without mitigation efforts are phragmites, purple loosestrife, and flowering rush, due to their high prevalence throughout the watershed. Reed canary grass is also a concern as it is found in pockets throughout the watershed and is becoming increasingly prevalent in southern Michigan.

10.3.1 Flowering Rush

Flowering rush (*Butomus umbellatus*) is a perennial reed-like wetland plant with pink flowers that grows 1 to 4 feet tall along shores in shallow, slow-moving water. In deeper water, it can grow in a submerged form that does not produce flowers. It flowers in early summer through mid-fall. It is native to Europe and Western Asia and was introduced into the Great Lakes through ballast discharge.

The leaves are tall, extend from the roots, and are dark green in color. Leaves have a triangular cross-section and tend to twist near the tip. Flowers comprise of three pink petals and three sepals arranged in clusters or umbels (umbrella shaped) on a flower stalk. Flowers typically bloom in June through early fall. Small buds that form in the clusters of flowers can disperse and grow into new plants. Populations in the eastern United States produce seeds. Roots are bulb-like and appear to "hug" or cup one another. The plant reproduces by vegetative spread from its rhizome (an underground stem that sends out roots and shoots from its nodes) in the form of small onion-like buds (bulbils). Bulbils can detach and spread through water currents. Individual pieces of the rhizome can also break off and produce new plants.

10.3.1.1 Preventing Flowering Rush Infestation (Years 0+ After Dam Removal)

Preventing infestations of Flowering Rush is by far the most cost-effective and environmentally-friendly solution. In the Pen Dam impoundment area, avoidance of invasive infestation will require regular and frequent monitoring throughout the growing season.

Newly exposed and re-exposed land areas should be monitored. Native plantings in the exposed land areas with fast-growing native plants will help stave off invasive flowering rush infestations. Encouraging native plant growth from existing, natural seed banks may be similarly effective.

10.3.1.2 Likely Remediation Actions (2+ Years After Dam Removal)

1. Management of invasive aquatic plants involving either mechanical removal of plants or application of herbicides to public waters requires a permit from the DNR.
2. Mechanical control can be done by cutting the plant below the water surface several times per summer and removing all cut parts from the water. However, in some instances, cutting has facilitated spread. Hand digging is best for small infestations, especially when water levels are low. Hand dig isolated plants with care, as root fragments can spread and sprout.
3. Chemical Treatment by herbicidal control can be done using imazapyr herbicide. Preliminary testing indicates that a mid-summer application during calm wind conditions may be most effective.

10.3.2 Purple Loosestrife

Purple loosestrife (*Lythrum salicaria*) is a perennial herb with a woody, square stem covered in downy hair. Its height varies from 4 to 10 feet and has leaves arranged in pairs or whorls. Its magenta flower spikes with 5 to 7 petals per flower are easily recognizable and are present for most of the summer.

Purple Loosestrife is an established invasive species throughout Michigan and is either established or found in every U.S. state except Florida. Given the right conditions, purple loosestrife can rapidly establish and replace native vegetation. This can lead to a reduction in plant diversity, which reduces habitat value to wildlife.

Purple loosestrife thrives along roadsides and in wetlands and is prominent in many areas of the Huron River watershed. The seeds can germinate in water, but establishment is much more successful in moist substrate that's not flooded. It prefers full sun, but can tolerate shade.

10.3.2.1 Preventing Purple Loosestrife (Ongoing)

Many privately-owned wetlands are dominated by Purple Loosestrife, often because landowners either

are not aware that the species is invasive or because they find the flowers aesthetically pleasing. The abundance of purple loosestrife throughout the watershed, in the impoundment area, and in nearby wetlands makes prevention and eradication within the impoundment virtually impossible. Active management efforts will be required in perpetuity.

10.3.2.2 Remediation Actions (Ongoing in Current Impoundment and After Dam Removal)

1. Digging, Hand-pulling and Cutting: In areas where there are few plants and easy access, manually removing the plants is recommended. Purple loosestrife can be cut or pulled without a permit in Michigan. It is important to dispose of the plants away from the water. Allow the plants to dry out, then burn if possible.

2. Pulling purple loosestrife by hand is easiest when plants are young (up to two years) or in sand. Older plants have larger roots that can be eased out with a garden fork. Remove as much of the root system as possible, because broken roots may sprout new plants.

3. Removing flowering spikes will prevent the current year's seeds from producing more plants in future years. Each mature plant can produce over 2 million seeds per year. The previous year's dried seed heads should also be removed as they may still contain seeds. Stems should be cut at the ground to inhibit growth.

4. Proper disposal of plant material is important. Put all plant pieces in plastic bags (vegetation rots quickly in plastic) and take the bags to a sanitary landfill site. Be sure the landfill site doesn't require bags to be broken open for composting. Composting is not advised, as purple loosestrife seeds may not be destroyed and the thick, woody stem and roots take a long time to decompose. Incineration is an effective way to dispose of plant material.

5. Chemical Control: Herbicide can be used to spot treat small infestations of purple loosestrife. A DNR permit is required to spray purple loosestrife in public waters and protected wetlands in Michigan. However, there is no fee for this permit.

6. Biological control: Leaf-eating beetles *Galerucella spp*. are available for control of purple loosestrife. They can be used on a variety of site types and on small sites with as few as 20 plants.

10.3.3 Phragmites

Phragmites australis is a perennial, wetland grass that can grow over 12 feet high. *Phragmites australis* is native to Michigan, but an invasive, non-native, variety of phragmites, likely from Europe, has become widespread and is a threat to the ecological health of some areas of the watershed. Invasive phragmites form tall, dense stands that degrade wetlands by crowding out native plants and animals. When left unmanaged, the tall reeds also block shoreline views, reduce access for swimming, fishing, and hunting. In some cases, it can create seasonal fire hazards when the foliage dries out.

Invasive Phragmites can be controlled by avoiding initial infestation with aggressive native species planting following dam removal, encouragement of native plant growth, and later on, a chemical and

mechanical treatment approach if invasive Phragmites is found. Annual monitoring or maintenance, similar to other riparian areas of the watershed will be required in perpetuity.

10.3.3.1 Preventing Invasive Phragmites Infestation (Years 0+ After Dam Removal)

Preventing large infestations of Phragmites is by far the most cost-effective and environmentally-friendly solution. In the Pen Dam impoundment area, avoidance of invasive infestation will require regular and frequent monitoring throughout the growing season.

Newly exposed and re-exposed land areas should be monitored. Native plantings in the exposed land areas with fast-growing native plants will help stave off invasive phragmites initial infestations of phragmites. Encouraging native plant growth from existing, natural seed banks may be similarly effective.

10.3.3.2 Remediation Actions (2+ Years After Dam Removal)

1. Identification of native or invasive phragmites. HRWC will coordinate with experts and volunteers to determine whether phragmites that grows in the restored impoundment is native or invasive.

2. Among other resources, *A Guide to the Control and Management of Invasive Phragmites*, provided by EGLE will provide a baseline guide for best practices and management.[12]

3. Controlling invasive Phragmites will likely require several permits from local, state and federal authorities. HRWC will work with the Jackson, Lenawee and Washtenaw Cooperative Invasive Species Management Area (CISMA), other partners, and landowners to obtain appropriate permits as needed.

4. Chemical Treatment: For inland areas like the restored Pen Dam impoundment, a permit is required to treat invasive Phragmites using herbicides if the plants are in standing water at the time of treatment. EGLE's Water Resource Division has created a general permit category for this type of activity, which allows property owners to request authorization for control of invasive or non-native species through a simplified permit process. Chemical treatment information, including permitting requirements and blank permit application forms, can be found on the EGLE inland lakes webpage under Aquatic Nuisance Control.[13] The General Permit for Aquatic Nuisance Control Activities for Certain Non-native Invasive Emergent Plants should be consulted beforehand.[14] The use of a licensed applicator who is certified in aquatic pest management is recommended for herbicide application, especially in large, dense stands and in sensitive areas such as wetlands.[15]

5. Mechanical Treatment: Mechanical treatment of invasive Phragmites is recommended at least 2 weeks after chemical treatment to remove dead stems and promote native plant growth. Mowing is the most commonly used method for mechanical treatment, particularly on privately owned, or smaller properties. Mowing activities should be limited only to areas where invasive Phragmites is present. Adjacent wetland areas where native species are dominant should be avoided. In wet areas, mowing invasive Phragmites as mechanical treatment can be done in the winter when the ground is frozen. This seasonal timing is safer and provides more reliable access to these areas

while reducing impacts to native plants and wildlife. Tilling or disking of plant roots and soil is not an effective mechanical treatment method for invasive Phragmites. These activities promote the spread of invasive Phragmites. While prescribed burning is another effective method of mechanical treatment of invasive Phragmites after chemical treatment, this method will not be suitable for the restored Pen Dam impoundment. Burning is typically used on very large sites in rural areas.

6. Monitoring impacts of the treatment(s) is an important part of a successful management project, and helps identify areas which require additional or follow-up chemical treatment. Monitoring can be as simple as before and after photo documentation or listing plant species growing in treated areas in the following spring. Monitoring can also help improve management techniques and hone recommendations for future projects.

7. Any entity that uses the above treatment methods may be required to report to the permitting authority following treatment.

8. Successful invasive Phragmites management in heavily infested areas can take several years, and almost always requires repetitive treatment. In later years following infestation, annual maintenance (spot treatment) is usually required and is critical to preventing re-infestation of the invasive plant. Spot treatment is highly effective and is usually low-cost.

10.3.4 Reed Canary Grass

Phalaris arundinacea, reed canary grass (RCG) is a cool-season forage grass actually considered a native Michigan species by the Michigan Natural Features Inventory (MNFI) though many Midwestern colonies are suspected of being escapes of cultivated and European forms. Many other organizations describe reed canary grass as an invasive species regardless of its origin. The invasive nature of reed canary grass to grow in dense stands that chokes out other vegetation may be the result of centuries of breeding for productive growth and drought tolerance.

In the 1960s and 1970s some varieties of reed canary grass were actually recommended for use under certain circumstances. Generally, current recommendations call for chemical and manual removal when feasible and aggressive planting of other native species to avoid population of reed canary grass.

RCG can be controlled by avoiding initial infestation with aggressive native species planting following dam removal, encouragement of native plant growth, and later on, chemical and mechanical treatments if desired and feasible. Annual monitoring or maintenance, similar to other riparian and natural areas of the watershed, will be required in perpetuity.

10.3.4.1 Preventing Reed Canary Grass Infestation (Years 0+ After Dam Removal)

RCG is unlikely to spread widely throughout the impoundment due to the soil conditions it requires but may become troublesome in some areas if left unattended. Preventing infestations of RCG is a cost-effective solution.

Newly exposed and re-exposed land areas should be monitored after dam removal. Native plantings in the

exposed land areas with fast-growing native plants will help stave off RCG. Encouraging native plant growth from existing, natural seed banks may be similarly effective.

10.3.4.2 Remediation Actions (2+ Years After Dam Removal)

1. Identification of RCG. HRWC will coordinate with experts to identify pockets of RCG.

2. Controlling RCG may require permits from local, state and federal authorities. HRWC will work with the Jackson, Lenawee and Washtenaw Cooperative Invasive Species Management Area (CISMA), other partners, and landowners to obtain appropriate permits as needed.

3. Chemical Treatment: For inland areas like the restored Pen Dam impoundment, a permit is required to treat invasive plants using herbicides if the plants are in standing water at the time of treatment. EGLE's Water Resource Division has created a general permit category for this type of activity, which allows property owners to request authorization for control of invasive or non-native species through a simplified permit process. Chemical treatment information, including permitting requirements and blank permit application forms, can be found on the EGLE inland lakes webpage under Aquatic Nuisance Control.[16] The General Permit for Aquatic Nuisance Control Activities for Certain Non-native Invasive Emergent Plants should be consulted beforehand.[17] The use of a licensed applicator who is certified in aquatic pest management is recommended for herbicide application, especially in large, dense stands and in sensitive areas such as wetlands.[18]

4. Mechanical Treatment: Mechanical treatment is recommended following chemical treatment to remove dead stems and promote native plant growth. Mowing is possible and preferred when the ground is suitably stable, such as when it is partially frozen. Manual extraction by hand when the plants are young is the most commonly used method for mechanical treatment, particularly on privately owned, or smaller properties. Removal with hand tools such as a garden fork may be required when the plants mature and develop roots.

5. Monitoring impacts of the treatment(s) is an important part of a successful management project, and helps identify areas which require additional or follow-up chemical treatment. Monitoring can be as simple as before and after photo documentation or listing plant species growing in treated areas in the following spring. Monitoring can also help improve management techniques and hone recommendations for future projects.

6. Any entity that uses the above treatment methods may be required to report to the permitting authority following treatment.

7. Successful RCG management in heavily infested areas can take several years, and almost always requires repetitive treatment. In later years following infestation, annual maintenance spot-treatment is usually required and is critical to preventing re-infestation of the invasive plant.

11. Monitoring to Assess Restoration Potential and Outcomes

11.1 Michigan Stream Quantification Tool

The Restoration Subcommittee intends to utilize the Michigan Stream Quantification Tool (SQT or MiSQT).[19] The MiSQT is a quantitative calculation tool that has several intended uses. In the case of the Pen Dam impoundment restoration, the MiSQT could be used to assess the restoration potential prior to dam removal and the extent of recovery, described in quantifiable terms as "functional lift," following dam removal. The MiSQT assesses parameters related to stream health that include hydrology and hydraulics, geomorphology, physiochemistry, and biology. This will help guide the practices of the Restoration Subcommittee and any contracted firms to maximize the ecological benefits of the dam removal.

11.1.1 Reach Selection

The MiSQT operates on a user-selected reach. Each reach is evaluated separately. Since stream condition or character can vary widely from the upstream end of a project to the downstream end, a large project may be subdivided into multiple reaches. Reaches are typically described by similar processes and morphology, including characteristics such as stream type, stability condition, riparian vegetation type, and bed material composition. While some similarities exist throughout the impoundment, it may be warranted to consider the impoundment as multiple MiSQT reaches. It will certainly be warranted when distinguishing between restoration above and below the current location of the dam. Findings from the bathymetry and hydraulic modelling completed in 2021 indicate the impoundment is not homogenous. There may be distinct reaches of the river with characteristics that need to be evaluated as separate MiSQT reaches.

11.1.2 Parameter selection

The MiSQT workbook includes 24 metrics used to quantify 12 parameters. It also includes a best management practice routine that incorporates changes in runoff and treatment of nutrients into scoring. Not all metrics and parameters will need to be evaluated at this site. The Restoration Subcommittee will consider the landscape setting of the impoundment area as well as the goals and objectives of the restoration in selecting parameters. A basic suite of metrics within 6 parameters are recommended for all sites and will be included in MiSQT analysis of the impoundment.

- Reach Runoff
- Floodplain Connectivity
- Large Woody Debris
- Lateral Migration
- Riparian Vegetation
- Bed Form Diversity

11.1.3 Considerations for Pre- and Post- Removal Assessment

Appropriate timing of monitoring activities and assessment conducted before and after dam removal will

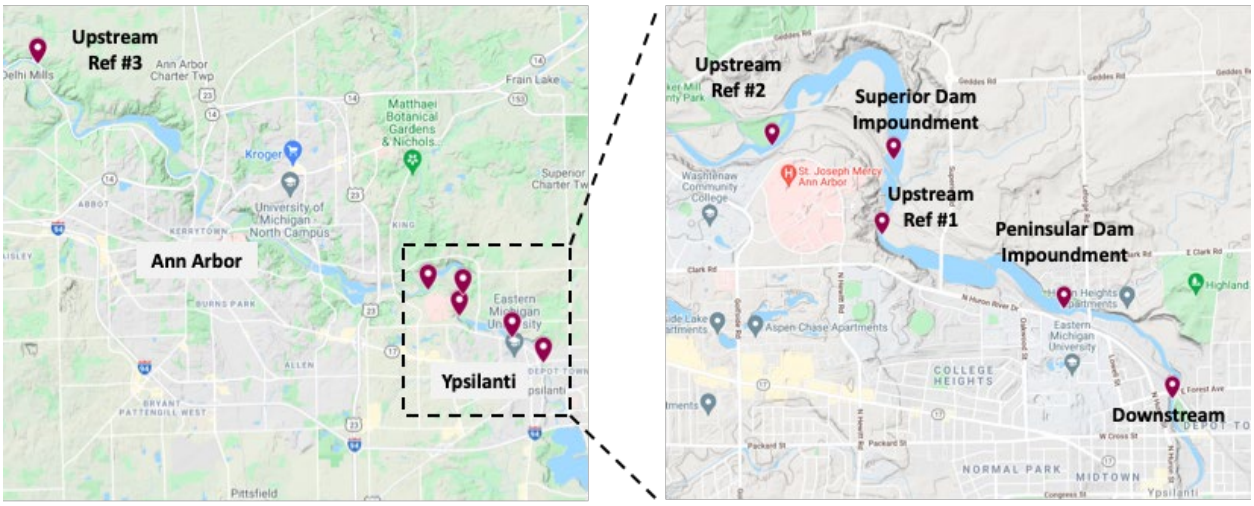

Figure 4. *Water quality sampling sites. Sites shown on inset in B are monitored weekly throughout the summer months. Upstream Reference site #3 was sampled monthly.*

be essential. The same parameters and metrics must be used in the existing condition and all subsequent condition assessments within a project reach, otherwise the relative weighting between metrics and parameters changes and the overall scores are not comparable over time.

11.2 Water Quality Monitoring

Dams alter physical and chemical conditions affecting aspects of water such as turbidity, temperature, oxygen, and nutrient availability. Sediments and organic material settle out in slow-flowing impoundments, reducing sediment transport. Anoxic conditions in impoundments can be due to the accumulated organic material and slow reoxygenation in stagnant waters. Increased exposure to sunlight behind dams can increase water temperatures. These conditions alter nutrient cycling and promote the production of methane, a greenhouse gas that is 30 times more potent than carbon dioxide. These conditions also may be favorable for undesirable species, such as cyanobacteria that can produce toxins and cause harmful algal blooms. Rooted macrophytes, such as water lilies, take hold in the shallow sediments that accumulate behind dams, resulting in increased inputs of organic matter to the sediments and facilitating the release to the atmosphere of greenhouse gasses produced in the anoxic sediments. Higher rates of primary production behind dams can be due to increased water clarity, warmer temperatures, and habitat for macrophytes. Increased respiration from the bottom of the impoundment, due to increased input of organic matter, can lead to greater river “metabolism.” River metabolism is a measure of river health and carbon balance, and a higher river metabolism can lead to increased methane emissions from the impoundment.

Water quality monitoring will incorporate several MiSQT function-based parameters related to physiochemistry and biology, including metrics for temperature, nutrients, dissolved oxygen, bacteria and macroinvertebrates. Turbidity measurements, dissolved organic carbon and absorbance measurements, and surveys for water column algal communities and aquatic macrophytes should be conducted by appropriate experts. Initial sampling sites, as shown in Figure 4, were determined by HRWC watershed ecologists and aquatic ecologists at Eastern Michigan University, based on several factors and their

relevance to conditions either in the current impoundment or expected conditions following dam removal. Sampling sites include the Peninsular impoundment and flowing water sites located 0.9 miles downstream and 1.2 miles upstream of Pen Dam. Samples will also be taken from the Superior dam impoundment located 1.5 miles upstream from the Peninsular Dam, which will serve as reference impoundment after Pen Dam is removed. Two additional upstream flowing-water sites will also serve as reference sites. One is located 1.5 miles upstream from the Superior Dam, just downstream from the Ann Arbor and the Ann Arbor wastewater treatment plant; the other is located higher in the catchment, and serves as a less-impacted reference site.

Weekly sampling of nutrients, dissolved oxygen, turbidity and dissolved organic carbon over the summer months began in 2021 and will continue through dam removal and for 1-2 years following removal; the most upstream reference site will be sampled at a lower frequency (monthly). Data loggers will take continuous measurements of temperature at all sites and of oxygen at three sites. In addition to providing information on average oxygen concentrations, continuous oxygen measurements provide a measure of river metabolism. Dam removal can have short and long-term impacts on water quality. Initial decreases in water quality caused by removal, such as increased sediment flux, are thought to be short-lived (days to months). During the dam removal phase, sampling frequency will increase at the sites up and downstream of the dam, aided by the use of two auto-samplers.

Twice during the summer months water column algal communities should be monitored in the Peninsular impoundment and at the sites immediately up and downstream from the Pen dam. Surveys for aquatic plants will also be conducted in the stretch between the Peninsular and Superior dams. Macroinvertebrates will be sampled annually, and bacteria will be sampled during storm events.

11.3 Methane Sampling

Methane produced in anoxic sediments may be released to the atmosphere through three pathways: diffusion to the surface, bubble formation (ebullition), or via active gas transport through vascular plants that are rooted in the sediments. Because impoundments collect sediments, promote anoxia, and create habitat for rooted macrophytes, they can be hotspots for methane production. Several studies have documented elevated methane release in large impoundments, but less is known about the role that small dams play in contributing to methane release to the atmosphere. We will study methane dynamics in the Huron River system two ways. First, we will measure dissolved methane in surface waters longitudinally across five sites that include the Superior and Peninsular impoundments, and flowing water sites up and downstream of each impoundment. We will also measure evasion of methane to the atmosphere across the water surface using floating chambers. Sampling sites in the impoundments will be stratified to include shallow vegetated area, shallow unvegetated areas, and deep-water sites.

12. Restoration Considerations for Peninsular Park

12.1 Peninsular Park Overview

Peninsular Park (Pen Park) is an approximately 7-acre parcel owned by the City of Ypsilanti on the north bank of the Huron River, accessible from Leforge Rd. Located close to Eastern Michigan University and residential areas, Pen Park exists at the boundary between urban Ypsilanti and rural Superior Township.

There are significant areas of woodland, wetland and farmland to the north. The Huron River provides a direct natural corridor as it passes through Ypsilanti. Pen Park is at the northern edge of Ypsilanti, immediately surrounded by relatively dense development. Large apartment complexes are within walking distance to the north, east, and south. The park is the closest natural area to Eastern Michigan's campus, across the river to the south.

Pen Park experiences low use and significantly less use than Riverside and Frog Island Parks along the Huron River in Ypsilanti, despite relatively high population density in close proximity.

Assessments and surveys conducted by HRWC to understand use along the Huron River Water Trail find that the most common users of Pen Park are: anglers that live locally and typically fish in the area many times per year, recreational fly anglers that access the river below Pen Dam, and recreational users paddlers along the Huron River Water Trail. Despite the presence of flatwater in the current impoundment, the park is not a popular access spot for novice paddlers. Waterfront owners along the impoundment that use the impoundment for fishing, paddling, birding, or other activities typically do so from their own private access.

Use of the park by residents of the adjacent apartment complexes is low. Anecdotal reasons identified for the low local use have been perceptions of safety and lack of amenities, programs, and aesthetic views. Enhancing the perceived safety, aesthetics, and uses of the park could draw in more park users from the immediate surroundings.

12.2 Restoration Goals for the Park

The City of Ypsilanti has previously stated goals for the park to 1) improve scenic views, 2) enhance park safety, and 3) improve park facilities and overall park accessibility. The intent of these improvements is to attract more users to enjoy the park and adjacent river while enhancing the ecological function and habitat value of the park.

Previous assessments of invasive and native species have been completed by HRWC or other organizations as recently as 2017. Follow-up investigations by HRWC staff indicate environmental conditions have not changed significantly at this site since that time.

12.3 Applicability to the Entire Project Area

The restoration options and priorities identified below for specific areas within the park will likely be applicable generally in areas throughout the impoundment under private ownership. Variations in topography, geomorphology, soil type, and existing flora are generally consistent with those found throughout the impoundment, except where substantial artificial landscaping or the planting of non-native species by private landowners has occurred.

12.4 Association with Dam Removal

The restoration options and priorities identified in this section are suitable regardless of the status of the dam removal and should not be viewed entirely as costs inherent or required by dam removal. The actions will be especially beneficial to pursue before structural removal of the dam commences, however. That relative timing will limit the spread of invasive species currently in the park to recovered land areas

within the park boundary, or to adjacent recovered private lands. Actions on recovered land following dam removal are additional actions that directly result from the dam removal and can be considered required.

12.5 Surrounding Land Use and the Human Aspect

Soil Conditions and Historical Land Use

The site of the park has been subject to extensive human use and disturbance due to the adjacent paper mill and dam. The two largest ecological impacts are the change in the water level and flow rate of the river behind the dam, and the construction of the dam and paper mill itself with attendant earth-shaping activities. According to the USDA soil survey maps, most of the park area is fill land. Apparently, the northern edge of the park was originally an escarpment with a much steeper slope down to the river or its floodplain, and the south facing slopes of the park were filled to some degree. Despite this massive disturbance, some of these slopes have large native trees on them, due to the length of time since the disturbance. Most of the soils surrounding Pen Park are Boyer sandy loams. It seems likely that the fill soil was taken from nearby (possibly the gravel pit at the west end of Clark Rd.) and that in the approximately 150 years since the land was shaped, a relatively mature forest has emerged.

12.6 Ecological Threats and Opportunities

Many invasive plants threaten the long-term biodiversity of the site. Left unchecked, various non-native shrubs and the vining Asian bittersweet will eventually choke out most of the site and turn it into an impenetrable thicket (as is well underway in the northeastern portion of the site). The non-native shrub layer is probably the largest threat to the site's biodiversity, with evergreen groundcovers such as wintercreeper and myrtle being secondary threats.

However, remnants of native plant communities persist. Western areas of the park are very restorable to a more open condition with relatively little effort and can be managed in the future with prescribed fire. The currently mown areas of the park would be relatively easy to convert to a savanna ecosystem and are good locations in which to locate more managed pollinator gardens.

The river itself presents many opportunities. Humans have a fascination with water and enhancing access to and appreciation of water-based recreation is an excellent way to promote an environmental ethic while protecting its natural resources and function. Dam removal would greatly increase the amount of land available for habitat and parkland, as well as having many other benefits for river function and water quality.

12.7 Management Units and Recommended Action Steps

The park has been divided into six units, as shown in Figure 5, with a different suite of recommended actions for each area. The different units generally fall into three categories: Units 1-3 are most suited for passive recreation/nature viewing/habitat. Unit 4 is in poor shape ecologically and would require a considerable amount of long-term effort to be restored and may be best left alone or considered for restoration or enhancement at a later date. Units 5 and 6 are most suitable for active recreation/river views/picnic/fishing/boating. Specifics of each unit follow. Prices are estimates for budgeting purposes.

Figure 5: Map of management units as described by PlantWise, LLC in the 2016 Peninsular Park Management Plan. Imagery from Google Earth, accessed 2016.

Unit 1 is 1.2 acres and consists of forested, south facing slopes. The dominant overstory trees are oaks and hickories. Although there is considerable shrub invasion, this is by far the easiest area to restore.

- Cut invasive shrubs, treat stumps, and remove brush from site. $4,000
- Prescribed burn. $1,400 (for all areas together)

Unit 2 is 0.6 acres and is also forested, with generally south-facing slopes and some lower-lying, moist areas. Although there are some oaks and hickories here, the majority of the overstory trees are basswood, hackberry, or maple. Invasive shrubs are more dense than in Unit 1, and the herbaceous vegetation is of lower quality. Restoring this area would be a secondary priority compared to Unit 1.

- Cut invasive shrubs, treat stumps, and remove cut brush from site. $6,000
- Prescribed burn. $1,400 (for all areas together)

Unit 3 is 1.1 acres and is currently mown and includes the river edge, which is dense with shrubs, and varies in degree of slope. There are some scattered picnic benches. This would be a prime area to establish a walking path to enjoy the natural features of this site and restore the remaining mown area to a natural state. Points that are most suitable for pedestrian access to the river's edge should be selected, and

the rest of the bank should be planted with native shrubs to discourage foot traffic that will otherwise lead to more erosion.

- Delineate path layout.
- Kill cool season turf and sow native seeds in areas beyond designated paths. $2,500
- Cut invasive shrubs, treat stumps, and remove cut brush from site. $7,000
- Prescribed burn. $1,400 (for all areas together)
- Plant native shrubs along riverbank in select areas. $1,000-$5,000

Unit 4 is 2.5 acres very disturbed and heavily invaded with invasive shrubs, overstory trees and groundcover species. There are potentially wonderful views of the river from the northern hilly portion, but considerable expense and effort would be needed to develop a trail and viewing area. Several approaches could be taken here, which vary widely in the amount of expense and effort needed.

- Herbicide Japanese knotweed along entrance drive ditch. (This action is of high
- priority for the park overall, since it's important to stop the spread of this highly
- pernicious weed.) $150/yr
- Slowly remove invasive species from southern edges and push toward northern
- edge of unit.

Unit 5 is 0.2 acres in an area of higher park use. It includes the concrete walk along the river, which is used by fisherman and pedestrians alike. The steps at the west end of this walk are in poor shape and need repair or complete replacement. The rest of the area is a south-facing slope dominated by black locust with some scattered native trees and an understory of invasive shrubs. This is a prime area where shrub removal could improve visibility and enhance park user's feelings of safety. At a minimum, shrubs would be removed within 10-15 feet of both sides of the walkway. If all the shrubs are removed, a maintenance plan will be critical for this area. With the black locust overstory and a lack of native plants, intentional plantings will be needed to help prevent a thicket of invasive shrubs growing back within a few years.

Several years of invasive shrub control and native grass plantings would help; eventually replacing the black locusts with several oaks would complete the transformation of this area.

- Cut, treat, and remove invasive shrubs to enhance view of river and safety. $3,000
- Follow up treatments to prevent woody re-invasion. $300/year
- Plant warm season grasses in understory. $200-$1,000
- Eventually remove and treat black locust for prairie/savannah establishment.

Unit 6 is 0.7 acres and is mostly composed of areas for parking, picnicking, and boating. The vegetation is mostly lawn, with the exception of the river's edge, which is shrubby. Removing non-native shrubs along the riverbank would enhance park users' interaction with the water and views of the river. There is an existing picnic shelter and picnic tables. Both could use some repair work, but seem generally serviceable. Addition of playground equipment would be a draw

for neighborhood families. This would be an ideal place to install demonstration gardens for pollinators and fruiting plants.

- Install pollinator garden(s). $750-$3,000
- Cut, treat, and remove invasive shrubs to enhance view of river. $3,000
- Plant native fruiting plants in select areas. $750-$3,000
- Plant native shrubs/trees along riverbank. $750-$3,000

12.8 Priorities

Although the traditional restoration priority would be to work on the least degraded portion of the site first (units 1 and 2), this park's most significant use is probably as a recreation and outdoors destination for people, with ecology and wildlife habitat being a secondary use. Therefore, working first on units 5 and 6 would have the most immediate impact from a park user's point of view. After that, clearing views in unit 3, and restoring unit 1. Lastly, working on a trail/overlook in unit 4 and restoring unit 2.

12.9 Estimated Costs of Restoration for Pen Park

Estimates for the total cost of restoration activities in Pen Park range from $10,000 up to $60,000, with the lower limit ($10,000) being relevant to what is essential to the river corridor and necessary to conduct before removal of the dam. Many of the actions identified are best practices for addressing invasive species or planting native species but are not of immediate concern and are unlikely to impact adjacent parcels over several years.

The estimated cost to remove invasive species throughout Pen Park on existing land was estimated in 2016 by Plantwise to by approximately $25,000. Adjusted for inflation and including a 20% contingency, the estimated cost as of 2021 comes to $35,000. Removal of invasive species on existing land within the park is recommended regardless of the status and timing of the dam removal, but will have additional benefits to reducing the risk of spread of invasive species to recovered land following dam removal.

The cost of initial native planting on the recovered park lands after dam removal is highly uncertain and dependent on many unknown factors, including decisions about the land area's intended use. Based on the findings of the Feasibility Study, the park may gain approximately 30% land area, or just more than 2 acres. At a bare minimum, if the entire recovered area needed to be seeded with native species, volunteers could complete that effort for approximately $2,000-$4,000 (up to 2.1 acres multiplied by 261 lbs of seed multiplied by $6 per acre). Better practices that include recommended seed mixes will increase the total cost of seeds but could still be completed by volunteers.

12.10 Prescribed Fire

Prescribed burns have many benefits and are often a cost-effective method for caring for natural areas. Fire was a key feature of many upper Midwestern landscapes prior to European settlement. Prescribed ecological burns are a way of managing prairies, savannas, oak woodlands, and many wetlands (all fire-dependent ecosystems) in a safe and controlled fashion. Prescribed fire has not been used in City of Ypsilanti parklands before. The local fire department has final jurisdiction over permitted uses of prescribed fire.

12.11 Chemical and Manual Removal

Non-native shrubs including common buckthorn, glossy buckthorn, honeysuckles, privet, autumn olive, and multiflora rose should be cut to within 6" of the ground and painted with a 20% or greater concentration of glyphosate or triclopyr, then removed from the site. This can take place any time of year except during spring when the sap is rising and herbicide becomes ineffective. Follow up treatments using foliar spray of herbicide and/or prescribed burning will help reduce the population in future years. Start treatment in the priority areas and slowly move outwards as time and money allow. Removing these shrubs will have ecological and aesthetic benefits. We recommend that wetland-approved herbicides be used on this site, these have been shown to generally not be detrimental to the health of fish and herps.

Larger stems of Asian bittersweet can be cut and treated as described above. Follow-up foliar treatments during late summer will be necessary to control sprouting and smaller plants and seedlings. Ideally, this plant would be removed from the entire park. Non-native groundcovers including wintercreeper, myrtle, and Japanese honeysuckle can be foliar sprayed with Pathfinder at a time of year when desirable groundcovers are dormant (such as in late fall or early spring).

Japanese knotweed is an extremely persistent and difficult plant to get rid of. There is only one small patch in the park, and it should be dealt with while it's still small. Yearly foliar treatments in August or September with triclopyr will be necessary for 3-5 years to ensure complete eradication.

Garlic mustard & dame's rocket can be hand-pulled in the late spring when flowering, and should be bagged and removed from the site. Neither of these plants are present in large numbers, and it should be relatively easy to sweep the park each spring and remove the small patches that exist.

Black locust and tree-of-heaven are large, suckering trees. Both should be girdled and the girdled area treated with a 20% or greater concentration of triclopyr. After 6 months to a year, the girdled stems can be removed and re-sprouting will be minimized, but several years of consistent treatment of all re-sprouts will be needed to ensure adequate control.

12.12 Native Species Planting

Areas to be seeded should be killed with herbicide 2-3 times over the growing season before native seed mix is sown sometime between November 1st and December 31st by broadcast sowing. Leaves that fall before seeding should be removed and/or shredded to ensure good seed/soil contact. Native seed is mixed with a bulk agent such as compost, sand, or potting soil and then hand broadcast over the desired area with two passes at right angles to each other. Half the seed should be sown in each direction. Seeding rate should be approximately 5 ounces of native seed per 1000 square feet. The proportion of grasses versus forbs (wildflowers) can be varied according to budget. Seed can be acquired from local sources, such as Michigan Wildflower Farm or Native Connections.

The pollinator garden and edible planting areas can either be sprayed with herbicide to eliminate existing vegetation, or sheet-mulched. Sheet-mulching is a technique where several layers of newspaper or cardboard are laid down, then coarse wood chips on top.

Turf grass and most herbaceous weeds will be smothered within 6-8 weeks and then planting can happen. The pollinator garden can be planted with plugs of native plants, which are available from a variety of local sources.

Shrubs and trees are best planted in fall (Sep/Oct) or spring (Apr/May) to minimize drought stress. We recommend purchasing shrubs and trees in 1- or 5-gallon containers from a native plant producer. The small sizes are easier to plant, establish more quickly, and require less watering.

Plugs, shrubs and trees will all require some amount of watering to establish.

12.13 Volunteer Activities

Many of the restoration activities are suitable for volunteers. Although volunteers can use chainsaws and herbicides and do in some cases, there are more liability concerns and it requires the right volunteer and more oversight. The most suitable activities for volunteers needed here could be:

- Sowing of native seed.
- Cutting brush high and hauling it to piles, leaving herbicide of stumps and chipping to professionals and city staff respectively.
- Watering and weeding of butterfly garden and edible plantings.
- Planting of plugs, shrubs, and trees with some experienced/professional oversight.
- Hand-pulling of garlic mustard, dame's rocket, and other biennial invasive plants

12.14 Suggested plant species

12.14.1 Seed Mix Species for Naturalizing

Achillea millefolium (wild yarrow)
Allium cernuum (nodding wild onion)
Anemone virginiana (Canada anemone)
Aquilegia canadensis (wild columbine)
Aster cordifolius (heart-leaved aster)
Aster sagittifolius (arrow-leaved aster)
Eupatorium rugosum (white snakeroot)
Geranium maculatum (wild geranium)
Helianthus divaricatus (woodland sunflower)
Monarda fistulosa (bee balm)
Penstemon digitalis (smooth beardtongue)
Penstemon hirsutus (hairy beardtongue)
Rudbeckia hirta (black-eyed susan)
Rudbeckia triloba (brown-eyed susan)
Solidago caesia (bluestem goldenrod)
Solidago speciosa (showy goldenrod)
Thalictrum dioicum (early meadow rue)
Zizia aurea (golden alexanders)
Carex vulpinoidea (fox sedge)
Elymus canadensis (Canada wild-rye)
Elymus hystrix (bottlebrush grass)
Elymus virginicus (Virginia wild-rye)
Schizachyrium scoparius (little bluestem)

12.14.2 Pollinator Garden Species

Asclepias tuberosa (butterflyweed)
Aster laevis (smooth aster)
Coreopsis lanceolata (sand coreopsis)
Echinacea purpurea (purple coneflower)
Fragaria virginiana (wild strawberry)
Monarda fistulosa (bee balm)
Penstemon digitalis (smooth beardtongue)
Senna hebecarpa (wild senna)
Solidago rigida (stiff goldenrod)
Vernonia missurica (ironweed)
Schizachyrium scoparius (little bluestem)

12.14.3 Shrub Replacement Species at River's Edge

Cornus sericea (red-twig dogwood)
Corylus americana (hazelnut)
Physocarpus opulifolius (ninebark)
Prunus americana (wild plum)
Sambucus canadensis (elderberry)
Staphylea trifolia (bladdernut)
Virbunum lentago (nannyberry)

12.14.4 Recommended Tree Replacements Near Current Shoreline or in Recovered Land Area

Carya cordiformis (bitternut hickory)
Celtis occidentalis (hackberry)
Gymnocladus dioicus (Kentucky coffeetree)
Liriodendron tulipifera (tulip tree)
Nyssa sylvatica (black gum)
Platanus occidentalis (sycamore)
Quercus bicolor (swamp-white oak)
Quercus macrocarpa (bur oak)
Quercus muehlenbergii (chinkapin oak)

13. Summary of Key Locations in the Project Area for Restoration Activities

For the purposes of restoration work before and after dam removal, efforts will overwhelmingly focus on the stretch of river between Superior Dam and Pen Dam.

Figure 6 is a map showing the impoundment area. The deep blue river channel indicates the anticipated future river channel following dam removal based on the best information available. The green areas indicate where recovered land area is expected to be above water under average river flow conditions.

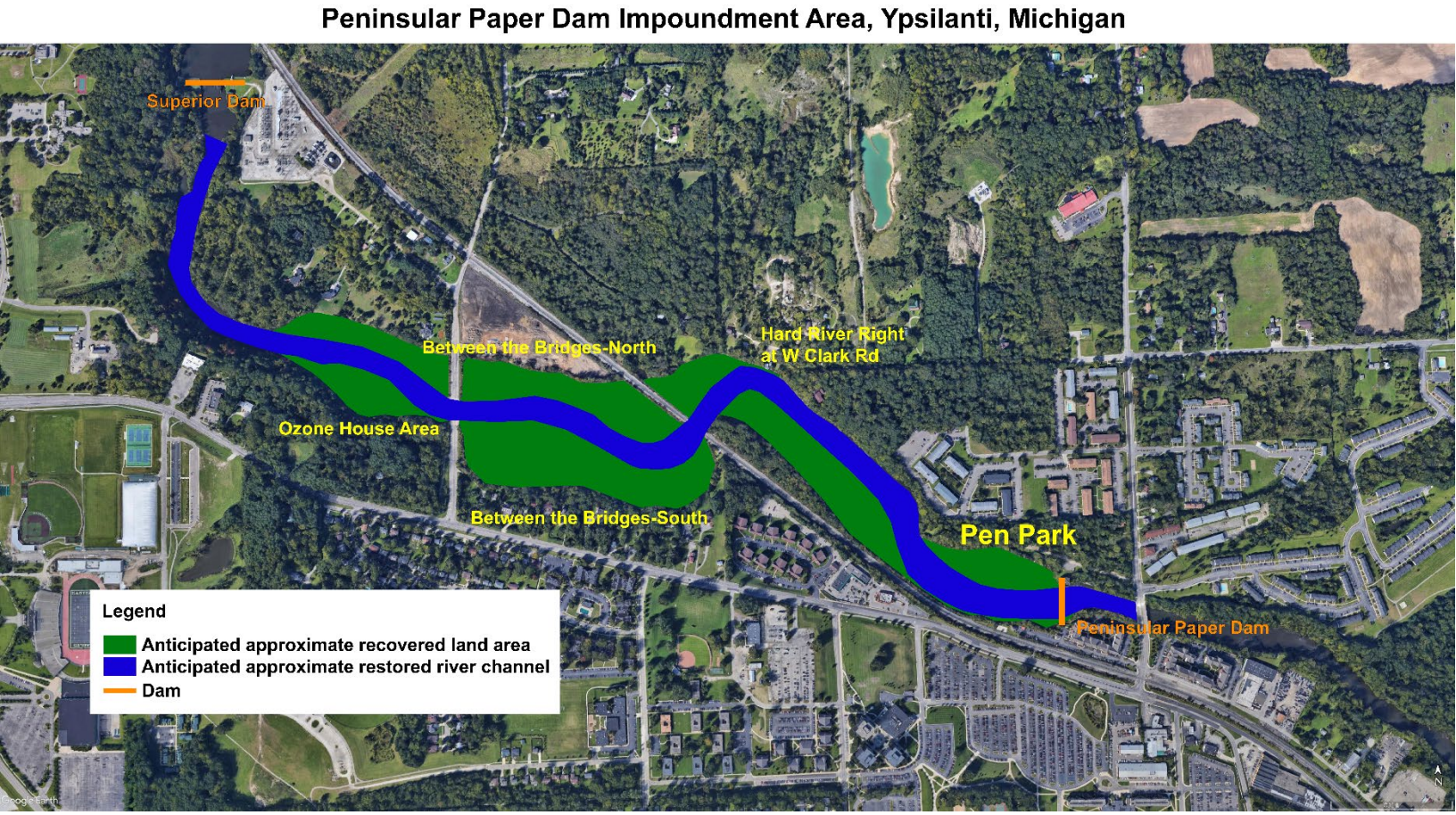

Figure 6. *This map shows the impoundment area. The deep blue river channel indicates the approximate anticipated future river channel following dam removal based on the best information available. The green areas indicate where recovered land area is expected to be above water under average river flow conditions.*

For convenience, we've named general locations within the project area that are distinguished by their anticipated restoration needs, ownership status, or accessibility for restoration work.

For convenience, we've named general locations within the project area that are distinguished by their anticipated restoration needs, ownership status, or accessibility for restoration work.

13.1 Ozone House Area

The Ozone House Area describes an area west of the Superior Road Bridge on both the North and South sides of the river. Waterfront owners on the north side of the Ozone House Area have generously provided access to research teams in this area in the past, and there is a primitive accessway to utility infrastructure close to Superior Road on the south side. This area features wooded banks on the south side and maintained lawns on the north side.

13.2 Between the Bridges

The Between the Bridges areas on the North and South side of the river represent a significant amount of the likely recovered land area in the impoundment. All the recovered land in this section will either be

under private ownership or governed by an easement, as it is now. There is also limited access to the waterfront between the bridges as the bank on the south side is steep and the heights of the bridges are an impediment for getting larger boats on the water in this location. As such, any restoration work in this important area will require permission from and significant collaboration with landowners. Any actions taken in this section will prioritize the ecological health of the river. Landscape management practices that do not benefit the ecological health of the river corridor, or practices that are not recommended by the relevant state and federal agencies, will not be considered in this section. The Restoration Subcommittee and the Huron River Watershed Council are committed to working with private landowners with waterfront between the bridges to maximize restoration of the impoundment and provide a pleasant, restored waterfront.

A drain outfall north of Cornell Road on the south side of the impoundment has been identified as being a location likely needing specific construction attention. This area and the lobe of the impoundment immediately to the east of the drain, also serve as preferred habitat for many insects and amphibians. The Restoration Subcommittee will consider potential impacts in this location specifically and may recommend practices for the removal design at this location.

13.3 Hard River Right at W Clark Rd

The Hard River Right at W Clark Rd features a relatively steep bank that overlooks an “S-curve” in the river as it passes under the Railroad Bridge. This area is considered one of the most sensitive to initial changes in river conditions in the impoundment. While there is great potential to create aesthetically pleasing and valuable habitat in the recovered lobe of the immediately to the west, this location will require additional geotechnical analysis prior to dam removal.

13.4 Peninsular Park (Pen Park)

Pen Park, which straddles the dam, may see significant recovered land area to the west of the current dam location. Since Pen Park is the only public parcel on the impoundment with recreational access, it will serve as the primary area for preparing, testing and launching many restoration efforts in the years to come. It is the only parcel on which restoration activities can take place without permission being granted by private landowner. It is therefore critical for demonstrating best practices throughout the impoundment. Anticipated Restoration Actions for Pen Park are described in detail later in this document.

14. Summary of Timing of Restoration Activities Relative to Dam Removal

Following deconstruction of the dam spillway and dewatering of the impoundment, recovered land will likely revegetate quickly. Previous dam removals across the country and in Michigan have demonstrated that recovered land in the impoundment can “green up” rapidly with small plants within the first growing season after dam removal. Reducing invasive species contamination in the first two years following dam removal will make restoration of the impoundment significantly more effective for native plants and wildlife while ensuring an aesthetically pleasing character of the restored river is maintained.

14.1 Water Quality, Environmental and Ecological Monitoring

Environmental monitoring is ongoing and will expand prior to dam removal to gain a better understanding of conditions in the current impoundment. Monitoring efforts are expected to continue for several years, or indefinitely, after dam removal. Long-term monitoring activities will be similar in scope to other monitoring conducted by EGLE, DNR, and HRWC on the Huron River and its tributaries. Research projects through Eastern Michigan University are likely as are focused projects through the University of Michigan.

14.2 Invasive Species Management

Invasive species management (which may include mowing, manual removal, chemical treatment, and prescribed fire) will be best begun before deconstruction of the dam spillways and dewatering of the impoundment. Some invasive species management techniques require recurring and ongoing application. Once the impoundment area is sufficiently established with native species, invasive species management will become similar in scope and rigor to what's conducted along other stretches of the Huron River.

14.2.1 Native Species Planting

Some native species planting is beneficial before dam removal, though it will be essential during the first two growing seasons following dam removal. Native grass seeding and native flower planting will be among the first activities following the dewatering of the impoundment.

14.2.2 Native Large Flora Planting

The planting of native shrubs and trees will be recommended following dam removal, though in some cases it may be beneficial to wait 1-3 years to plant certain species or alter the restored landscape for larger flora. Some areas of the impoundment will benefit from native tree planting. This activity has long-term ecological benefits and can provide some additional bank stabilization early on.

14.2.3 Bank Stabilization

Some bank stabilization will almost certainly be required along outside bends of the restored river channel or in places where the water level drops significantly in a narrower, steeper channel. Based on the understanding of the gradient of the restored river. Some bank stabilization may be required to protect structures before or immediately after removal and dewatering of the impoundment. Other bank stabilization efforts to prevent unwanted but slower erosion can occur 1-2 years after dam removal.

15. How to Provide Comments to Inform and Improve Restoration Activities

The planning of the restoration of the Pen Dam impoundment will continue for several years and will continue to evolve as new information is learned. It is possible, if not likely, that elements of this plan will change over time. It will certainly adapt to new data and information regarding best management practices. Revisions are expected throughout the entire restoration process even after the dam is removed.

This Restoration Plan will be revised periodically. The most recent version will be accessible on the Huron River Watershed Council's website at http://hrwc.org/pendam.

Area residents that would like to provide comments to help inform and improve the restoration plan are encouraged to do so by emailing comments to dbrown@hrwc.org. Please include "Pen Dam Restoration Plan comments" in the subject line of your email.

Volunteer opportunities to support the restoration of the Huron River through Ypsilanti will continue to become available throughout the dam removal planning and impoundment restoration process. Volunteer inquiries are welcome. Submit inquiries to HRWC at dbrown@hrwc.org. Please include "Ypsilanti River Restoration Volunteer Opportunities" in the subject line of your email.

[1] Huron River Fisheries Special Report. Michigan Department of Natural Resources. 1995. https://www2.dnr.state.mi.us/Publications/pdfs/ifr/ifrlibra/Special/Reports/sr16/sr16_ttf.pdf

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[12] *A Guide to the Control and Management of Invasive Phragmites*. Michigan Department of Environment, Great Lakes, and Energy. 2014. https://www.michigan.gov/documents/invasives/egle-ais-guide-phragmites_708909_7.pdf

[13] Inland Lakes Aquatic Nuisance Control Program. Michigan Department of Environment, Great Lakes, and Energy Water Resources Division. www.michigan.gov/egleinlandlakes, egle-wrd-anc@michigan.gov. 517-284-5593.

[14] General Permit for Aquatic Nuisance Control Activities for Certain Non-native Invasive Emergent Plants. https://www.michigan.gov/documents/deq/wrd-ANC-GP-ANC9410000_477558_7.pdf

[15] Pesticide Application Businesses Licensed by the State of Michigan. (For inland areas, search under Category 5, Aquatics; for Great Lakes shoreline, search by Category 5 for wet areas and Category 6, Right-of-Way, for dry areas). https://www.michigan.gov/mdard/licensing/findafirm/pesticide-application-businesses-currently-licensed-to-do-business-in-michigan

[16] Inland Lakes Aquatic Nuisance Control Program. Michigan Department of Environment, Great Lakes, and Energy Water Resources Division. www.michigan.gov/egleinlandlakes, egle-wrd-anc@michigan.gov. 517-284-5593.

[17] General Permit for Aquatic Nuisance Control Activities for Certain Non-native Invasive Emergent Plants. https://www.michigan.gov/documents/deq/wrd-ANC-GP-ANC9410000_477558_7.pdf

[18] Pesticide Application Businesses Licensed by the State of Michigan. (For inland areas, search under Category 5, Aquatics; for Great Lakes shoreline, search by Category 5 for wet areas and Category 6, Right-of-Way, for dry areas). https://www.michigan.gov/mdard/licensing/findafirm/pesticide-application-businesses-currently-licensed-to-do-business-in-michigan

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