FINAL Plan

Sunset Park/Bradley Lake Coastal Resource Management Plan

Bradley Lake, Door County, Wisconsin

Project I.D.: 17S032

City of Sturgeon Bay
Sturgeon Bay, Wisconsin

July 2019

Green Bay Location

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July 2, 2019

Mr. Mike Barker
Director of Municipal Services
City of Sturgeon Bay
835 N. 14th Avenue
Sturgeon Bay, WI 54235

Dear Mr. Barker:

RE: *Sunset Park/Bradley Lake Coastal Resource Management Plan*
Lake Dredging & Restoration Project for Bradley Lake
Sturgeon Bay, Wisconsin

On behalf of the city of Sturgeon Bay, Foth Infrastructure & Environment, LLC (Foth) has prepared this *Sunset Park/Bradley Lake Coastal Resource Management Plan* (*CRM Plan*) for the Bradley Lake Dredging & Restoration Project. The intent of this *CRM Plan* is to provide a framework for current and future stakeholders to protect, restore, and maintain the health of Bradley Lake, as well as to incorporate stakeholder recreational desires for Sunset Park into a plan that will balance recreation with coastal resource preservation.

Should you have any questions, please contact Ms. Tara Van Hoof at (920) 497-2500 or via email at tara.vanhoof@foth.com.

Sincerely,

Foth Infrastructure & Environment, LLC

Tara Van Hoof, P.E.
Project Manager

Steve Garbaciak, P.E.
Senior Technology Manager

cc: Josh Van Lieshout, City of Sturgeon Bay
Brian Hinrichs, Foth
Gwen Clendenning, Foth

Sunset Park/Bradley Lake Coastal Resource Management Plan

Distribution

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Prepared for

City of Sturgeon Bay

Sturgeon Bay, Wisconsin

Prepared by

Foth Infrastructure & Environment, LLC

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Sunset Park/Bradley Lake Coastal Resource Management Plan

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List of Abbreviations, Acronyms, and Symbols

ADA	Americans with Disabilities Act
ADLP	Aids for the Acquisition and Development of Local Parks
AIS	Aquatic Invasive Species
BMP	Best Management Practices
City	City of Sturgeon Bay
CRM Plan	*Sunset Park/Bradley Lake Coastal Resource Management Plan*
Foth	Foth Infrastructure & Environment, LLC
Green Bay	bay of Green Bay
GTK	GTK Consulting LLC
lake	Bradley Lake
LAWCON	Land and Water Conservation
Midwest	Midwest Archaeological Consultants
Miller	Miller Engineers & Scientists
NFWF	National Fish and Wildlife Foundation
NOAA	National Oceanic and Atmospheric Administration
Sturgeon Bay	bay of Sturgeon Bay
USACE	US Army Corps of Engineers
WDNR	Wisconsin Department of Natural Resources
YOY	Young of year

Acknowledgements

Funded by the Wisconsin Coastal Management Program and the National Oceanic and Atmospheric Administration, Office for Coastal Management under the Coastal Zone Management Act, Grant # NA17NOS4190035, and the Wisconsin Department of Natural Resources Surface Water Grant# LPL-1679-18.

1 Introduction

Bradley Lake (lake) is a 20-acre lake within Sunset Park, a park which has approximately 3,000 feet of Sturgeon Bay shoreline. The 60-acre park, including the lake, is one of 15 community parks serving approximately 9,000 residents of the city of Sturgeon Bay (City), Wisconsin.

This *Sunset Park/Bradley Lake Coastal Resource Management Plan* (*CRM Plan*) details a lake management plan to improve the health and aesthetics of Bradley Lake and surrounding Sunset Park by directing improvements of water quality, aquatic habitat, and biodiversity. To re-establish Bradley Lake as a quality ecological landscape and socioeconomic value to the community, a restoration initiative encompassing watershed management and lake management must coincide. Within this *CRM Plan*, Foth Infrastructure & Environment, LLC (Foth) will address restoration activities in a holistic approach to achieve management goals for the lake and adjacent park. Concurrent to restoration design and planning for the lake, a master planning task for Sunset Park was completed on January 16, 2019 and was submitted to the City the following day. (Refer to Appendix A for a copy of the Sunset Park Master Plan.) The Sunset Park Master Plan was finalized based on public review and comment from attendees of two public meeting, held on October 25, 2017 and March 28, 2018. The implementation of the congruent lake and park plans will lead to improvements in water quality, aquatic habitat, and biodiversity such that Bradley Lake will evolve into a beneficial resource not only for outdoor enthusiasts but for all the community to appreciate.

1.1 Site History

Historically, Bradley Lake, which is also referred to as "Little Lake," has undergone many changes with most being the result of industrial activities encroaching on the lands surrounding the lake. From 1853 to 1909, Bradley Lake was used for lumber and wheat mill operations, as described by Dr. John Herlache, in *History of Little Lake, Sturgeon Bay, Wisconsin* (Herlache). Although Bradley Lake was originally connected to the bay of Sturgeon Bay (hereinafter referred to as "Sturgeon Bay") through hydrologic passages on the north and south ends, those passages, over time, were closed and reopened for industrial operations and water quality issues. For the duration of the industrial milling period, portions of the lake were filled in with dredged material and other industrial material including wood cutting waste. The last major change to the historical layout of Bradley Lake was in the 1970s when the access channel at the south end of the lake was closed with dredged material from the completion of the large graving dock adjacent to Sunset Park.

2 Previous Work

Investigations conducted in 2007 and 2008, by Miller Engineers & Scientists (Miller) and GTK Consulting LLC (GTK), found Bradley Lake to be a highly eutrophic system heavily influenced by storm water contributions causing shallow water depth, high nutrient loading, low dissolved oxygen, and invasive vegetation impairment, as detailed in the GTK report, *Water Quality Monitoring and Aquatic Plant Inventory Bradley (Little) Lake, Sturgeon Bay, Wisconsin,* submitted in October 2008 (GTK, 2008). Water quality data from Bradley Lake (i.e., unseasonal patterns in parameters such as chlorophyll-a concentrations) exhibits a degraded system suggesting the lake's current condition to be a function of storm water inputs (GTK 2008). The 2008 GTK report provides a detailed assessment of historical data, watershed and land use, water quality, sediment characteristics, aquatic plant inventory, shoreline vegetation, recreational use and watercraft survey, and fish survey. In 2015, Foth performed bathymetric soundings, characterized nutrient-rich sediment thickness, and characterized sediment quality. Based on the previous results, additional sediment and soil characterization activities were performed by Foth in December 2017 and January 2018. The locations of all samples are shown on Drawing 1.

2.1 Miller Engineers

The first sediment sampling program for Bradley Lake was completed by Miller Engineers in 2007. The initial sediment samples were collected, at the request of the City, as the first steps to begin the Chapter 30 permitting process. The samples were analyzed for metals and general chemistry parameters (e.g., pH, conductivity), nutrients, and oil and grease.

2.2 GTK Consulting Lake Study and Management Plan

The second sampling program was completed by GTK in 2009. Six sediment samples were collected through the ice and submitted to a lab for analytical chemistry analysis. Based on the results of the studies performed and public input of renovation goals, GTK developed a lake management plan in 2009 to scope restoration activities to improve water quality, habitat, and overall ecosystem function. The lake management plan, provided by GTK, consisted of a holistic approach containing improvements to the lake, shoreline, storm water structures, and recreational opportunities. The details of the restoration and lake management plan, submitted by GTK, can be found in the 2009 document, *Lake and Storm Water Management Plan for Bradley (Little) Lake* (GTK, 2009).

2.3 Foth Sediment Investigation

2.3.1 Bathymetric Study

Foth completed a bathymetric survey of Bradley Lake, in 2015, in support of the dredging design and evaluation. Foth performed bathymetric survey by poling methods to characterize depth to top of sediment and sediment thickness as described in a February 5, 2016 letter addressed to Ms. Cheryl Bougie, of Wisconsin Department of Natural Resources (WDNR), regarding "Sediment Characterization Results" (February 2016 letter) (Foth, 2016). As seen on Drawing 1, the bathymetric survey illustrates the shallow nature of the lake, which has an average depth of approximately 5 feet.

2.3.2 Sediment Sampling

Several sediment sampling programs have been undertaken to better understand the physical and chemical properties of the sediment. These data sets provide the background for understanding the sediment's role in water quality, as well as providing the necessary information for completing restoration design.

Based on the results of the sediment sampling completed by GTK, Foth completed two additional sediment sampling locations for chemistry and physical analysis in 2015, as described in the February 2016 letter. Additionally, in winter 2017-2018, samples were collected for geotechnical and environmental analysis along the alignment of the access channel, as described in the February 28, 2018 letter addressed to Ms. Bougie, of WDNR, regarding "Soil and Sediment Characterization Results – Access Channel Area" (Foth, 2018). Soil samples were collected on December 5, 2017 in the upland area of Sunset Park, between the lake and Sturgeon Bay, at locations selected based on the proposed Sturgeon Bay access channel location, and sediment samples were collected on January 8, 2018 in the waters of Sturgeon Bay, at locations selected based on the proposed access channel.

2.4 Midwest Archaeological Consultants Phase I Archaeological Survey

Midwest Archaeological Consultants (Midwest) conducted a Phase I archaeological survey to determine the direct impact of the proposed project to any historic properties that may be in or on the ground.

A literature search of the Wisconsin Historical Society database for previously recorded historic properties revealed that there are several previously recorded archaeological sites near the project area.

Archaeological fieldwork in the form of pedestrian survey and shovel testing, performed over five days between April 22 to May 10, 2019, did not locate any historic properties. Multiple lines of evidence via shovel testing stratigraphy, local informants, current facilities and land use indicate that Sunset Park exists largely in a disturbed context and contains many episodes of fill and landscaping.

The archeological report was submitted to the USACE in May, 2019. The USACE archeologist forward a "No Effect" determination to the WI State Historic Preservation Office for concurrence; their review is in progress.

3 Current/Future Work

To satisfy requirements of the associated permits and grants, the following tasks will be completed prior to beginning restoration activities:

- Endangered resources review (required per the Endangered Species Act Section 7).

- Bathymetric survey of the near shore Sturgeon Bay area. The survey may be completed using boat-mounted acoustic survey equipment. The data from this survey would supplement the previously collected Bradley Lake survey data and topographic survey and aerial photography of the shoreline area, as well as the data collected for the 2008 GTK report (as described above in Section 2) for evaluation of habitat types.

4 Lake Management Activities and Improvements

Improving Bradley Lake will require the undertaking of several different restoration activities. Each activity will provide a benefit to improve water quality, habitat, and biodiversity of Bradley Lake, thus providing an overall valuable resource to the community.

4.1 Goals

Bradley Lake is designed to provide spawning, nursery, foraging, and over-wintering habitat for game and non-game fish species. Game fish include popular species targeted by anglers such as northern pike and smallmouth bass (both are focus species of the WDNR's *Lake Michigan Integrated Fisheries Management Plan 2017-2026* [WDNR, 2015]). Management activities and improvements are designed to address the specific target species and their ecological uses such that these are the overarching restoration goals for the lake management activities and improvements.

Northern pike (Esox lucius) are a native fish that show a positive response to coastal habitat restoration. They also have relatively slow swim speeds (sustained versus bursts), and because of this, the prevailing view is that if pike habitat is restored, many other species benefit by using the same habitat as well. During a successful pike spawning season, pre-spawn adult pike will stage in bays, river mouth areas, and deeper pools in lower reaches of larger rivers during the "late ice" season in Wisconsin. In early spring, fish swim up rivers and creeks for miles to spawn and lay eggs in water less than 12 inches deep. Spring "high water" is brief, and in the Green Bay basin, which includes Sturgeon Bay, this is typically late-March through early April. The shallow spawning areas serve as a nursery, and by early summer (typically mid-June), these ephemeral areas are nearly dry, by which time juvenile pike are on their way out into Sturgeon Bay, where they start their lives as adult fish. Young of year (YOY) pike are specifically dependent on emergent and dense submerged aquatic vegetation located close to shore for protection from predation and cannibalism. Vegetation is also critical to YOY fish as forage habitat in early summer. Later in the season, juvenile pike tend to use heavy vegetation, and adult fish will often be found just on the edge of vegetation for protection and predation.

There are many challenges to functional restoration ecology of pike habitat, most of which relate to hydrology and quality of habitat. Altered hydrology and reduced habitat quality, due to siltation and invasive species, create an inability for adult fish to find their way into shallow spawning areas and juvenile fish to find their way out to open water. Bradley Lake restoration would ameliorate issues of hydrologic impediments caused by culverts and embankments found in seasonal ditches by providing optimal spawning and nursery habitat with direct connection to Sturgeon Bay.

Other fish species will also benefit from Bradley Lake wetlands restoration. Even more popular and accessible to family anglers, panfish (bluegill, pumpkinseed, and crappies) will directly benefit from this diversity of habitat. Panfish and smallmouth bass will use the littoral and transitional zones for spawning and nursery habitat. Sunfish will create nests in more shallow, sandy, and gravelly substrates. Smallmouth bass guard nests in deeper water around structures such as rock piles and woody debris. In addition, Bradley Lake wetlands and littoral zone will

function as habitat for nongame species such as cyprinids (minnows) that serve as forage for other fish. During the winter, sport fish will typically migrate to the deepest water in the lake. The size and availability of deep, over-wintering habitat will vary with the water levels of Sturgeon Bay.

4.2 Dredging

Throughout its history, Bradley Lake has been filled with nutrient rich sediment from milling operations, dredged material from adjacent projects, and from storm water runoff. Made up of nitrogen and phosphorous rich sediment, the shallow lake bed has caused many ecological issues impairing Bradley Lake's biodiversity. The shallow depth of the lake coupled with high nutrient containing sediment has driven poor water quality, excessive vegetation growth, and algae blooms. Due to the current eutrophic state of the lake, a productive quality fishery for the community is not achievable.

Foth has developed a conceptual dredge design, submitted to Ms. Carrie Webb, of WDNR, on January 20, 2017 as *NR-347 Pre-Application Package* (Foth, 2017), to remove nutrient rich sediment from Bradley Lake to improve water quality, habitat, and recreational activities. Preliminary design drawings are provided as Attachment B of the dredge design. Also, included in the dredge design, Bradley Lake will be hydraulically reconnected to Sturgeon Bay to provide access for dredge equipment. The channel is designed to remain open after dredging is completed to allow water exchange, thus improving water quality and fish ingress and egress. In a phone conversation with Dr. Jim Diana, of the University of Michigan, on November 17, 2017 (Diana, 2017), dredging and hydraulic connection was believed to provide the best opportunity to restore overall water quality and biodiversity.

In addition to removing nutrient rich sediments, dredging is anticipated to improve aquatic habitat by providing both pelagic and littoral environments. By deepening the lake, vegetation growth will be reduced to the littoral zone and a deep water refuge will be provided. Additional lake bed features will include mid-depth lake flats to provide a transition zone between the pelagic and littoral zones.

To assess the effectiveness of sediment removal, water quality monitoring/sampling will be completed before and after dredging, as well as during dredging to assess the effectiveness of best management practices (BMPs) in minimizing potential impacts of in-water activities. A sampling and analysis plan will be developed prior to construction activities, which will provide detailed plans for sampling activities, including types on sampling, sampling and monitoring frequencies, analytical and field parameters, and associated target levels.

4.3 Invasive Species Management

Invasive species are present throughout the Great Lakes region and can have major impacts on both water quality, native species, and biodiversity. In many instances, introduced species, freed of the constraints of competition and predation, will expand rapidly and aggressively until their range covers the extent of environmental tolerance (Noatch and Suski, 2012). Ecological interactions between native and invasive species may be direct (e.g., predation, herbivory,

parasitism, competition, mutualism) or indirect (e.g., habitat alteration, apparent predation, cascading trophic interactions) and result in changes in the population biology of the native species (Sakai et al., 2001). Predictability of establishment and utilization of invasive species within Bradley Lake is unknown. Restoration of Bradley Lake will include plans to monitor and mitigate the impact of invasive species.

4.3.1 Invasive Aquatic Vegetation Management

Invasive aquatic vegetation was documented in Bradley Lake during the GTK study in 2008 (GTK, 2008). Invasive vegetation found within the lake included submergent (Eurasian watermilfoil and Curly-leaf pondweed) and emergent (Phragmites) vegetation. The planned dredging activities will remove a majority of the submergent invasive vegetation from the lake; however, the disturbance of the dredging activities may cause leaflets of Eurasian watermilfoil to become displaced posing a threat of establishment elsewhere within Bradley Lake. Herbicide treatment of Bradley Lake may be beneficial before commencing dredging activities to remove invasive vegetation. Permits for treatment will be obtained where necessary.

With its excessive vegetation growth and shallow water, Bradley Lake, in its current state, exhibits an environment as a large littoral zone. By reducing the overall surface acreage of the littoral zone by dredging, a decreased submergent plant growth area will occur. Unfortunately, because natural establishment of native aquatic plant species is a relatively slow process, invasive species often arrive first, establish, and spread to excess (Smart et al., 1998). As part of the aquatic vegetation plan, establishment of native submergent aquatic plants will be an important deterrent to the spread of invasive plants (Smart et al., 1998). Located in an urbanized setting, Bradley Lake may be limited to native seed bank sources and dispersal which, in turn, can limit recovery of plant species richness (Zedler, 2000). To restore biodiversity and increase species richness of the submergent plant community within Bradley Lake, an establishment plan is needed to initiate native aquatic plant growth. The establishment plan must focus on plant species to be used, planting methods (seed dispersal and/or planting enclosures), and protection (e.g., turtles, crayfish, fish and muskrats). As recommended by Dr. Patrick Forsythe (Forsythe, 2017), broad leaf vegetation, submergent or emergent , would increase northern pike (Esox lucius) egg survival as he has found eggs stay on leaves more efficiently than a narrow leaf plant. Therefore, habitat restoration for Bradley Lake will focus on broad leaf vegetation varieties. Possibilities for emergent include common bur-reed (Sparganium eurycarpum), three-way sedge (Dulichium arundinaceum), or bulrush (Scirpus acutus).

Management of invasive submerged aquatic vegetation must continue after restoration has been completed by incorporating an abatement plan for Canadian geese as they transfer aquatic plants, along with a plan to spot treat invasive species with herbicides should they become an issue. A survey of the vegetation types will need to be completed on an annual basis for five years within the project boundary for any growth of invasive species. If invasive species are identified, a remediation plan to eradicate the invasive species will be submitted to the WDNR for approval. If chemical treatment is proposed, appropriate permits will be obtained as necessary. Currently, it is anticipated that a significantly reduced turf zone around Bradley Lake will also mitigate lake incursion by Canadian geese.

4.3.2 Invasive Aquatic Fish and Invertebrate Management

It is unknown if there are any current invasive fish and/or invertebrate species within Bradley Lake. No fish, mussel, or invertebrate surveys were performed by GTK in 2008 (GTK, 2008). The report from GTK did mention that fish caught during the recent community fishing derbies consisted of black bullheads (Ameriurus melas). Dr. John Herlache (Herlache), stated first place prizes were given to the largest fish which included numerous gamefish species along with invasive common carp (Cyprinus carpio) in 1985.

The hydraulic connection of Bradley Lake to Sturgeon Bay will provide a pathway for invasive fish and invertebrates to access the lake. Even if the access channel is closed after restoration activities have been completed, invasive species movement into Bradley Lake is inevitable via pathways such as human activity (boats/fishing equipment), wildlife, and barrier breach during high lake levels, and storm events. A management plan will include physical and non-physical exclusion barriers to prevent or slow the spread of invasive fish and invertebrate species.

4.3.2.1 Physical and Non-Physical Exclusion Barriers

To discourage the movement of invasive species into Bradley Lake, Foth researched mechanisms to inhibit invasive species access through the proposed access channel. Mechanisms researched included both physical and non-physical barriers.

Physical barriers include dams, embankments, roads and gates. Currently, Bradley Lake is disconnected from Sturgeon Bay by an embankment on the southwestern corner restricting the ingress and egress of fishes and water flow. In a study conducted by Mr. Joseph R.P. French III (French et al., 1999), it was found that fish passage with gates composed of vertical bars with slit widths of 2.0 inches would exclude common carp larger than 13.4 inches from ingress into a restored wetland while allowing northern pike smaller than 27.6 inches to ingress and egress. As slit width increased, so did the percentage of common carp biomass. If common carp less than 13.4 inches ingress into Bradley Lake and take residence, those fish may become too large to egress back to Sturgeon Bay. Although the access channel would provide a “choke point” for the installation of a physical fish exclusion barrier for common carp, additional concerns are important for such a barrier. Physical gate exclusion barriers must consider fish behavior and size. The physical barrier will restrict larger more fecund female northern pike and smallmouth bass (Micropterus dolomieu) from ingress and egress. A physical barrier will also restrict boat access, disrupt water flow (fish migration triggering mechanism), and possibly cause debris buildup and impingement if the gate is utilized continuously. Physical gate barriers could be engineered to deter common carp during spawning runs and not interfere during other ecologically important time periods if the gate is capable to be lifted vertically or pivot on an axis to allow ingress and egress. By preventing common carp spawning in Bradley Lake, a reduction in overall recruitment contribution can be achieved.

Non-physical barriers include electricity, strobe lights, bubble curtains and sound. In a review by Noatch and Suski (2012), the primary drawback to any non-solid fish barrier is their <100% long-term effectiveness. Turbidity, high water, conductivity and power outages could hamper overall effectiveness. Most non-physical barriers can be custom designed and effectively positioned within water ways without posing a restriction to navigation or impounding water

flow (Noatch and Suski, 2012). By positioning the barrier within "choke points," efficiency will increase and minimize the expense of equipment and infrastructure. In the case of restricting common carp movement into Bradley Lake, non-physical barriers can be temporarily used to target predictable spawning migration movements.

To determine validity of a physical or non-physical barrier, specifically for common carp, more understanding is needed about current common carp populations within the central portion of the bay of Green Bay (hereinafter referred to as "Green Bay") and Sturgeon Bay. In a report by R. I Paulson (1981), mean calculated total lengths of female common carp were 14.4 inches at age 3 and 17 inches at age 4 while male mean calculated total lengths were 12.7 inches at age 3 and 15.8 inches at age 4. No length at sexual maturity data could be found for Green Bay. In a study by Coulter et al. (2008), the 50% age at maturity calculation for common carp was 3.4 years with the smallest mature female being 13.7 inches in a shallow Nebraska marsh. Overall, common carp population abundance within Sturgeon Bay is expected to be low due to its position within the mesotrophic location of Green Bay. It could also be generalized that energy assimilation into gonadal growth for female common carp cause a reduced overall total length growth comparatively to male common carp during the first four years of life as seen by Paulson (1981). This would imply female common carp possibly mature at 3.5 to 4 years of life at a total length at approximately 15.7 inches in Green Bay.

For the betterment of restoration goals (northern pike spawning, water quality, and biodiversity), management of invasive species (common carp and Eurasian watermilfoil) is necessary. Common carp negatively affect vegetation abundance by reducing light availability, increase siltation rates, and uproot vegetation during feeding activities (Parkos et al., 2003). A barrier system will need to be utilized continuously for the first 3 years or until necessary to allow native vegetation establishment and to reduce the chance of common carp utilizing the newly restored lake as a spawning area. For the revitalization of Bradley Lake, a physical gate structure is recommended to allow other fishes to ingress and egress but most importantly to inhibit common carp from becoming an issue. As seen in other studies, the implementation of carp exclusion barriers, such as the one seen at Tommy Thompson Park, in Toronto, Canada, have become a standard practice to deter the effects of common carp on newly restored systems. In a study by R. M. Van Dam (2016), an evaluation of northern pike recruitment contributions of restored wetlands, found the average length of male and female northern pike to be 17.8 inches and 27.3 inches, respectively. In conjunction with the John French et al. (1999) study, along with total length data of common carp, it is recommended a physical barrier with vertical bars composed of maximum slit widths of 2.125 inches be implemented. Vertical bar grates with a 2.125 inches slit width would potentially allow northern pike up to 28.3 inches in total length to pass through the barrier while continuing to restrict common carp, specifically sexual maturing female common carp at 15.7 inches (French et al., 1999). If juvenile common carp, ingress into Bradley Lake through the physical barrier and take residence, the overall biomass would be assumed minimal and have little to no effect on the ecosystem within the lake. In a study by Silbernagel (2011), it was found that sunfish are voracious predators of the early life stages of common carp and is likely responsible for reducing recruitment of common carp through predation on its eggs and larvae.

Following the establishment of native vegetation, the function of the barrier from permanent to temporary should be evaluated or if the slit width of the barrier is functional in regards to overall purpose to deter common carp while establishing a pathway to spawning habitat for northern pike and other native fishes of Green Bay. Dr. Forsythe stated he has found fish spawning within the bay of Green Bay to have a pronounced chronological order. That is, northern pike spawn at ice out and common carp spawn the first through second week of May. The implementation of a physical gate barrier temporarily at the time of the carp spawning window would inhibit the utilization of Bradley Lake as a common carp spawning area, thus reducing a potential source of common carp recruits (Penne and Pierce, 2008). The physical barrier, then could be removed for other fish species to more easily ingress/egress Bradley Lake pre- and post-common carp spawn.

Refer to Section 6 for discussion of effects of the physical barrier on watercraft access to the lake.

4.4 Fishery Improvements and Angler Opportunities

As viewed by the community, the re-establishment of a quality recreational fishery within Bradley Lake is a critical aspect. Once a highly utilized spawning area for northern pike and smallmouth bass, the quality of the fishery of Bradley Lake has become nonexistent with recent reports of only bullhead catches due to the eutrophic state (Herlache). In partnership with the National Fish and Wildlife Foundation (NFWF) and Sustain Our Great Lakes funding through the Great Lakes Restoration Initiative, the hydraulic connection between Bradley Lake and Sturgeon Bay is seen as a project of much importance that will restore a palustrine coastal wetland and in turn increase spawning, nursery, and forage habitat to support fish such as northern pike.

4.4.1 Fishery Improvements

Widespread human development has led to impairment of freshwater coastal wetlands and embayments, which provide critical and unique habitat for many freshwater fish species (Rous et al., 2017). In a study by Bosley (1978), almost 40 years ago, areas occupied by coastal wetlands near the southern end of Green Bay and along the western shore had been already reduced by 60-75% due to human impacts such as draining, shoreline development, and sediment loading. In a paper by Brazner (1997), a study was conducted to establish the importance of wetland utilization by fishes of Green Bay. In the study, fish were collected from the lower, middle and upper portions of Green Bay from four site types including: undeveloped wetlands, developed wetlands, undeveloped beaches, and developed beaches. Brazner (1997) reported that there were more fish, more fish species, and more species with strong site affinities at wetland and undeveloped sites than beach and developed sites suggesting that wetland and undeveloped sites have a greater overall value to fishes. Results from the study highlighted the importance of maintaining wetland sites from a fishery management, conservation, and biodiversity perspective, therefore, concluding the significance of maintaining and restoring wetland habitats and embayments such as Bradley Lake (Brazner, 1997).

By hydraulically re-establishing the connection of Bradley Lake to Sturgeon Bay, a quality fishery can be developed. The connection will allow fishes to access Bradley Lake for migrating, spawning, habitat usage and foraging. As shown in the NR-347 Pre-Application Package (Foth, 2017), the restored Bradley Lake will contain a pelagic, transition, and littoral habitat. Each habitat will serve a purpose to promote fish utilization. The pelagic habitat will provide a winter and summer staging area. The transition habitat will provide structural elements such as flats, points, and turns to promote deeper spawning refuge for species along with ambush areas so predator fish can forage on fish leaving the littoral habitat. The littoral habitat, consisting of native submergent vegetation, will be the primary productive habitat of Bradley Lake providing spawning and nursery habitats for species such as northern pike, yellow perch (Perca flavescens) and centrarchids. A study by Rous et al. (2017), found that habitat restoration of coastal wetlands in Toronto Harbor showed northern pike and yellow perch having higher site fidelity in restored habitat areas compared to non-restored areas while non-native common carp had lower site fidelity for restored compared to non-restored habitats. From Dr. Forsythe's studies of Green Bay (Forsythe, 2017), northern pike utilize homing mechanisms and will return to natal spawning areas year after year as he has collected many tagged recaptures. Dr. Forsythe believes hydraulic connection of Bradley Lake to Sturgeon Bay would be a benefit to northern pike recruitment as the lake would provide sufficient spawning habitat.

The restoration of Bradley Lake will not only improve the overall local fishery of yellow perch, northern pike and various centrarchids but other non-game and game species as well. Research in Green Bay, by Dr. Jim Diana (Diana, 2017), has found that muskellunge (Esox masquinongy), a priority species in the Lake Michigan Integrated Fisheries Management Plan, to have limited natural recruitment due to the decline in coastal wetlands. According to a phone conversation with Mr. Scott Hansen, of the Wisconsin Department of Natural Resources, on January 11, 2018, until recently, documented natural recruitment has been seen in muskellunge populations in Sturgeon Bay (Hansen, 2018), furthermore emphasizing the need in reconnection of Bradley Lake. Native non-game species, such as bowfin (Amia calva), have also benefited from restoration activities as seen in research conducted by Dr. Forsythe.

4.4.2 Angler Opportunities

A productive fishery can be measured by angler acceptance, days and quality of fishing provided, and economic benefit to anglers and local community (Kohler and Hubert, 1999). Although the usage of Bradley Lake by some fishes may be temporary, such as spawning only, habitat availability will be present to promote resident populations of gamefish over time. After the completion of restoration activities, an initial stocking of brood gamefish may be productive to initiate a fishable population with specific angler harvest limits.

Fish populations and diversity will increase as fish begin to utilize Bradley Lake for spawning, feeding, and other life functions. Currently, Bradley Lake has little to no angler acceptance as the current fishery only consist of bullhead species. Historically, Bradley Lake has provided a diversified fishery enjoyed by many and through restoration activates and the improvements of water quality, aquatic habitat, and biodiversity. Bradley Lake will once again promote a quality angler accepted fishery for all to enjoy.

5 Shoreline Restoration and Management

Restoring the shoreline along Bradley Lake will reduce the amount of nuisance waterfowl-friendly turf directly adjacent to the lake and stabilize the banks to prevent sloughing of soil.

5.1 Lake Shoreline Restoration

Long-term shoreline restoration should focus on using native emergent vegetation within the wetted perimeter and native vegetation on the shoreline. Emergent vegetation will provide areas to evade predators and spawning habitats for fishes coupled with shade provided by the shoreline vegetation. Native vegetation and other soft armoring techniques will be implemented to create a buffer zone around the lake. This buffer zone will increase infiltration of water, as well as provide a root system to stabilize the soils along the shoreline. Native vegetation will also be used to prevent geese and other nuisance waterfowl from wanting to enter the lake. Once these plants are established, they will require little to no ongoing maintenance.

Currently, a planting and seeding plan is in development for submittal and implementation during other restoration activities at the site. This plan will specify means and methods for removing invasive plant communities (Phragmites), determine appropriate native vegetation types and reputable suppliers, and methods for protecting and maintaining the plantings until they are mature enough to survive without intervention.

5.2 Future Access Channel and Bay Side Shoreline Improvements

The creation of the access channel, as described in the conceptual dredge plan, will introduce wave and hydrodynamic forces from Sturgeon Bay to Bradley Lake. These forces will require special restoration to the access channel shorelines, as well as the bayside shoreline. These restoration activities may include shoreline armoring through rip rap or other similar materials, as well as placement of sand and restoration of beaches along the bayside shore. Design of these features will be included in the Sunset Park Master Plan and will work to implement vegetation and other soft armoring concepts where possible.

6 Storm Water Management

As described in previous sections, storm water has historically provided a significant source of contamination and sediment to the lake. Storm water historically entered the lake through overland runoff and direct discharge of storm water culverts. To protect the lake against future storm water inputs, a multi-layer protection plan has been developed and implemented, to a large degree; however, opportunities still exist to continue storm water improvements. The basis of this *CRM Plan* was presented by GTK in 2009, and further refined and implemented by Foth and the City.

6.1 Buffer Zone

A continuous buffer zone of native vegetation will be implemented around the lake, except for the location of the future boat launch. As described in Section 4.1, the buffer zone will act to increase storm water infiltration, reduce sediment and contaminant load to the lake, and deter geese and other nuisance waterfowl from entering the lake. Vegetative buffers will be utilized near impervious surfaces, i.e., roads and parking lots, to further reduce the impact of overland runoff to the lake. This vegetative buffer zone will be implemented according to the planting and seeding plan. Upon implementation, at no time should the vegetation be removed or mowed up to the water's edge.

6.2 Storm Water Retention and Treatment Wetland Forebay

A storm water retention forebay and treatment wetland were designed by Foth and implemented by the City in 2015 and 2016. Most storm water discharges to Bradley Lake were capped and re-routed to the wetland forebay, which acts to retain sediment and contaminants contained within the storm water. This forebay was built at the southeastern corner of the lake. Storm water then passes to a treatment wetland where the use of natural treatment and bioremediation removes and breaks down contaminants and nutrients in the storm water. The treated storm water then passes into Bradley Lake. Currently, Bradley Lake is hydrologically connected to Sturgeon Bay via groundwater; however, upon completion of restoration activities, this water will also pass through the future access channel into Sturgeon Bay and Lake Michigan. Native plant species were chosen to create the wetland's vegetation community, which also provides natural habitat for many animal species.

As much of the storm water has largely been rerouted to the storm water retention and treatment wetland forebay at the south end of Bradley Lake, a similar opportunity exists for storm water entering Bradley Lake on the northeast corner. Space is somewhat more limited in the northeast part of Sunset Park. There is an opportunity to route an influent storm water drain into a small constructed treatment wetland, as part of a long-term operations and maintenance plan to reduce storm water inputs into Bradley Lake.

The water quality monitoring/sampling efforts described in Section 3.2 to assess effectiveness of sediment removal will also serve to measure effectiveness of the current storm water treatment. If the current system is not performing appropriately, storm water treatment in the northeast part of Sunset Park should be considered.

7 Recreation

Recreational access to Bradley Lake is one of the central goals for restoring the lake to a more user friendly resource. Historically, Bradley Lake and Sunset Park have provided the City with valuable space for many outdoor recreational activities. Future recreational opportunities will be created for fishing access and watercraft launching. The restoration of Bradley Lake will also provide the framework for other recreational activities not included in this *CRM Plan* but which are central to the Sunset Park Master Plan.

7.1 Fishing Access

As not all anglers have fishing opportunities elsewhere, recreational fishing access is a center point for the community's vision of the restoration of Bradley Lake. The lake historically maintained a quality urban fishery for the community and provided opportunities for youth fishing tournaments. To increase fishing access around the lake, a fishing pier will be constructed along the dike separating the treatment wetland from Bradley Lake or along the former fish hatchery pond structures. This fishing pier will be Americans for Disabilities Act (ADA) accessible. In addition, future fishing access from shore will be available along the access channel linking the lake to Sturgeon Bay. Along with shoreline fishing access, Bradley Lake will provide ice fishing opportunities as well in the winter once the lake has been dredged.

A large portion of Bradley Lake will be inaccessible to shoreline fishing due to the restored buffer implementation to improve water quality. To improve angler acceptance and success, artificial habitats potentially could be used near shoreline access points. Artificial habitats, such as the Georgia Cube, provide additional fish habitat and are angler friendly (Clark-Kolaks, 2015).

7.2 Watercraft Launch Site

A boat launch facility has been conceptually designed for placement in the south central portion of the lake. This launch facility will support construction activities and provide the public with future access to the lake, as well as potentially to Sturgeon Bay and Lake Michigan. With the implementation of a fish barrier to deter common carp, watercraft will be restricted to Bradley Lake for the first three years or until the barrier is deemed removable on a seasonal basis. This facility will be geared towards launching of kayaks and canoes, however, it may also be completed to accept the launching of small, trailered watercraft, such as small jon boats. Currently, work is underway to secure funding for the boat launch facility as part of the restoration dredging design portion of the project.

7.3 Paths and Boardwalks

Upon completion of restoration activities in Bradley Lake, paths and boardwalks will be strategically implemented around the park to provide access. These paths and boardwalks will link up to the existing parking areas and sidewalks within Sunset Park. All paths and board walks will meet ADA standards to provide access to the new recreational opportunities.

These paths will be designed with the restoration goals of the project in mind. As such, the paths shall be constructed of a porous material to provide for infiltration of storm water. Such acceptable materials include crushed limestone or porous pavers. If non-porous materials must be utilized in construction, those areas shall be graded such that storm water flows to a collection point where a vegetative buffer zone is implemented. In addition the paths will be placed at a setback distance to minimize disturbance to vegetative buffer zones and the treatment wetland and forebay areas. In certain areas, it may be necessary to construct a boardwalk to raise the path out of areas that contain sensitive habitats. It is anticipated that these paths and boardwalks will be utilized by foot traffic, bicycles, and other human powered wheeled devices.

8 Summary List of Proposed Management Actions

To retain the improved quality of Bradley Lake after restoration activities, an operations and maintenance plan detailing BMPs must be in place to reduce or eliminate potential sources of contamination and maintain biodiversity. The management actions proposed to be implemented to achieve the target level of resource protection, analysis of the need for the action, key components of the action, and strategies for tracking effectiveness are summarized below.

- Dredging
    - Removal of nutrient rich sediment from Bradley Lake will improve water quality, habitat, and recreational activities.
    - Perform water quality monitoring/sampling before and after dredging to assess effectiveness of dredging in reducing nutrient levels, as well as perform water quality sampling during construction to confirm effectiveness of BMPs in minimizing potential impacts of in-water activities.
- Native submergent aquatic plant establishment plan
    - Important deterrent to the spread of invasive plants.
    - Restore biodiversity and increase species richness of the submergent plant community within Bradley Lake.
    - Focus on plant species to be used, planting methods (seed dispersal and/or planting enclosures), and protection (e.g., turtles, crayfish, fish and muskrats).
    - Focus on broad leaf vegetation varieties.
    - Annual vegetation types survey for five years within the project boundary for any growth of non-native exotic species. If exotic species are identified, a remediation plan to eradicate the invasive species will be submitted to the WDNR for approval. If chemical treatment is proposed, appropriate permits will be obtained as necessary.
- Abatement plan for Canadian geese
    - Reduce transfer of invasive aquatic plants.
    - Spot treat invasive species with herbicides should they become an issue. Obtained necessary permit.
    - Anticipated that a significantly reduced turf zone around Bradley Lake will also mitigate lake incursion by Canadian geese.

- Invasive aquatic fish and invertebrates management plan
    - May include physical and non-physical exclusion barriers to prevent or slow the spread of invasive species.
    - A physical gate structure is recommended to allow other fishes to ingress and egress but most importantly to inhibit invasive species, such as the common carp, from becoming an issue.
    - Evaluate temporary/seasonal use of the structure following the establishment of native vegetation.
        - Temporarily installing the structure at the time of the carp spawning window would inhibit the utilization of Bradley Lake as a common carp spawning area, thus reducing the potential for common carp recruits. The physical barrier, then could be removed for other fish species to more easily ingress/egress Bradley Lake pre- and post-common carp spawn.
- Fishery Improvements
    - Hydraulically re-establishing the connection of Bradley Lake to Sturgeon Bay allows development of a quality fishery.
        - Fish can access Bradley Lake for migrating, spawning, habitat usage and foraging.
- Angler Opportunities
    - After the completion of restoration activities, an initial stocking of brood gamefish may be productive to initiate a fishable population with specific angler harvest limits.
    - Fish populations and diversity will increase as fish begin to utilize Bradley Lake for spawning, feeding, and other life functions.
- Lake Shoreline Restoration
    - Implement native vegetation and other soft armoring techniques to create a buffer zone around the lake.
        - Increase infiltration of water, as well as provide a root system to stabilize the soils along the shoreline.
        - Prevent geese and other nuisance waterfowl from entering the lake.
        - Require little to no ongoing maintenance once established.

- Planting and seeding plan is in development for submittal and implementation during other restoration activities at the site.

- Storm Water Management

    - Native vegetative buffer zone will be implemented according to the planting and seeding plan.

        - Increase storm water infiltration, reduce sediment and contaminant load to the lake, and deter geese and other nuisance waterfowl from entering the lake.

    - As much of the storm water has largely been rerouted to the storm water retention and treatment wetland forebay at the south end of Bradley Lake, a similar opportunity exists for storm water entering Bradley Lake on the northeast corner.

        - Route an influent storm water drain into a small constructed treatment wetland, as part of a long-term operations and maintenance plan to reduce storm water inputs into Bradley Lake.

    - Water quality monitoring/sampling efforts performed before and after dredging can be used to measure effectiveness of the current storm water treatment. If the current system is not performing appropriately, storm water treatment in the northeast part of Sunset Park should be considered.

- Recreation Improvements

    - Recreational fishing access is a center point for the community's vision of the restoration of Bradley Lake.

        - ADA accessible fishing access points, piers, and/or platforms will be constructed at select points along the northwest portion of Bradley Lake, as well as along the access channel linking the lake to Sturgeon Bay.

        - Bradley Lake will provide ice fishing opportunities as well in the winter once the lake has been dredged.

        - To improve angler acceptance and success, artificial habitats potentially could be used near shoreline access points.

    - Upon completion of restoration activities in Bradley Lake, paths and boardwalks meeting ADA standards will be strategically implemented around the park to provide access to the new recreational opportunities and will be designed with the restoration goals of the project in mind.

- Paths shall be constructed of a porous material to provide for infiltration of storm water or the areas shall be graded such that storm water flows to a collection point where a vegetative buffer zone is implemented.

- Paths will be placed at a setback distance to minimize disturbance to vegetative buffer zones and the treatment wetland and forebay areas.

- In certain areas, it may be necessary to construct a boardwalk to raise the path out of areas that contain sensitive habitats.

- Education Through Public Outreach Programs

  - Discourage visitors from feeding resident geese.

  - Emphasize application rates and times of year for yard fertilization with nitrogen and phosphorous based products.

  - Prevent transfer of invasive species from other water bodies.

  - Encourage general cleanliness, by way of trash and debris removal, to improve the overall aesthetic appearance of Sunset Park and Bradley Lake.

- The *CRM Plan* will be re-evaluated after each key component of the implementation plan is completed, and will be revised as necessary.

9 Phasing Strategy for Implementation

9.1 Proposed Phasing Strategy

The Sunset Park Master Plan, which is provided in Appendix A, is divided into two phases and an Alternate option. The first phase is associated with improvements aligned with dredging high nutrient-polluted sediments from Bradley Lake (including re-establishing the lake-bay connection) and amenity enhancements heavily in favor of implementation by the public. Some of these enhancements may include upgrades to/construction of fishing access/revetments, docks, and piers in the lake and along the bay; island improvements; trail improvements; path and boardwalk construction; landscape and northeast wetland enhancement; and installation of a pedestrian bridge over the access channel. This first phase focuses on the north area of the park ultimately creating a passive recreation experience with added naturalized area to improve wildlife habitat and organic storm water management. This phase also includes the removal of invasive vegetation, water quality monitoring/sampling, installation of the carp barrier in the channel, restoring native plants, and monitoring of fish populations.

The second phase provides a complete vision for the park post construction of phase one. Based on public interest in improving circulation and active recreation in the southern region of the park, phase two provides a central drive with expanded boat and vehicular parking. Additional upgrades to Sunset Park could include landscape improvements/restoration, pavilion renovation, playground improvements, shipyard overlook/butterfly sanctuary construction, concession facility improvements, and site furnishings (e.g., benches, picnic tables, trash receptacles, signage, and kayak storage).

The Alternate park plan has been provided as an overall park vision with an intimate Bradley Lake sand beach and paddle craft launch without the channel open to Sturgeon Bay.

Enhancements including the removal of invasive vegetation, water quality monitoring/sampling, restoring native plants, and monitoring of the carp barrier in the channel and fish populations are expected to carry into phases beyond the first phase. Additional phases could include additional storm water management, if necessary, and long-term operations and maintenance of the site.

9.2 Public Involvement

The Sunset Park Master Plan was presented to the public during meetings held on October 25, 2017 and March 28, 2018. Public comments were summarized in meeting minutes and were taken into account in subsequent revisions to the Sunset Park Master Plan (Appendix A).

A public information meeting will be held at the beginning of the lake restoration project. Once the restoration of Bradley Lake has begun, the City will have an educational field day. The event information will be provided to Door County Soil and Water Conservation Department and the WDNR for dissemination to interested communities. The Rotary Club will also be involved with providing information in their local and statewide newsletter. Additionally, project updates will be provided on the city's web page.

9.3 Funding and Grant Support

The work described in Section 7.1 will be completed by the City of Sturgeon Bay. Phase 1 is anticipated to begin in the spring of 2020 with the dredging of high-nutrient sediment from Bradley Lake. The work will be funded by the City, with the support of grant funding.

Several grant programs support activities associated with the Sunset Park Master Plan such as landscape naturalization, pathways/boardwalks, shore and recreational access. Potential grant funding for Phase 1 includes the following:

- Stewardship (Aids for the Acquisition and Development of Local Parks [ADLP])
- Stewardship (Recreational Trails Program)
- Surface Water (Lake Management Plan Implementation)
- Coastal Management
- Surface Water (Aquatic Invasive Species [AIS])
- Sport Fish Restoration

Potential grant funding for Phase 2 includes the following:

- Stewardship (ADLP)
- Stewardship (Land and Water Conservation [LAWCON])
- Sport Fish Restoration
- Surface Water (Lake Management Plan Implementation)
- Coastal Management
- Sport Fish Restoration
- Recreational Boating Facilities

Potential grant funding for the Alternate option includes the following:

- Surface Water (Lake Implementation)

Potential grant funding for optional storm water management includes the following:

- Fund For Lake Michigan
- Coastal Management

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Drawings

N

LEGEND

570	BOTTOM OF SOFT SEDIMENT DREDGE ELEVATIONS WITH BARGE ENTRY CHANNEL (1' CONTOURS)
F-1	ACTUAL LAKE SAMPLE LOCATIONS (FOTH 2015)
5	ACTUAL LAKE SAMPLE LOCATIONS (GTK 2009)
B	ACTUAL LAKE SAMPLE LOCATIONS (MILLER 2008)
SO-02	ACTUAL LAND SAMPLE LOCATIONS (FOTH 2017)
SED-02	ACTUAL BAY SAMPLE LOCATIONS (FOTH 2018)

NOTES:

1. THE HORIZONTAL CONTROL IS REFERENCED TO THE NAD83 WISCONSIN STATE PLANE COORDINATE SYSTEM (WISCONSIN CENTRAL ZONE).
   THE VERTICAL CONTROL IS REFERENCED TO NAVD 88.
2. COLOR ORTHO PHOTO SUPPLIED BY PICTOMETRY COMPILED IN APRIL 2015.
3. SINGLE BEAM BATHYMETRIC SURVEYED PERFORMED BY FOTH ON OCTOBER 15, 2015.
4. SEDIMENT DEPTH POLING PERFORMED BY FOTH ON OCTOBER 16, 2015.
5. LAKE WATER ELEVATION OF 579.5' ABOVE MEAN SEA LEVEL SURVEYED BY FOTH ON OCTOBER 15, 2015.

Foth
Foth Infrastructure & Environment, LLC
2121 Innovation Court, Suite 300
P.O. Box 5126
De Pere, WI 54115-5126
Phone: 920-497-2500 Fax: 920-497-8516

COASTAL RESOURCE MANAGEMENT PLAN
BRADLEY LAKE RESTORATION PROJECT

CITY OF STURGEON BAY

DOOR COUNTY WISCONSIN

REVISIONS NO.	BY	DATE	DESCRIPTION

RECORD DRAWING OF COMPLETED CONSTRUCTION BY:
RECORD DRAWINGS OF COMPLETED CONSTRUCTION CONFORMING TO CONTRACTOR AND / OR OWNERS RECORDS.
BY _____ DATE _____

DATE OF PREPARATION

	BY	DATE
SURVEYED		
DRAWN	JRB2	JAN, 2019
DESIGNED		
CHECKED	CMH	JAN, 2019

HISTORICAL SOIL AND SEDIMENT SAMPLING LOCATIONS

HORIZONTAL SCALE:
0 100' 200'

PROJECT ID: 17S032

1

pw:\\PW-APPS1.foth.com:PW_IE\Documents\Clients\Sturgeon Bay, WI C\0017S032.00\CAD\Permit Plans\Drawing-1 - Actual Barge Access Sampling Locations.dgn
1/3/2019 1:11:08 PM JRB2

Appendix A

Sunset Park Master Plan

Sunset Park Master Plan

January 16, 2019

Prepared By

City of Sturgeon Bay

Applied Ecological Services

Foth Infrastructure & Environment

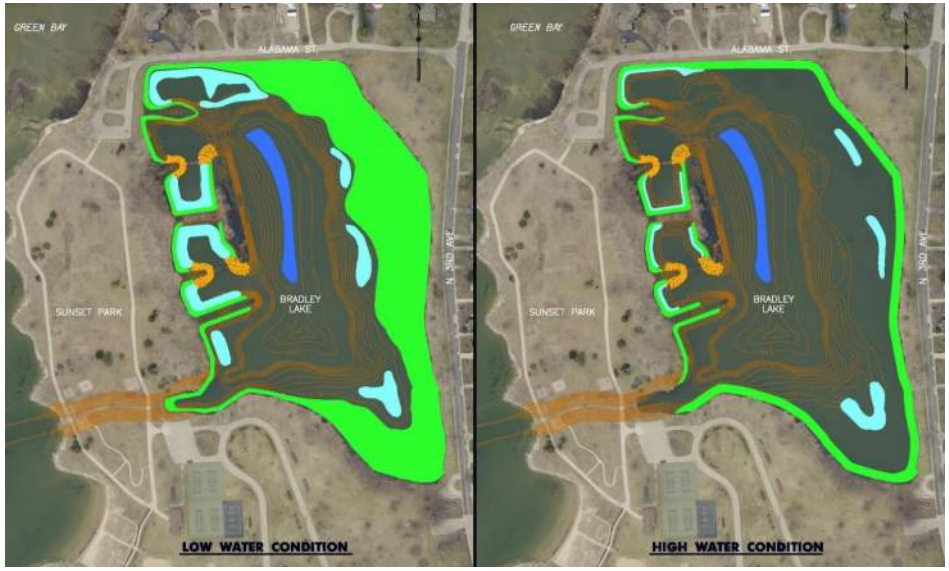
NOAA

Wisconsin Coastal Management Program

Project Background

The master plan for Sunset Park was first instigated in 2016 following plans to remove sediment accumulation and to create additional aquatic habitat for native species by dredging Bradley Lake. While this work is being completed, parts of Sunset Park will be disrupted. The master plan that follows looks at future improvements that capitalize on the dredging project while improving circulation, landscape aesthetic, wildlife habitat, stormwater treatment, and recreational amenities for the residents and visitors to Sturgeon Bay.

The two plans below to the left provide an example of designed topography and aquatic plant vegetation zones associated with the dredging project that will re-establish the fish hatchery and optimize shoreline restoration. The aerial below to the right provides existing conditions of stormwater detention wetlands that were a separate project and recently installed as the first natural area in the park.



Goals and Objectives

Goals for Bradley Lake Work

- Improve **water quality**
- Create fish habitat & **fishing** nodes
- Paddle **access** to and from Bradley Lake and Bay
- Discourage **invasive species** such as phragmites and carp
- Able to be **permitted** and **funded**
- Design **improvements** to attract multiple **funding sources** (water quality, habitat, parks and rec, boating access, etc.)

Purpose of the Master Plan

- Inform **future planning** and implementation
- Assess **opportunities** and **constraints**
- Identify **community** goals
- Incorporate recent completed **projects** at park
- Implement **phased** planning strategy
- Leverage **dredging** momentum to advance the above goals

Existing Conditions

Opportunities & Constraints

Bradley Lake Improvements

Opportunities

- Great **views** of Sturgeon Bay and Bradley Lake
- Opportunities to enhance **connections to water**
- Flat terrain allows for a variety of improvements including **reorganizing circulation system**
- Space to grow and **improve walking** trail network
- Some nice old trees and existing **vegetation**
- Underutilized lawn can transform into **native plantings** to improve habitat and **lower maintenance** costs

Constraints

- Disconnected and **confusing circulation** system
- **Limited network** of trails
- Minimal room on **north side** of park for trail connection
- **Shipbuilding yard** is a hard edge to the south that is a source of noise and industrial views but also a **connection opportunity**
- **Playgrounds** are outdated and not **accessible** to those with disabilities
- Beach is shrinking with **higher water levels**
- Bradley Lake **channel connection** could divide park
- Plethora of dying **ash trees**

Public Participation

Public participation has been a vital element to providing a complete master plan vision for Sunset Park. In collaboration with the City of Sturgeon Bay, two public meetings were held at City Hall to present ideas and gain feedback for the parks future. The first meeting was an open charrette where attendees voted on ideal amenities and outlined past, current, and future elements the park can accommodate.

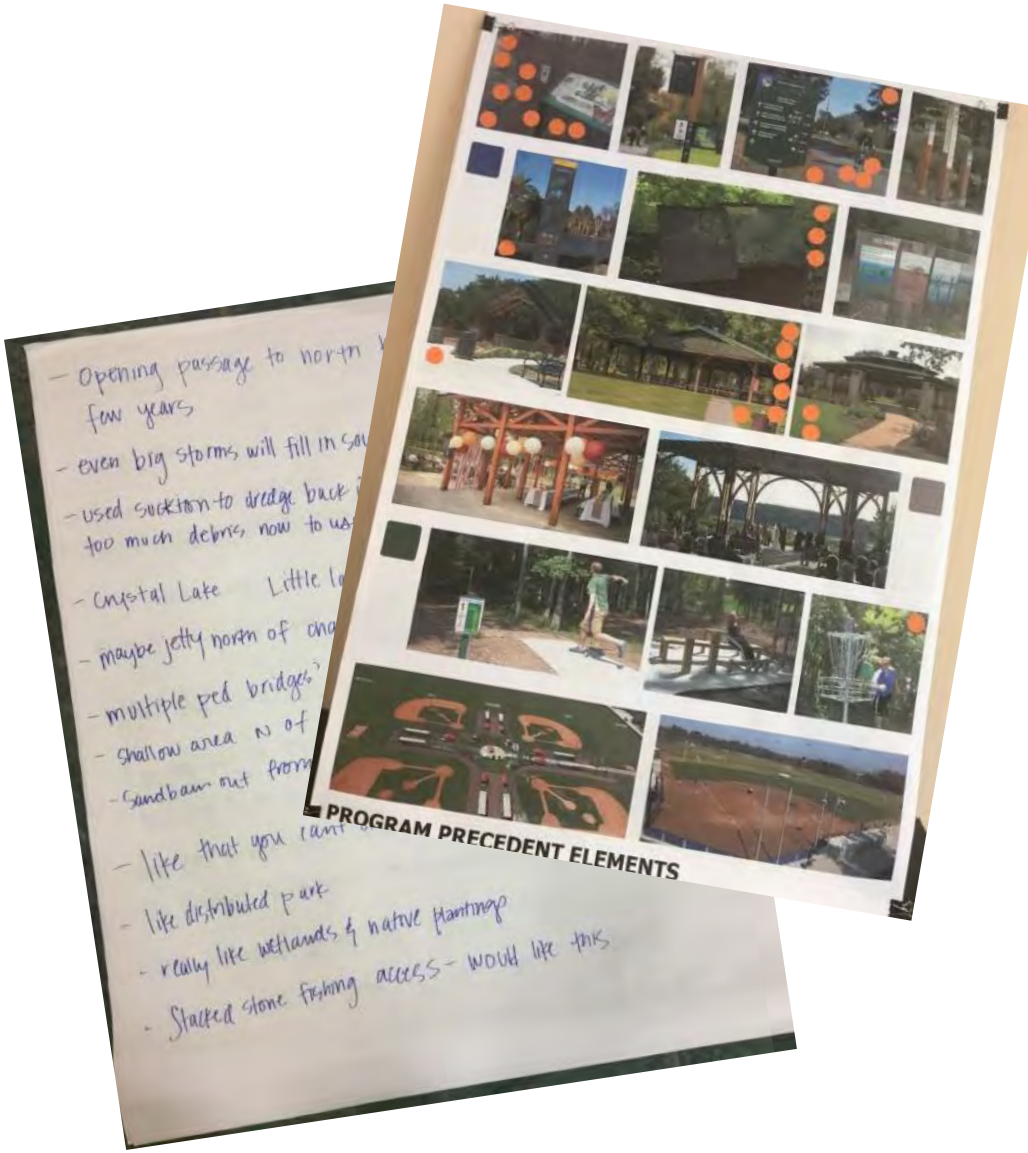
The second meeting was a public presentation to the City Council, Parks & Recreation Board, and community members of a draft master plan with several phased options for attendees to review. This meeting provided attendees with the first interpretation of Sunset Park's overall vision that was then finalized based on public review.

The following slides provide outlined notes of public comments from both meetings.

Master Plan Public Charrette

October 25, 2017
Public and Board Member Comments

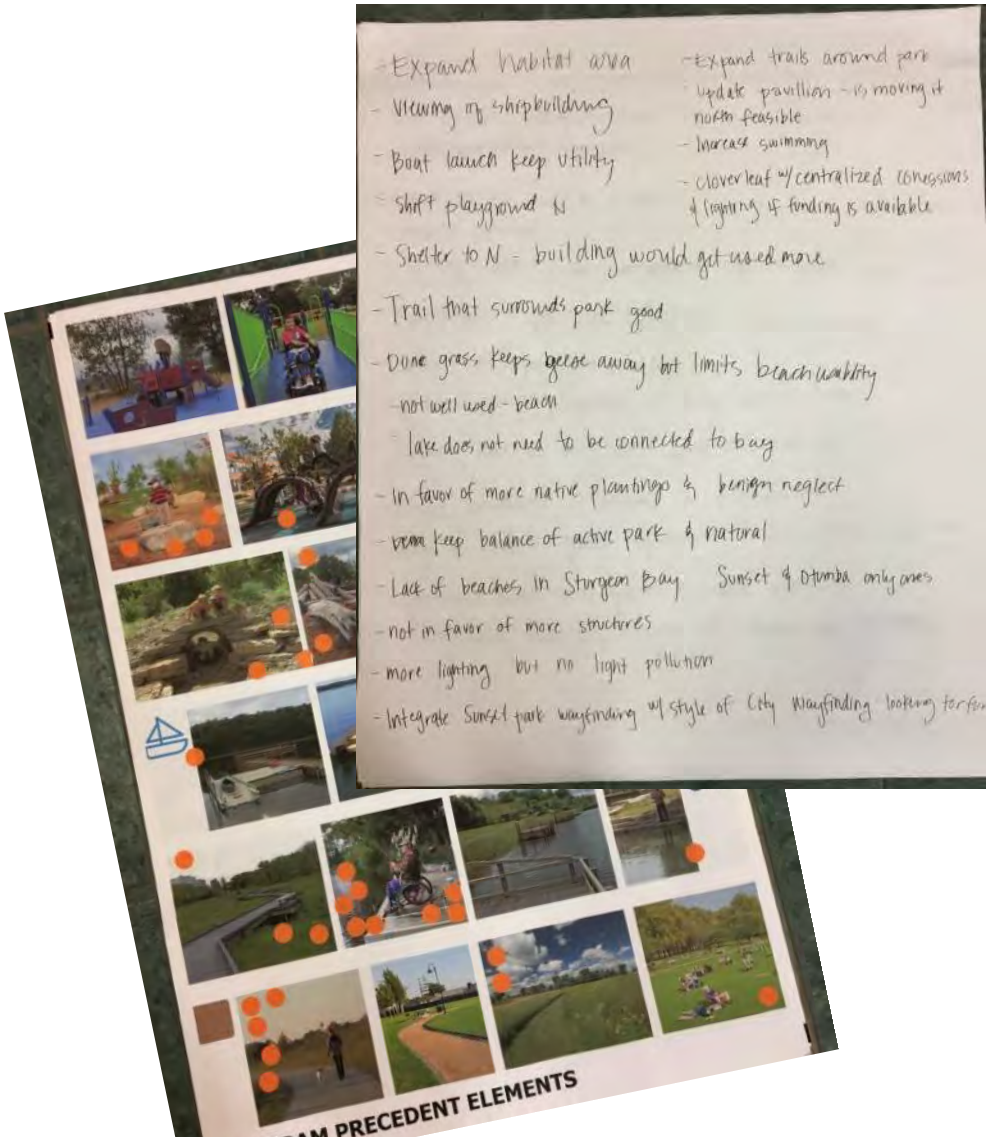
- Preference to expand **natural areas** with a balance between a nature conservancy and traditional recreational park.
- Provide a **trail** that surrounds the entire park with new seating areas.
- Update the existing pavilion with **upgraded amenities**
- Provide a **new enclosed pavilion** in the north area of the park for year-round events. Enhance existing Bay overlooks for sunset viewing and water access.
- Highlight the **beach** drawing locals along with visitors from northern and southern Door County.



Master Plan Public Charrette

October 25, 2017
Public and Board Member Comments

- Reconfigure the **ballfields into a cloverleaf layout** with new lighting and concessions.
- **Upgrade playground** equipment to ADA standards and incorporating nature play zones.
- Provide educational **signage** or incorporate into the City wayfinding plan.
- Accentuate Sturgeon Bay ship building history with an **overlook** from the park into neighboring ship yard.
- Debatable measure whether opening the lake to the bay may allow invasive species to enter the lake and impact overall **water quality**.



Master Plan Draft Public Meeting

March 28, 2018
Public and Board Member Comments

- Preference toward keeping the north park **passive recreation** and the south area **recreation** based.
- Limited agreement for expense of adding second event **pavilion.** Favor in **renovating** existing pavilion.
- Updated central **playground** and addition of **nature play** amenities is favored.
- Create a higher **overlook** to accommodate ship yard viewing for all ages.
- The **boardwalk** features and **tea house** create great passive experiences for park users.

Master Plan Overview

The Master Plan is divided into two phases and an alternate option. The first phase is associated with improvements aligned with dredging Bradley Lake and amenity enhancements heavily in favor of implementation by the public. This first phase focuses on the north area of the park ultimately creating a passive recreation experience with added naturalized area to improve wildlife habitat and organic stormwater management.

The second phase provides a complete vision for the park post construction of phase one. Based on public interest in improving circulation and active recreation in the southern region of the park, phase two provides a central drive with expanded boat and vehicular parking. The alternate park plan has been provided as an overall park vision with an intimate Bradley Lake sand beach and paddle craft launch without the channel open to Sturgeon Bay.

Each point of enhancement has an associated opinion of probable cost based on a magnitude of planning with a contingency reflecting implementation experience and current 2019 economic parameters. A cost range is provided for particular elements from low to high based on customizable elements.

Master Plan - Phase 1

Trail Improvements

Trail Improvements

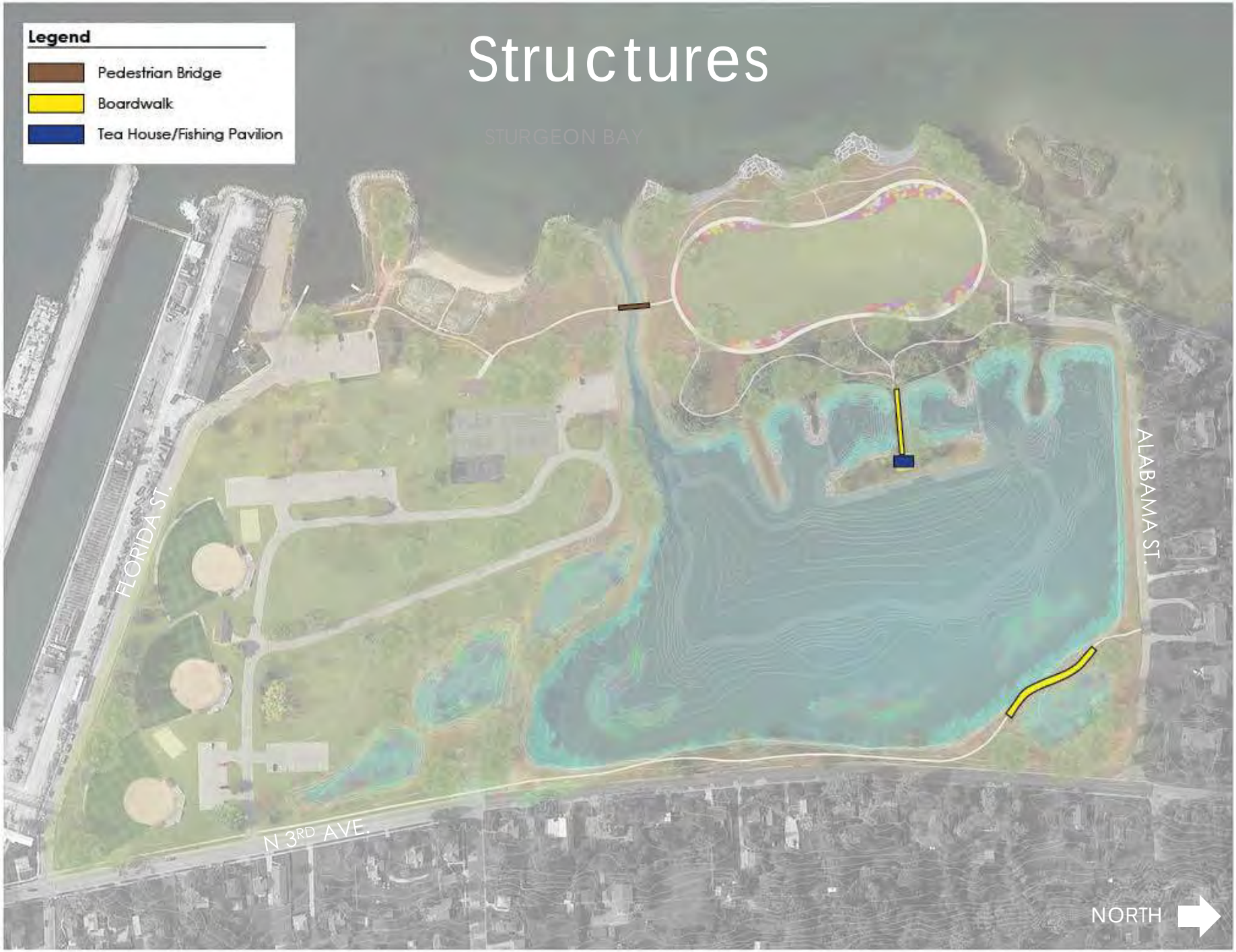
Crushed Gravel Trails

Rustic Trails

Concrete Path Extension Along 3rd Ave

Trail Improvements		
	Remove existing trails	
	Install concrete walking paths	
	Install gravel walking paths	
	Install rustic trails	
		$124,000.00

Structures


Legend
Pedestrian Bridge
Boardwalk
Tea House/Fishing Pavilion
STURGEON BAY
FLORIDA ST.
ALABAMA ST.
N 3RD AVE.
NORTH

Pedestrian Channel Bridge

Pedestrian Bridge Connection Over Channel

Integrated With Crushed Gravel Trail

Structures				
	Pedestrian bridge	**$146,000.00**	**to**	**$ 219,000.00**

Tea House/Fishing Pavilion

Open Element Tea House or Fishing Pavilion

Trail Structures			
Tea house pavilion	$52,000.00	to	$ 78,000.00

Connected to Park by Boardwalk

Picturesque Event Space or Photography Setting

Tea House/Fishing Pavilion Boardwalk

Provides Lake Observation Point and Fishing Access

Structures			
Boardwalk – Tea House	**$41,000.00**	**to**	**$ 62,000.00**

Boardwalk Connects the Park to the Tea House Island

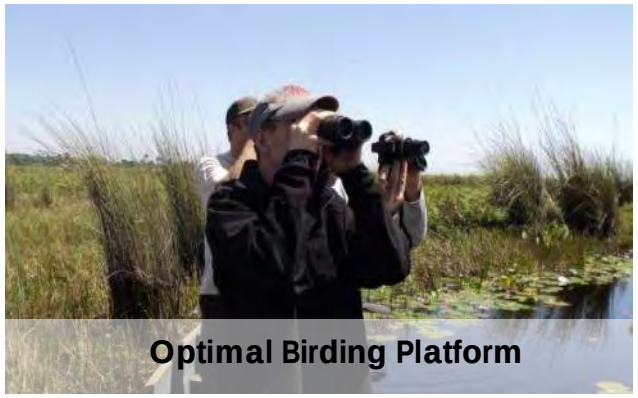
Opportunity to Provide ADA Accessibility

Northeast Wetland Boardwalk

Section View of Proposed Wetland Boardwalk

Structures			
Boardwalk - Northeast Wetland	**$128,000.00**	**to**	**$ 192,000.00**

Provides Lake Bradley Observation



Optimal Birding Platform

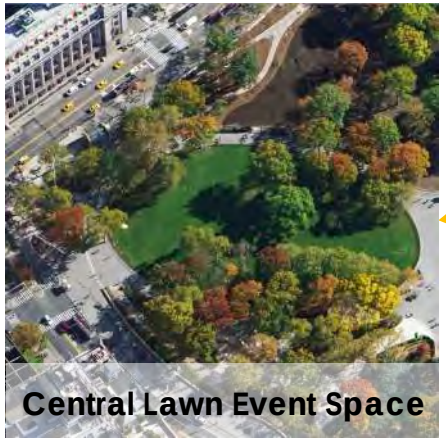
Connected to Concrete Path

Landscape


Legend
Mown Lawn
Ornamental Plantings
Upland Native Meadow
Emergent Vegetation
STURGEON BAY
FLORIDA ST.
ALABAMA ST.
N 3RD AVE.
NORTH

Landscape Enhancements

Ornamental Landscape Beds



Central Lawn Event Space

Naturalized Shoreline Along Lake and Channel

Landscape		
	Trees of varying sizes throughout phase 1	
	Shrubs and perennials in planting beds	
	Emergent plants-lakeshore and channel	
	Native seeding in naturalized areas	
	Seeded turfgrass in active lawn areas	
		$396,000.00

Lawn Converted to Low Prairie

Emergent Vegetation

Northeast Wetland

Low Drainage Point Converted to Wetland

Northeast Wetland		
	Earthwork for northeast wetland	
	Native seed and erosion control	
	Emergent plants	
		$42,000.00

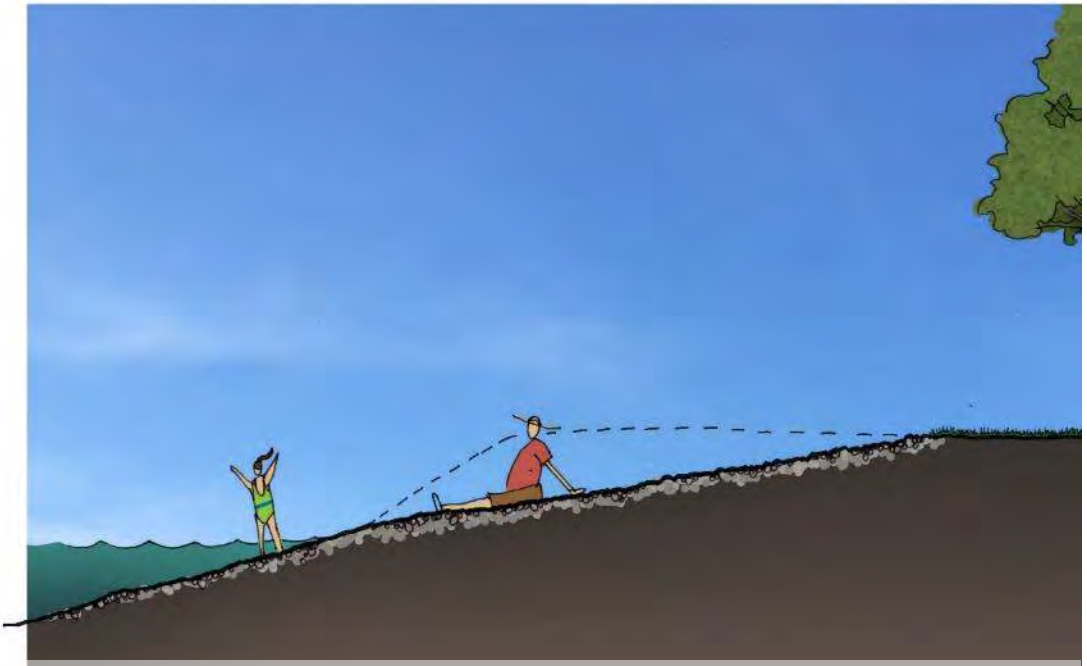
Expansion of Existing Turtle Habitat

Provides Internal Park Buffer and Enhanced Property Value

Activity


Legend
Fishing Access
Beach Enhancement
STURGEON BAY
FLORIDA ST.
ALABAMA ST.
N 3RD AVE.
NORTH

Pebble Beach Cove



Section View of Pebble Beach In-between Revetment

Activity – Shoreline Revetment	
Three pebble beach coves	**$133,000.00**

Stepped Stone Revetment

Section View of Shoreline Revetment and Fishing Access

Activity – Shoreline Revetment		
	Boulder/rip-rap revetment	**$122,000.00**
	Four stepped stone revetments	**$135,000.00**

Boulder Revetment Adjoining Step Access

Fishing Access

Four Fishing Access Points Along Bradley Lake

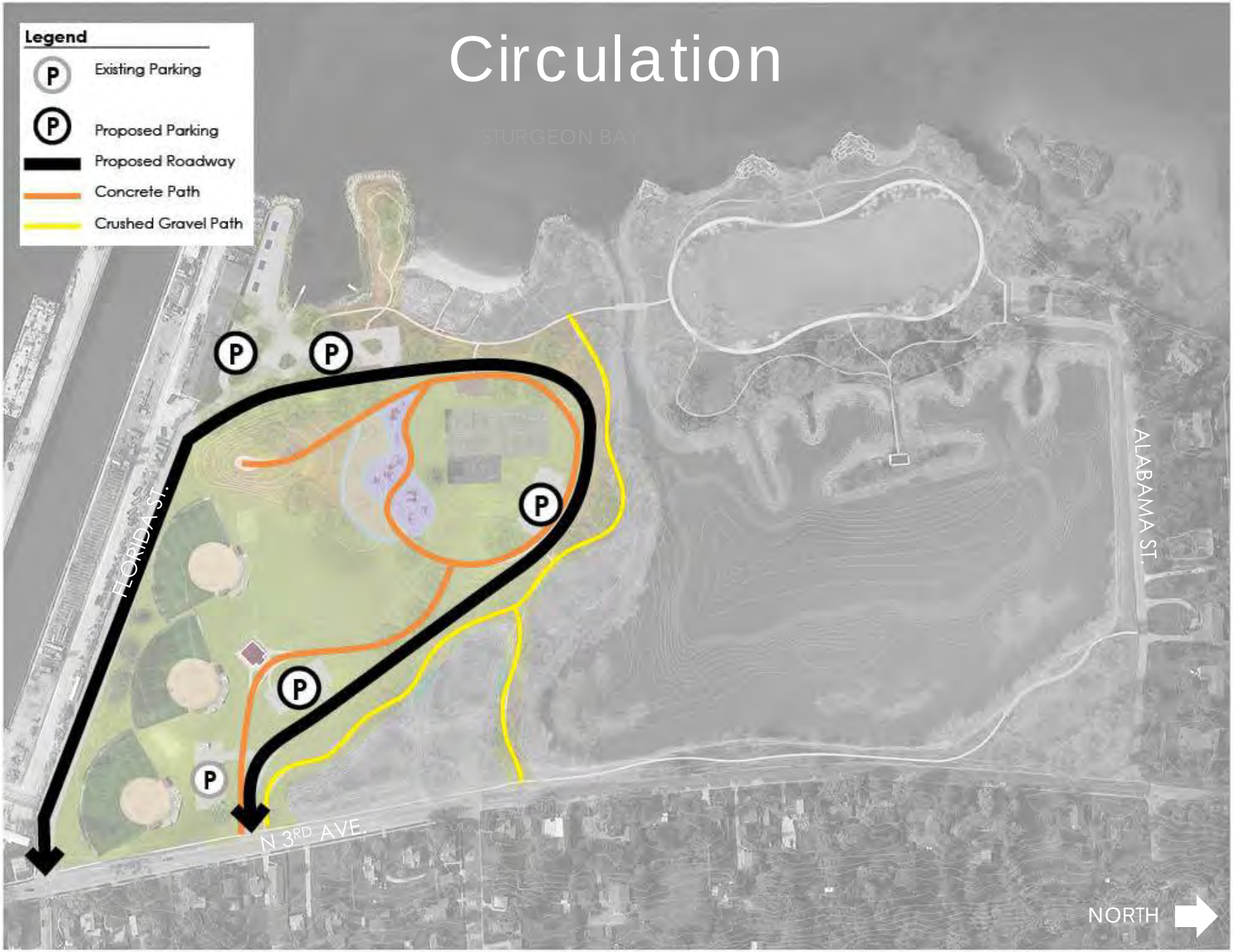
Activity		
	Four stepped stone fishing access points	**$67,000.00**

Stone Steps Accommodate Fluctuating Lake Depth

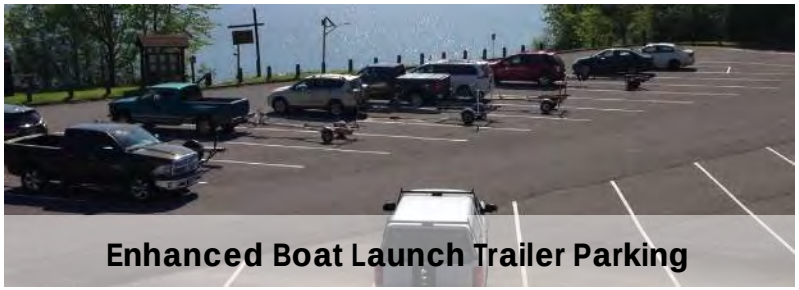
Encourages Direct Water Access Routes

Master Plan - Phase 2

Circulation



Circulation



Enhanced Boat Launch Trailer Parking

Boat Launch One-Way Traffic Pattern Loop

Proposed Single Roadway Loop

Gravel Path

Circulation - Roadway Realignment		
	Demolish existing roadway	
	Prepare and pave new roadway	
		$566,000.00
Circulation - Parking		
	Demolish storage building	
	Demolish existing parking lots	
	Resurface single parking lot to remain	
	Prepare and pave new parking lots	
		$554,000.00
Circulation - Trail Improvements		
	Remove existing remaining trails	
	Install concrete walking paths	
	Install gravel walking paths	
		$213,000.00

Structures


Legend
Renovated Picnic Shelter
New Concessions Building
STURGEON BAY
FLORIDA ST.
ALABAMA ST.
N 3RD AVE.
NORTH

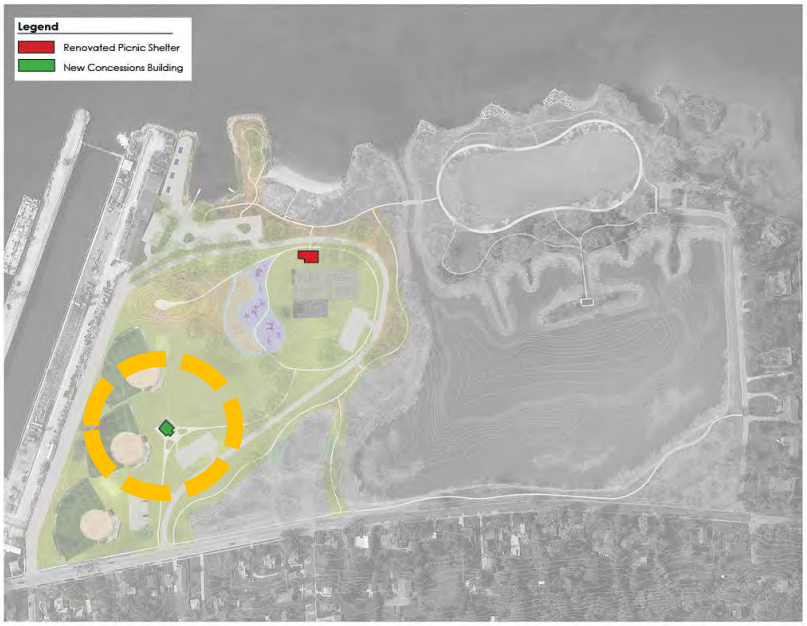
Renovated Picnic Shelter

Perspective of Renovated Picnic Shelter with Restroom Extension

Structures			
Renovate picnic shelter	$57,000.00	to	$90,000.00

New Concessions Building

Expansive Concessions Facility



Structures				
	Demolish old concessions building			
	New concessions building			
		$312,000.00	**to**	**$468,000.00**

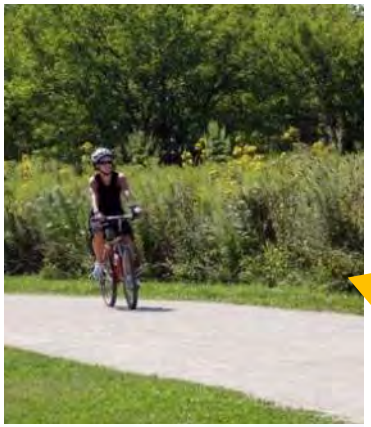
Larger Kitchen Area with Viable Storage Space

Landscape


Legend
Mown Lawn
Ornamental Plantings
Upland Native Meadow
Emergent Vegetation
STURGEON BAY
FLORIDA ST.
ALABAMA ST.
N 3RD AVE.
NORTH

Landscape Enhancements

Upland Meadow Along Paths



Open Lawn Space Between Baseball Fields and Pavilion

Landscape		
	Trees of varying sizes throughout phase 2	
	Shrubs and perennials in planting beds	
	Emergent plants-lakeshore and channel	
	Native seeding in naturalized areas	
	Seeded turfgrass in active lawn areas	
		$62,000.00

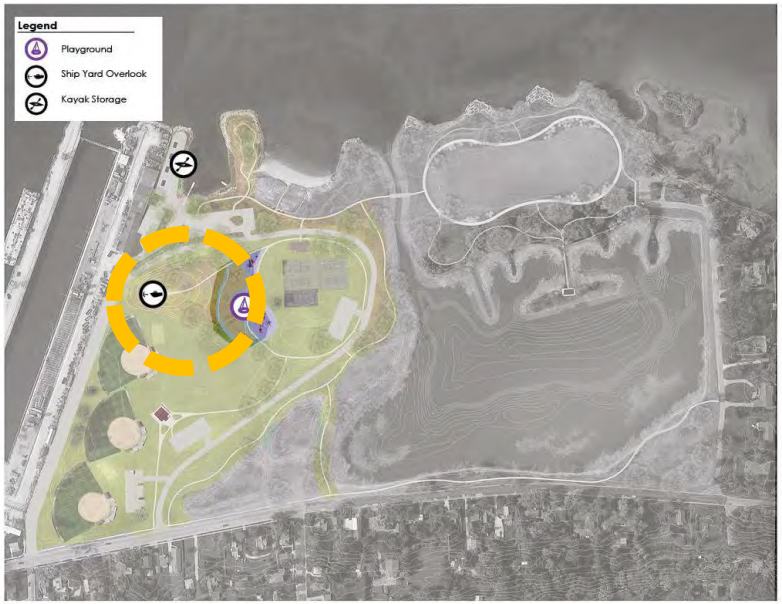
Ornamental Park Entrance

Activity


Legend
Playground
Ship Yard Overlook
Kayak Storage
STURGEON BAY
FLORIDA ST.
ALABAMA ST.
N 3RD AVE.
NORTH

Overlook and Butterfly Sanctuary

Overlook Constructed with Dredge Material



Activity - Overlook/Butterfly Sanctuary	
Naturalized overlook built from dredged material	**$175,000.00**

Prairie Restoration Provides Butterfly Habitat

Playground

Activity - Playground			
Playground-soft surface play	$390,000.00	to	$600,000.00
Playground-nature play	$39,000.00	to	$60,000.00

ADA Accessible Play Features

Nature Play Features for Creative Amusement

Site Features

Interpretive Signage

Wayfinding Signage

20 Kayak Storage Lockers

Activity - Site Features		
	Benches	
	Picnic tables	
	Dog waste stations	
	Trash receptacles	
	Signage - wayfinding and interpretive	
	Twenty kayak storage lockers	
		$80,000.00

Master Plan - Alternate

Sand Beach

Extension of Shoreline Revetment

Paddle Craft Launch

Activity - Shoreline Revetment		
	Single pebble beach cove	**$170,000.00**
	Boulder/rip-rap revetment	**$91,000.00**
	Single stepped stone revetment	**$173,000.00**
Activity - Sand Beach		
	Sand beach	**$1,300.00**

Sand Beach Along Bradley Lake

Applied Ecological Services

Foth Infrastructure & Environment