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Grand Trunk - Bay View Wetland Restoration

Engineered Design Feasibility Report

Project No. 60490610

November 2017

Prepared for:

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1. Introduction, Project Background and Planning Efforts

The Grand Trunk-Bay View Wetland is situated on city-owned properties located at 1980 S. Marina Drive and 632 E. Bay Street in Milwaukee's inner harbor (See Figure 1). These parcels combined make up a property that is approximately 28-acres in size that is currently managed by Port Milwaukee. The property was filled and developed for manufacturing and railroad uses in the mid-19th century. The Grand Trunk Milwaukee Car Ferry Company used the property for 75 years to load railroad cars on and off of ferries for cross-lake transport. The City of Milwaukee acquired the parcels in the early 1980s and currently uses them for port-related activities.

Figure 1. Grand Trunk-Bay View Wetland Location Map

Image courtesy of Google Earth.

Past industrial development in the area resulted in drastic changes of landscape, deforestation, wetland fill, creation of docks and navigation channels, bank armoring, along with soil and groundwater environmental impacts. However, the property still contains approximately seven acres of wetland. This is one of the only remaining wetland areas in the Milwaukee estuary.

The Grand Trunk-Bay View Wetland restoration project is the result of multiple stages of planning and recommendations put forth by the City of Milwaukee. The City adopted the Southeast Side Area Plan on October 29, 2008. The plan included Catalytic Project Area #3: Kinnickinnic River Area which recommends "maintaining and protecting water and habitat resources" within the Grand Trunk property. Restoration of the Grand Trunk wetland is also a recommendation for urban resiliency in ReFresh Milwaukee, the City's sustainability plan 2013-2023. The 2014 Bay View Wetland Master Plan is the result these recommendations. It articulated and evaluated various potential wetland restoration alternatives

with the outcome being the “Recommended Concept Plan” (see Figure 2).The Recommended Concept Plan provided for the following site features:

- A restored stream Channel west of the S. Marina Drive access road. The restored stream channel (north and south banks) will include a new box culvert that provides a hydraulic connection between the channel and the eastern wetland area.
- A Seiche Wetland east of the S. Marina Drive access road. The seiche wetland will provide fish spawning habitat that is functional for variable water levels.
- The restoration of Sand Dune and Meadow habitats north of the seiche wetland.
- A restored Amphibian Pond east of the seiche wetland.
- Restored features south of the seiche wetland include a Meadow, an Upland Prairie, along with a Floodplain Forest.

Figure 2. Recommended Concept Plan

Source: The Bay View Wetland Master Plan Figure 3.3: The recommended concept plan for the Bay View Wetland.

With the selection of a Recommended Concept Plan completed, the next step in the project was to advance the Plan through an engineering design feasibility study.

The engineered design, the focus of this report, was a collaborative effort that followed an iterative process to produce a design for the restoration of a seiche wetland with fish spawning habitat within the Milwaukee estuary.

The site features, as referenced in the following design discussions, are identified as follows (see Figure 3):

- Northern Lease Area, the northern portion of the property is leased and used for the storage of materials and construction staging.
- Lease Area Access Road, service to the Northern Lease Area, the road includes the Bridge/Culvert feature.
- South Channel, west of Lease Area Access Road and associated with the Skipper Buds docks.
- Wetland Area, east of the Lease Area Access Road.
- Allis Pond (amphibian pond), east of the Seiche Wetland.
- Southern Upland Area, including the Marquette Interchange fill pile, south of the Seiche Wetland.

Figure 3. Engineered Design Site Features

Image courtesy of Google Earth.

In 2015 the Redevelopment Authority of the City of Milwaukee (RACM) assumed management of the wetland restoration due to the complexity of the project. RACM staff is familiar with the technical and regulatory aspects of restoring a wetland within a site that is impacted by soil and ground water contamination, among other challenges. In early 2016 RACM requested proposals from multiple consultants to build upon and advance the recommendations in the Bay View Wetland Master Plan. The AECOM team was selected to fulfill this task. Presented on the following pages is the Grand Trunk-Bay View Wetland Engineered Design report prepared by AECOM between February 2016 and November 2017.

2. Project Design Team

The project "Design Team" included representatives from RACM, Port Milwaukee, the Wisconsin Department of Natural Resources (WDNR) Milwaukee Estuary Area of Concern (AOC) Coordinator, and the AECOM consulting team.

2.1 Team Members

Redevelopment Authority of the City of Milwaukee:

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Owner/Managers:

The properties are owned by the City of Milwaukee and controlled by Port Milwaukee and the Board of Harbor Commissioners. RACM is managing the wetland restoration project on behalf of Port Milwaukee and the City of Milwaukee.

Additional Technical Advisors:

- Milwaukee Estuary AOC Fish and Wildlife Technical Advisory Team
- City of Milwaukee Board of Harbor Commissioners
- RACM Board of Commissioners

Funding:

Funding for this work was generously provided by the Fund for Lake Michigan and RACM.

3. Project Communication and Public Outreach

Project communications and outreach for this phase of the project included regularly scheduled project meetings including kickoff, 25%, 40%, and 60% project milestone meetings, regularly scheduled and intermittent project conference calls, and presentations at Milwaukee Estuary Area of Concern Fish & Wildlife Technical Team (AOC Tech Team) meetings.

3.1 Project Kickoff Meeting

A kickoff meeting and site visit was conducted on March 18, 2016. The meeting was attended by RACM, WDNR, and AECOM representatives. The site walk covered a majority of the site and discussions focused on the upcoming project, including project scope, communication protocols, and meeting schedules.

3.2 Technical Outreach

The AECOM project team convened a technical outreach conference call with Mr. Will Wawrzyn, AOC Tech Team member, on May 10, 2016. The discussion provided background information on the project, a perspective on the different values of the diverse habitats possible on the property, and ideas on the pathways forward for the restoration of the habitats.

3.3 Port Milwaukee Presentation

On May 25, 2016, the RACM Project Manager provided a presentation to the Port Milwaukee, Finance & Personnel Committee of the Board of Harbor Commissioners. The presentation included a short project history, a review of the conceptual plan, discussion of the feasibility study, a schedule for the work, and a summary of the project funding.

3.4 Project 25% Milestone Meeting

On June 8, 2016, the Design Team conducted the first milestone project meeting. The topics of discussion included a summary of the work to-date (e.g. topographic and bathymetric surveys), a preliminary discussion about soils management, presentation of design drawings, and discussion about potential phased site improvements.

Engineer drawings presented at the meeting built upon the conceptual draft designs and the Recommended Concept Plan presented in The Bay View Wetland Master Plan. Drawings presented included:

- Drawing C-01, Proposed Plan Phase I, showing the South Channel.
- Drawing C-02, Proposed Plan Phase II, Option A, showing the Seiche Wetland as a small cul-de-sac feature.
- Drawing C-03, Proposed Plan Phase II, Option B, showing the Seiche Wetland as a longer linear feature.
- Drawing C-04, Proposed Plan Phase II, Option C, showing the Seiche Wetland as a broader feature with an island.
- Drawing C-05 thru C-08, Channel Cross Sections for the above noted plans.

The bottom of channel elevation at this phase of the design was 576.0 based on the long-term Lake Michigan recorded water levels and monthly averages for the typical fish spawning months (e.g. March & April). A set of the 25% drawings are presented in Appendix A.

The 25% milestone meeting was followed by a conference call with WDNR and RACM on July 7, 2016, and an alternatives meeting with RACM on August 22, 2016. At the end of the 25% milestone review process the following project parameters were defined:

- The Design Team will focus on the design that matches the spirit of the Recommended Concept Plan and expand it to the physical, topographic and Northern Lease Area limitations of the site.
- The project work zone, or design zone, will primarily concentrate on the South Channel and the Seiche Wetland, including:
    - The eastern portion of the South Channel, starting approximately 50 feet east of the eastern most Skipper Buds boat slip within the channel.
    - The eastern portion of the north bank of the South Channel, but not the south bank.
    - The culvert/bridge design associated with the Lease Area Access Road will be incorporated as a conceptual design feature as noted in the Master Plan.
    - The existing sand dune feature north of the Seiche Wetland will be incorporated as a conceptual design feature.
    - Allis Pond will be incorporated into the design as a special amphibian habitat, but the pond would be topographically separated from the Seiche Wetland so that the surface waters are not connected.
    - The southern boundary of the design zone will be the north toe of the Marquette fill pile.
- The project design alternatives include:
    - Alternative #1, the north bank of the South Channel with a uniform spawning shelf side slope.
    - Alternative #2, the north bank of the South Channel with a spawning shelf with a stepped slope design.
    - Alternative #3, the Seiche Wetland, east of the Lease Area Access Road, with islands and a uniform spawning shelf slope.
    - Alternative #4, the Seiche Wetland with islands and a stepped spawning shelf slope design.
    - Alternatives #5 and #6 included the defined project work zone and incorporating stormwater features into the design.

3.5 Project 40% Milestone Meeting

The Design Team met to discuss the 40% design on September 29, 2016. Also attending the meeting was Ms. Cheryl Nash, AECOM Senior Project Scientist and Ecologist. Prior to the meeting, the AECOM attendees toured the project site. During the site walk, which occurred after a rain event, Allis Pond was observed to have a high water level, possibly from surface storm water runoff, and very milky/poor water quality.

Hand-outs presented at the meeting included:

- “Grand Trunk Wetland – South Channel Fish spawning and Bank Improvements Planting List” AECOM, dated revised September 13, 2016.

- The 40% drawings:
    - Drawing C-01, Alternative 1 Plan, West Channel (i.e. South Channel) Uniform Side Slope.
    - Drawing C-02, Alternative 2 Plan, West Channel (i.e. South Channel) Stepped Side Slope.
    - Drawing C-03, Alternatives 1 and 2 Cross Sections.
    - Drawing C-04, Alternative 3 Plan, East Channel (i.e. Seiche Wetland) Uniform Side Slope.
    - Drawing C-05, Alternative 3, Cross Sections.
    - Drawing C-06, Alternative 4 Plan, East Channel, (i.e. Seiche Wetland) Stepped Side Slopes.
    - Drawing C-07, Alternative 4, Cross Sections.
    - Drawing C-08, Alternative 5 Plan, Upland Improvement & Storm Water Management.

Based on feedback from the 25% milestone meeting and AECOM's review of Kinnickinnic River hydrological data[1], the bottom of channel elevation for the 40% design was lowered six-inches to 575.5, approximately one foot below the historic low Lake Michigan level. A set of the 40% milestone meeting handouts are presented in Appendix B.

Feedback from the 40% milestone meeting included removal of a sediment trap feature from the storm water alternative and incorporating sediment control (i.e. a bio-filtration basin) closer to S. Marina Drive, where maintenance access will be simpler.

3.6 AOC Tech Team Meeting with 40% Design Presentation

The WDNR and RACM presented the 40% design to the AOC Tech Team meeting at the East Branch of the Milwaukee Public Library on September 26, 2016. The meeting went well with the AOC Tech Team providing feedback on two design parameters:

1. Input was received regarding the bottom elevation of the channel (i.e. the base flow channel). The Tech Team expressed the need to increase the channel depth to accommodate for the possibility of future historic low water level (i.e. "climate change resiliency"). The Tech Team understood that the 40% design bottom of channel elevation (e.g. 575.5) was based on the historical record, but they would like to incorporate a climate change resiliency safety factor. At the time of the meeting, the Tech Team did not have a suggestion for the new target elevation.
2. The Tech Team also preferred the channel design with uniform spawning shelf side slopes versus the stepped-slope design.

As a follow up to the AOC Tech Team bottom of channel discussion, on October 23, 2016, the WDNR and RACM chose 575.0 as the bottom of the base flow channel elevation.

3.7 AOC Tech Team Meeting and 60% Milestone Presentation

On November 29, 2016, the Design Team presented the 60% design to the AOC Tech Team during a meeting at the Gordon Park Pavilion. The intent of the meeting was to present the uniform spawning shelf side slope design combined with a bottom of channel elevation of 575.0, answer questions, and to receive feedback from the Tech Team.

[1] Veriotti, Dan P.E., AECOM Technical Memorandum "Bay View Wetland Restoration, River Hydrology and Water Levels", August 24, 2016.

Hand-outs at the meeting included:

- AECOM Memorandum "Bay View Wetland Restoration, River Hydrology and Water Levels" by Dan Veriotti, P.E., dated August 24, 2016.
- The 60% drawings:
    - Drawing C-01, West Channel (i.e. South Channel) Plan View.
    - Drawing C-02, West Channel (i.e. South Channel) Cross Section.
    - Drawing C-03, East Channel (i.e. Seiche Wetland) Plan View.
    - Drawing C-04, East Channel, (i.e. Seiche Wetland) Cross Sections.

Feedback from the AOC Tech Team was positive, but no additional design considerations were forwarded to the Design Team after the meeting. Copies of the meeting handouts are presented in Appendix C.

3.8 AOC Community Advisory Committee 2016 Annual Meeting

On December 7, 2016, WDNR staff gave an update for the Grand Trunk-Bay View Wetland project at the Milwaukee Estuary Area of Concern Community Advisory Committee Annual Meeting at the Miller Inn. The updated included a summary of the planning efforts underway, the next steps in the pathway of the project, and the timing associated with the pathway.

3.9 Scope of Work Shift

RACM authorized AECOM to proceed with professional services for the Bay View Wetland Restoration project on February 24, 2016. The intent was to build upon and advance the Recommended Concept Plan presented in the Bay View Wetland Master Plan. AECOM moved forward with this scope of work throughout 2016, however with the completion of the 60% design delivery it became clear that additional steps would be necessary prior to finalizing the engineering design.

In January 2017 RACM provided an update to the Fund for Lake Michigan[2] (FFLM) requesting reassignment of budget to manage the change in scope. As noted to the FFLM,

> "These steps include, but are not limited to, analyzing sub-surface environmental and geotechnical data gaps, working with WDNR staff to develop a final remediation/restoration scenario, designing a new culvert between the channel and wetland, evaluation storm water runoff impacts from adjacent properties, designing a storm water total suspended solids (TSS) reduction and mitigation strategy, and additional public outreach."

Based on RACM's request, FFLM approved[3] a change in the use of the project's funds to address the change in scope. Therefore, these documents stand as the final engineering design feasibility study for this phase of the project. A subsequent report will be issued that will provide the findings for the reassigned tasks.

3.10 WaLUP Public Input Meeting

RACM staff hosted an informational display for the Grand Trunk-Bay View Wetland on April 27, 2017, at the Harbor District Water and Land Use Plan (WaLUP) Public Input Meeting at the UWM School of Freshwater Science. The public was able to ask questions and share their thoughts regarding the forthcoming WaLUP, which includes recommendations for the Grand Trunk-Bay View Wetland. Milwaukee Public Radio WUWM aired a piece about the public input meeting on April 28, 2017. The event was attended by over 150 people.

[2] Misky, David P., RACM, Letter to Vicki Elkin, Executive Director, Fund for Lake Michigan, January 20, 2017.
[3] Elkin, Vicki. "Re: Bay View/Grand Trunk Wetland Restoration Update & Scope Change Request" email correspondence to Benjamin Timm, RACM, January 25, 2017.

3.11 Port Milwaukee Presentation

On August 16, 2017, the RACM Project Manager provided a presentation to the Port Milwaukee, Board of Harbor Commissioners. The topics of discussion included an overview and history of the site, a list of the stakeholders, an update of the feasibility study, a presentation of the restoration alternatives along with the current schedule and funding sources.

3.12 AOC Community Advisory Committee 2017 Annual Meeting

On October 27, 2017 WDNR and RACM staff gave a project update for the Grand Trunk-Bay View Wetland at the Milwaukee Estuary AOC Community Advisory Committee Annual Meeting at the Ale Asylum Riverhouse. The updated included a summary of the planning efforts underway, next steps, and timing.

4. Data Gathering

4.1 Site Elevation Data

Through the history of the site multiple data have been used to identify the elevation of features at or around the Grand Trunk property. The data include:

> National Geodetic Vertical Datum of 1929 (NGVD29) – The Sea Level Datum of 1929 is a vertical control datum in the United States by the general adjustment of 1929. This datum has been used for most current topographic survey work on the site.
>
> City of Milwaukee Datum – as City Datum has historically been applied to the site, most elevations are presented as single digit numbers. For example, an elevation of zero (0) (i.e. approximate Lake Michigan level) or an elevation of five (5) (i.e. 5 feet above approximate Lake Michigan level). The elevation of zero (0) in City Datum is equal to 580.60 NGVD29 datum.

Similarly, water elevations associated with Kinnickinnic River and Lake Michigan are typically referenced as Lake Michigan Low Water Datum (LWD) or International Great Lakes Datum of 1985 (IGLD85).

> Low Water Datum is the accepted base elevation for Lake Michigan that is used for navigation charts and authorized depths for navigation improvements projects. It is an approximation of mean low water that has been adopted as a standard reference.
>
> International Great Lakes Datum of 1985 is an international datum used within the Great Lakes basin that takes into account the isostatic rebound of the earth's crust. As such, the datum is updated periodically. A water level conversion between IGLD85 and LWD is: IGLD85 = LWD + 577.61.

The conversion to compare water level elevations and land based elevations is:

> IGLD85 = NGVD29 – 0.53 feet

Elevations presented on the project base map drawings are all provided as NGVD29 datum.

4.1.1 Topographic Survey

On March 18, 2016, during the project kickoff meeting, AECOM's surveyor conducted topographic spot checks to verify current site conditions and to verify topographic data collected by others. The current and historic topographic survey data was used to prepare base maps for the project.

4.1.2 Bathymetric Survey

The topographic survey was supplemented by a bathymetric survey of the South Channel sediment elevation conducted by AECOM on April 26, 2016. The bathymetric survey extended from approximately 50 feet east of the Skipper Buds Marina docks, towards the access road crossing the channel. The data was collected along cross-sections that extended to both the north and south banks.

The bathymetric data was added to the project base maps as NGVD29 datum.

4.1.3 Ordinary High Water Mark and Limit of Navigability

The published[4] IGLD85 Ordinary High Water Mark (OHWM) for Lake Michigan is 581.50.

At the request of RACM, on November 22, 2016, staff from the WDNR's Wetland & Waterways Southeast Team flagged the OHWMs along the north bank of the South Channel. One flag was located at the west end of the channel and another was located at the east end of the channel.

AECOM surveyed in the location and elevations of the two pin flags that represent the OHWMs. The west pin has an elevation of 580.63. The east pin has an elevation of 581.12.

In a conversation[5] with Mr. Travis Schroeder, WDNR Water Regulations and Zoning Specialist, it was determined that the eastern OHWM, elevation 581.12, best represents our project area and that it would also be used to define the eastern extent of navigability for the South Channel.

The eastern OHWM, as NGVD29 datum, has been incorporated into the project base maps.

4.2 Utility Information

Utilities exist within the project area that will impact construction activities associated with the restoration work. Information on the utilities is presented in an effort to memorialize historical information and to anticipate impacts the utilities may have on the project. The utility's noted below have been incorporated onto the site base maps.

4.2.1 Natural Gas

A 6-inch natural gas main is present along the west side of S. Marina Drive and it enters the site along the west side of the Lease Area Access Road. The main continues north into the Lease Area. See Port of Milwaukee Grand Trunk Site Utilities figure, dated October 13, 2015, in Appendix D.

4.2.2 Water

There are two water mains in the vicinity of the site. A 6-inch water main is present along S. Marina Drive, but it does not appear to have a service that enters the property (ibid).

A second water main has been mapped along the north alleyway extension of S. Allis Street. The main appears to cross the South Channel and extend onto the site in the vicinity of the north bank of the South Channel (see The GTW Milwaukee, Applied Ecological Services aerial photo figure, provided by RACM, in Appendix D). Evidence of the water main is present on the north bank of the South Channel in the form of a manhole with a casting lid identifying the structure as a "Water Meter" structure.

4.2.3 Sanitary Sewer

A sanitary sewer main or lateral appears to serve the site from the north alleyway extension of S. Allis Street. The main appears to cross the South Channel and extend onto the site in the vicinity of the north

[4] IGLD 1985, Brochure on the International Great Lakes Datum 1985, Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data, January 1992.
[5] Schroeder, Travis, WDNR, phone conversation with David Henderson, AECOM, May 8, 2017 at 1:14 pm.

bank of the South Channel. This main/lateral is identified as Structure No. 34977 extending north from manhole No. SE-693 on a historical City of Milwaukee sewer system map hand annotated as D4-9-18-1 (Sheet 1) See Appendix D. This figure also includes a note referencing correspondence with the Grand Trunk Railroad with dates of 1962 & 1963.

The historical City of Milwaukee Sewer System Plat Map No. 466A also identifies Structure No. 34977/63 extending north from manhole No. 66, across the South Channel, and onto the site. See historical Sewer System Plat Map No. 466A in Appendix D.

The current City sewer map does not show the main/lateral onto the property, but it does identify the downstream manhole as No. 466B066. See City of Milwaukee, DPW, Sanitary and Storm Sewer System Micro Station Map provided by RACM in Appendix D.

4.2.4 Storm Sewer

Research into storm sewers was important for two reasons; first, the 36-inch storm sewer along S. Marina Drive currently discharges into the South Channel just west of the Lease Area Access Road and, second, preliminary engineering designs have incorporated a re-routing of this sewer to provide a supply of storm water to the reconstructed wetland.

Research by RACM discovered what appears to be the 1942 as-built drawings for the 36-inch storm sewer along S. Marina Drive (Bureau of Sewers, Plan of Sewer, ~~S. Mound St.~~ S. Marina Drive, File No.-65-3, in Appendix D). Detailed examination of the drawing provides information on the sewer construction, layout and elevations of the structures, and notes on the dredging of the South Channel to accommodate the storm sewer discharge. Also identified on the drawing is information on the 30-inch diameter culvert (e.g. “corr. iron pipe”), underneath the Lease Area Access Road that connects the wetlands east of the access road to the South Channel.

Historic information on the S. Marina Drive storm sewer was also found on both the City of Milwaukee sewer system map hand annotated as D4-9-18-1 (Sheet 1) and the Sewer System Plat Map No. 466A.

A current City of Milwaukee, Department of Public Works, Bureau of Engineers, Sewer Engineering Division drawing identifies the S. Marina Drive storm sewer as System #2557 with a drainage area of 10.2 acres (Drawing No. 466, updated 6-4-13, Appendix D). Additional correspondence[6] with the Department of Public Works indicates that:

> “This sewer was designed to convey the storm water runoff from 10.2-acres of land zoned as Heavy Industrial. The design flow rates for the 2, 10 & 100-year storm events are 40.6- cfs, 60.2-cfs and 90.1-cfs respectively.
>
> The as-built shows that the discharge elevation of the pipe is at -3.81-feet. It also shows that per plan this pipe discharges below the water elevation of the existing ditch, a submerged outlet. We sent a field crew out to investigate the last manhole in S. Marina Dr. before the pipe discharges and the crew found that the 36-inch pipe is full of water, 36-inch invert is -3.24-feet and the water elevation is at -0.8-feet. The upstream end of this storm sewer run is near the intersection of S Marina Dr. and E. Steward St. at this location the invert of the 36-inch pipe is -1.3-feet, so there is about 0.5-feet of water in the pipe here. This means there is no location that this storm sewer system could be day-lighted without being submerged.
>
> Regarding the downspouts on the building on the west side of the street, our records do not make a mention of any connections. I however feel that the 1 story metal building at E Burnham Ave and S Marian Dr does connect to the storm sewer while the 7-story brick building does not connect to this storm sewer.”

[6] Seleen, Robert, P.E., DPW, “Re: 36” Sewer – S. Marina Dr.” email correspondence to Benjamin Timm, RACM, March 16, 2017

Currently, the storm sewers in the vicinity of the site are mapped as being out-side the Combined Sewer Area. The project area is identified as being in the Kinnickinnic River watershed and the sub-basin is identified as KKR-19 Direct. See Map Milwaukee: Property Information map dated 3/22/2016, in Appendix D.

The current City sewer map shows the storm sewer and identifies the layout and structure numbers (DPW Micro Station Map, in Appendix D).

On September 1, 2016, AECOM observed the storm sewer system and surveyed manhole 466A043 with a rim elevation of 584.50 and an invert depth of 9.8 feet.

The information provided on the S. Marina Street storm sewer, including the Access Road culvert, is key to the understanding of the sewer's outfall at the South Channel, the interferences it may create during construction activities, to the possibility of re-routing the sewer to provide pre-treatment to the storm water, and to the possibility of discharging treated storm water to the reconstructed wetland.

5. Design Summary

The goal for this phase of the project was to advance the "The Recommended Concept Plan", as presented in the Bay View Wetland Master Plan, from a plan to an engineered design feasibility study.

The design procedure followed an iterative process with input from the Design Team (RACM staff, the WDNR Milwaukee Estuary AOC Coordinator, and AECOM staff), the Milwaukee Estuary AOC Fish and Wildlife Technical Advisory Team, Port Milwaukee and other community stake holders.

This collaborative effort produced an engineering design for the restoration of a seiche wetland with fish spawning habitat within the Milwaukee Estuary AOC.

5.1 Design Overview

The Grand Trunk-Bay View Wetland site is under the backwater influence of Lake Michigan, meaning the Kinnickinnic River water level adjacent to the site is controlled by the ebb and flow of the Lake Michigan water level. In the vicinity of the site, the Kinnickinnic River has a very low base flow and flashy hydrology.

There is considerable uncertainty in predicting future water levels in the Great Lakes as a result of man-made actions and natural climate variability. Based on historical data, the high water level for the project was designed at 583.0 and the design low water level at 576.5 NGVD29.

To account for possible future historic low water levels and to build "climate change resiliency" into the design, the bottom of the base flow channel, the hydraulic connection between the South Channel and the Seiche Wetland, was selected to be 575.0 NGVD29, which provides a minimum 18 inches of water depth at the design low water level for fish spawning and wetland water supply.

The restoration of the South Channel was designed to contain the following main elements:

- As its main function, the South Channel provides the hydraulic connection between the Kinnickinnic River, as the backwater to Lake Michigan, and the restored Seiche Wetland to the east. The Channel was also designed to provide fish spawning habitat along its north bank.
- The elevation of the OHWM that applies to the South Channel portion of the project is 581.12.
- The channel has an approximately 20-foot wide base flow channel with a bottom elevation of 575.0. The channel elevation was designed to be 18-inches below the historic low Lake Michigan water level elevation.

- The north bank was designed to provide a fish spawning shelf, approximately 50 feet wide and 440 feet long; the spawning shelf is created with a very mild 1:20 (Vertical to Horizontal) side slope that will provide spawning habitat at a wide range of water levels;

  Above the fish spawning shelf, a regraded north bank with a 1:4 side slope will include a storm water runoff berm and a screening (green buffer) to separate the restored bank from the Northern Lease Area;

- The south bank, above the base flow channel, was designed to match the current bank elevations.

At the east end of the channel, replacement of the existing occluded culvert between the South Channel and the Seiche Wetland and rerouting of the S. Marina Street storm water discharge will create the potential to construct a new open culvert/bridge structure with a naturalized bed. The new structure will allow seiche water movements into the restored wetlands and promote the passage of fish.

The Seiche Wetland area was maximized within the constraints of the property. It includes the following main design elements:

- The Seiche Wetland is to function primarily as a fish spawning habitat.

- The base flow channel extends through the wetland area at a bottom elevation of 575.0, an elevation that is 18-inches below the historic low Lake Michigan water elevation.

- The north bank of the wetland was designed to provide a fish spawning shelf, approximately 60 feet wide with a very mild 1:20 side slope that will provide spawning habitat at a wide range of water levels.

  Above the fish spawning shelf, a regraded north bank with a 1:4 side slope will grade into the existing sand bank/dune. The sand bank/dune will provide storm water runoff protection and a screening berm to separate the wetland from the Northern Lease Area. Additionally, the berm can be restored as a sand dune habitat providing nesting areas for species such as turtles.

- The central portion of the Seiche Wetland includes three island features with the braided base flow channel between the islands. The islands will be constructed at differing heights. The two smaller islands have top elevations that, at higher water levels, will become submerged to create additional spawning habitat. The two islands were designed with either 1:4 or 1:10 spawning side slope grades. The larger island was designed to provide an upland island habitat with 1:4 spawning side slope grades.

- The south bank of the Seiche Wetland, above the base flow channel, also has a spawning shelf with a very mild 1:20 side slope.

- At its southeastern extent, the base flow channel ends, poised to accept surface water drainage from the wetlands on the southern portion of the property. Additionally, diverted storm water from the S. Marina storm sewer system enters the headwater of the Seiche Wetland at this location. The storm water diversion includes a bio-swale feature to treat the water prior to its introduction into the wetland.

- Allis Pond lies to the east of the Seiche Wetland. The Pond was kept as an isolated feature to create a separate habitat for amphibians. As a conceptual design, a sand berm/dune feature has been placed between the Seiche Wetland and Allis Pond to provide a topographic divide between the two features and to provide additional amphibian habitat.

5.2 Future Design Considerations

This phase of the restoration process was completed to the point of a feasibility concept plan. There are a number of future design considerations that were discussed by the Design Team, but not fully developed during this phase of the work. These include the following topics.

For work along the South Channel, there are two areas for future design consideration; a possible expanded work zone along the north bank, westward to the sheet pile sea wall along the Kinnickinnic River, and the south bank of the South Channel. It is anticipated that the restored slope along the westward extension of the north bank will be limited by the boundary of the Northern Lease Area. This will probably require that the restored slope in this area will be different (i.e. steeper) than the slope within the design zone. Restoration activities associated with the south bank, including removing the remnants of the railroad bridge foundation pilings, may require coordination with the adjacent property owner. The final design should take into consideration both the restoration of the westward extension of the north bank and the south bank.

The design of a replacement culvert structure associated with the Lease Access Road. The Master Plan conceptual design of the structure envisions a three sided box culvert with a naturalize stream bed that is conducive to fish passage. A geotechnical soil boring and a preliminary foundation design for the culvert/bridge structure has been completed under a separate cover. The Access Road and culvert invert elevation will have to be adjusted to the final channel bottom elevation. This information should be incorporated into the final design for the Lease Access Road and the replacement of the culvert structure.

Concerning utility conflicts, consideration should be given for possible construction conflicts associated with the historically noted water service and sanitary sewer lateral within the South Channel work zone and the gas main located within the Lease Area Access Road.

The incorporation of storm water from the S. Marina Drive storm water system as a water source for the Seiche Wetland will require final hydraulic design. Additionally, consideration for incorporating additional storm water flows from outside the current design zone (e.g. site grading to incorporate surface flows from the wetland areas on the southern portion of the property and the impacts of the surface flows on Allis Pond water quality) should be considered in the final design.

Public access features that directly interface/connect to the South Channel and Seiche Wetland (i.e. a canoe launch). It is anticipated that additional public outreach, with feedback from the AOC Tech Team and other project stakeholders, will be conducted prior to decisions being made concerning public access features being incorporated into the final design.

Historic environmental impacts to soil and groundwater within the project area. Environmental investigation activities (e.g. NR 700 soil and groundwater and NR 347 sediment work) and regulatory discussions with the WDNR Bureau of Remediation and Redevelopment staff have been occurring concurrent with, but under a separate cover from, the engineering design work. The outcome of these investigations and discussions will have a direct impact on the final engineering design of the project. Future design efforts should be cognizant of these activities.

The final design is expected to include a complete ecological design for the restoration of the wetland.

Finally, possible phasing of construction should be considered if future budget considerations limit the funding available for the project.

5.3 Land Division and Wetland Protection Considerations

The former Grand Trunk property contains two parcels (i.e. 1980 S. Marina Drive and 632 E. Bay Street). The northern portion of the property, which includes a majority of the 632 E. Bay Street parcel, is also under a long term lease agreement. Additionally, the WDNR has identified two open Bureau of Remediation and Redevelopment Tracking System (BRRTS) numbers that relate to the environmental impacts on the property (i.e. BRRTS No. 0241530072 Port of Milwaukee Grand Trunk South Parcels and BRRTS No. 02415661744 Port of Milwaukee North).

The proposed footprint for the wetland restoration work bisects the 1980 S. Marina Drive and 632 E. Bay Street parcel boundaries, overlaps the WDNR BRRTS areas, and interfaces with the Northern Lease Area boundary. How the property is ultimately subdivided to facilitate the wetland project will have a significant impact on the final design and project costs. This is especially true for how the WDNR may regulate the historic environmental impacts and how regulatory site closure could be attained.

One way to separate the environmental impacts and manage the parcel boundary issues more effectively is to separate the proposed wetland project from the rest of the Grand Trunk areas by creating a separate parcel. This could be done through a land division such as the creation of a Certified Survey Map (CSM). One vision for the CSM would be to create a Northern Leased Area parcel, a restored wetland parcel, and a southern upland parcel. This approach would bring clarity to the project by facilitating lease agreements, environmental regulatory review and closure, and simplify future development planning.

Another consideration for the owner is to create a conservation easement around the wetland area. Conservation easements are voluntary and permanent legal agreements that restrict some land uses in order to protect important natural areas or features.

6. Engineer’s Opinion of Probable Cost

The engineer's opinion of probable construction cost is based on the engineer's experience and judgement. The engineer cannot control the cost of labor, materials, equipment, and services provided by others or the means and methods of construction. Actual costs will only be determined upon receipt of construction bids for the work.

6.1 Project Scope

The scope of work associated with the engineer’s opinion of probable construction cost is as follows:

- The project work identified as the South Channel and Seiche Wetland restoration, as defined below:
    - The eastern portion of the South Channel, starting approximately 50 east of the eastern most Skipper Buds boat slip.
    - The eastern portion of the north bank of the South Channel.
    - The Seiche Wetland area.
    - The sand pile/dune buffer feature north of the Seiche Wetland, as it currently exits.
    - Allis Pond, as it currently exists.
    - A storm water feature associated with the S. Marina Drive storm water system.

The following project scope items have not been included in the engineer’s estimate of probable costs:

- Final engineering or ecological design services, permits, construction specifications and bidding, and construction management costs.
- Construction costs associated with the Lease Area Access Road and its associated culvert/bridge structure (e.g. the foundation, structure, and roadway).
- Restoration of the western portion of the north bank and the south bank of the South Channel.
- Construction of buffer features in-so-far as they currently don’t exist.

- Possible dredging of Allis Pond and the construction of a topographical separation from the Seiche Wetland.
- Incorporation of off-site storm water features, except the S. Marina Drive storm water system.
- Restoration of ecological systems.

6.2 Cost Assumptions

By necessity of the process, the engineer must make a number of assumptions to compile an opinion of the estimated construction cost. The following assumptions are generally associated with the means and methods of construction.

- All quantities and volumes of materials are estimates. Final quantities will be determined during the plans and specifications phase of the project.
- Wood chips created during clearing and grubbing operations can stay on-site for future use.
- Soil and groundwater environmental impacts within the project area may be mitigated through the use of an engineered soil barrier (i.e. a cap). The need for a cap, the required thickness of a possible cap, and the composition of a cap (e.g. clay, sand, or soil) is currently under assessment and may change after regulatory review.
- The preliminary design for the engineered soil barrier to be installed over impacted native and fill soils includes a 2-foot cap. The lower 1-foot would be a clay layer and the upper 1-foot would be a soil sand mixture layer.
- Dredging of sediments within the South Channel only encompasses the area below the OHWM, including the 2-foot off-set for the engineered barrier installation. Soils behind and above the OHWM will be excavated, including the 2-foot off-set for the engineered barrier installation.
- Excavation for the Seiche Wetland assumes removal of fill and native soils to the extent of the feature. This includes the 2-foot off-set for installation of the engineered barrier and the island features. The island features will be re-installed over the engineered barrier using on-site soils present in the Marquette Interchange fill pile. The lack of environmental impacts to the Marquette fill soils must be confirmed before finalizing its use.
- Dredging and excavation activities will be conducted in-the-dry. Dewatering within the South Channel can be accomplished in a two-step manner; 1) surface water to one foot of depth above sediments can be pumped directly to the Kinnickinnic River without treatment; 2) dewatering within one foot of sediments only require treatment for total suspended solids (TSS) and the treated water can be disposed of, under permit, to the local sanitary sewer. Dewatering for the Seiche Wetland excavation only requires treatment for TSS and the treated water can also be disposed of, under permit, to the local sanitary sewer.
- During construction, storm water from the S. Marina Drive system can be by-passed pumped to the Kinnickinnic River without treatment.
- Excavated sediment can be disposed of at the Jones Island Combined Disposal Facility (CDF) at no cost to the project. Due to the short distance (i.e. 1.2 miles one way), transportation of sediment to the CDF will be by truck.
- Excavated fill and native soils can be disposed of at a local Sub-Title D landfill as direct disposal into the landfill.

6.3 Estimated Probable Cost

The Project Design Team requested a cost opinion for enlarging the wetland footprint to the physical limitations of the property. This cost estimate is reflective of the fact that the management of contaminated or unsuitable soils will be the most significant cost associated with this project. The following cost opinion focuses on soil management and is considered a conservative estimate. The opinion does not include the cost for landscape restoration, nor does it include the cost for annual maintenance. This information is intended to be used as guidance for the Project Design Team and will assist them with determining the scale of the project and the level of fundraising that will be required to implement it.

The engineer's opinion of probable cost for the construction of the Grand Trunk-Bay View Wetland Restoration, as presented in the report, is $ 4,492,290 in 2017 dollars. This cost assumes that excavated fill and native soils are disposed of at a Sub-title D landfill by direct landfilling. The estimate includes a 10% construction contingency.

A savings of approximately 30% to the project cost can be realized if the landfills accept the excavated fill and native soils for use as daily cover instead of disposal by direct landfilling.

A worksheet detailing the Engineer's Opinion of Probable Construction Cost is included in Appendix E.

7. Literature Review

A review of available reports and data was conducted, to identify relevant information for the study, as summarized below.

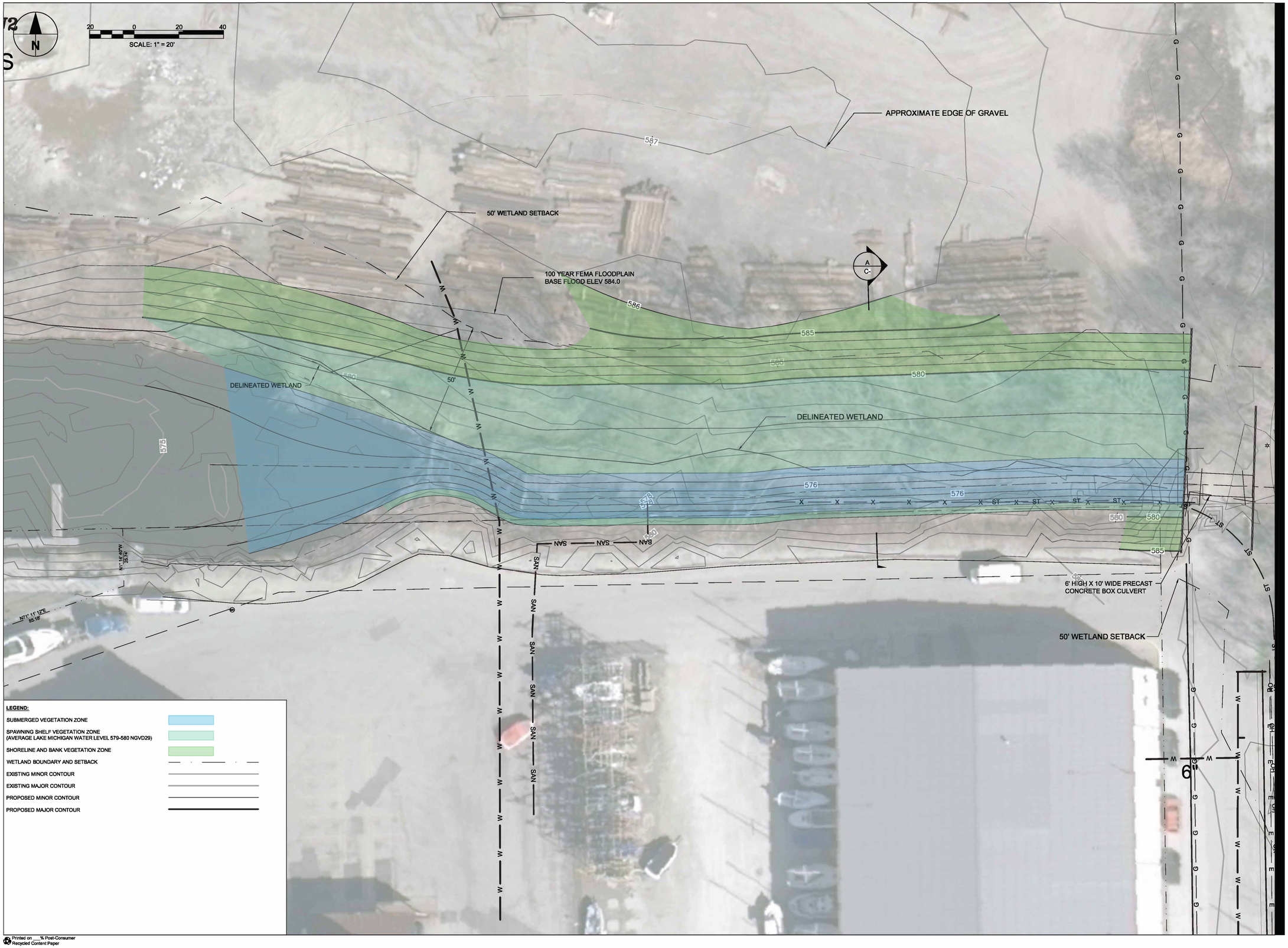
- Applied Ecological Services, 2014, The Bay View Wetland Milwaukee Master Plan.
- Gary S. Casper, UWM, 2016, Example Species for Local Conservation Interest Analysis for Bayview Wetland.
- WDNR, Northern Pike and Buffers-a Close Relationship.
- Peter A. Cott, Fisheries and Oceans Canada , 2004. Northern Habitat Enhancement in the Northwest Territories.
- Clark, C.F. 1950. Observations on the spawning habits of the northern pike, Esox Lucius, in northwestern Ohio. Copeia, 1950(4): 258-288.
- Fish and Wildlife Services, July 1982, Habitat Suitability Index Models: Northern Pike.
- WDNR, July 2008, Northern Pike.
- Frost WE, Kipling C., 1967. A study of reproduction, early life, weight-length relationship and growth in pike (Esox lucius L.) in Windermere. Journal of Animal Ecology. 36:651–693.
- Minns CK, Randall RG, Moore JE, Cairns VW. A model simulating the impact of habitat supply limits on northern pike (Esox lucius).
- Schindler, Otto 1946. Concerning the development, habits and the culture of the pike. Allgemeine Fischereizeit, 71(7/8): 13-16; (9/10): 1-6.
- Southeastern Wisconsin Regional Planning Commission, Relationship at Milwaukee, Wisconsin Between Selected Vertical Survey Control Datum Surfaces.
- K. Singh and Associates, April 2015. Environmental Site Assessment Kinnickinnic River Channel Rehabilitation Project.

- HNTB, October 2014. Kinnickinnic River Flushing Station Improvements Feasibility Study.
- Tetra Tech, December, 2010. Kinnickinnic River Sediment Transport Study.
- WDNR, December 2010. Remedial Action Plan Update for the Milwaukee Estuary Area of Concern.
- Milwaukee Harbor Water Level Gauge, https://tidesandcurrents.noaa.gov/waterlevels.html?id=9087057
- USACE Detroit, 1993. Design Water Level Determination on the Great Lakes.
- City of Milwaukee Storm Sewer Atlas Maps, 1963-2011.

These documents provided information about ecological inventory, Kinnickinnic River hydraulics, sedimentation, water quality, soils and environmental data, fish spawning and habitat design, storm sewer data, and Lake Michigan water levels that was taken into consideration for the engineered design.

Appendix A

25% Milestone Design Drawings



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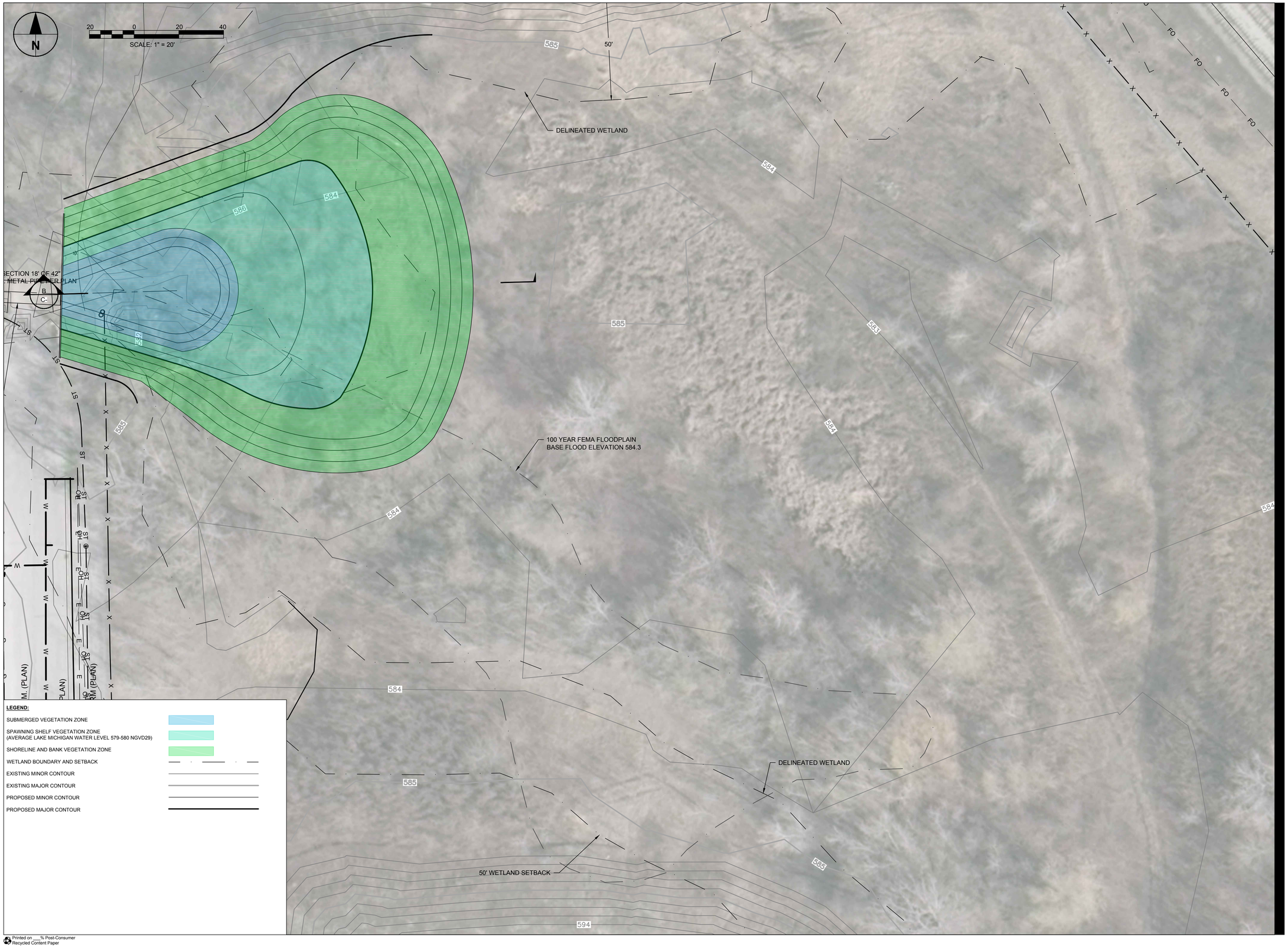

LEGEND:

- SUBMERGED VEGETATION ZONE
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- SHORELINE AND BANK VEGETATION ZONE
- WETLAND BOUNDARY AND SETBACK
- EXISTING MINOR CONTOUR
- EXISTING MAJOR CONTOUR
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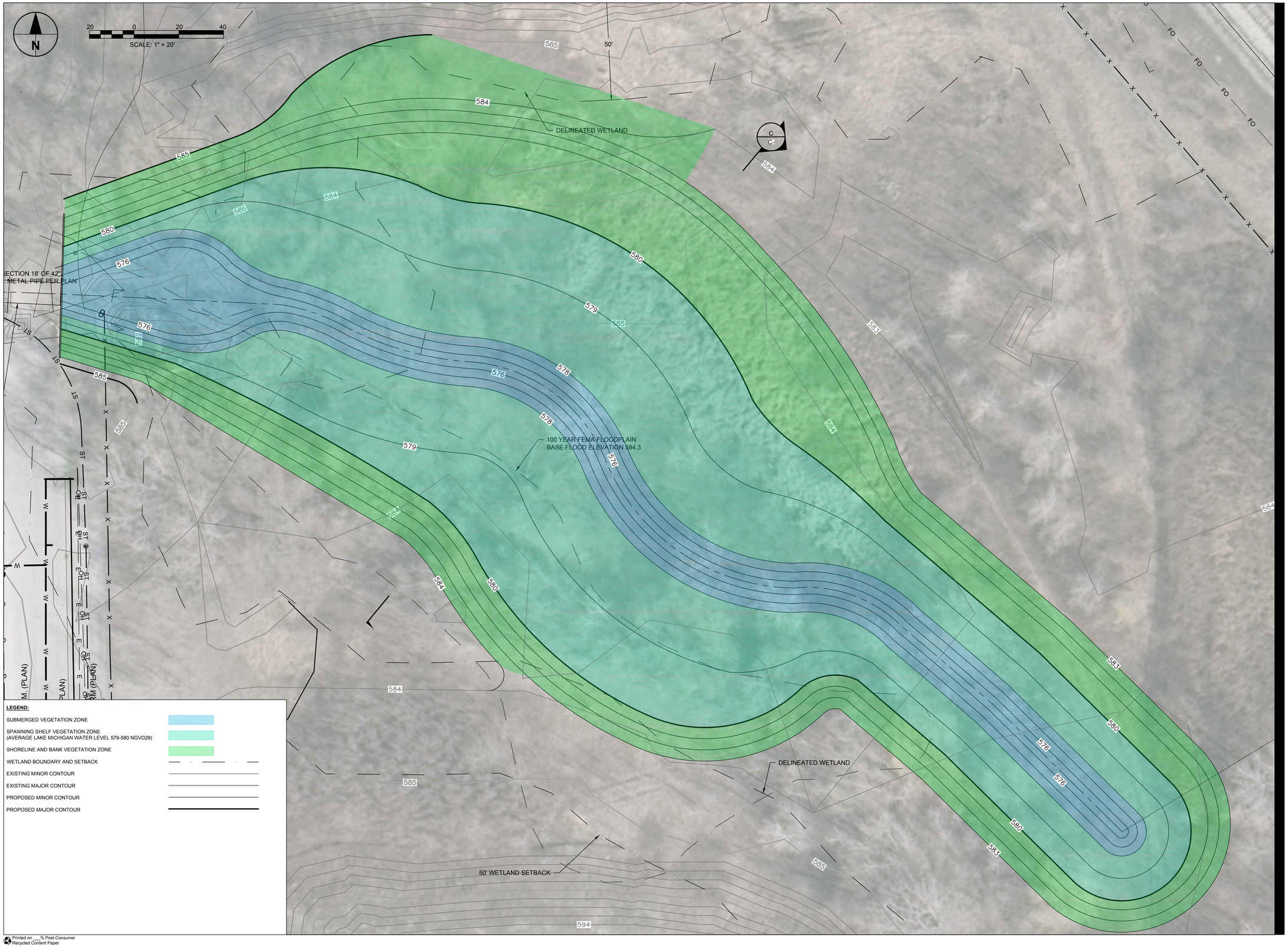

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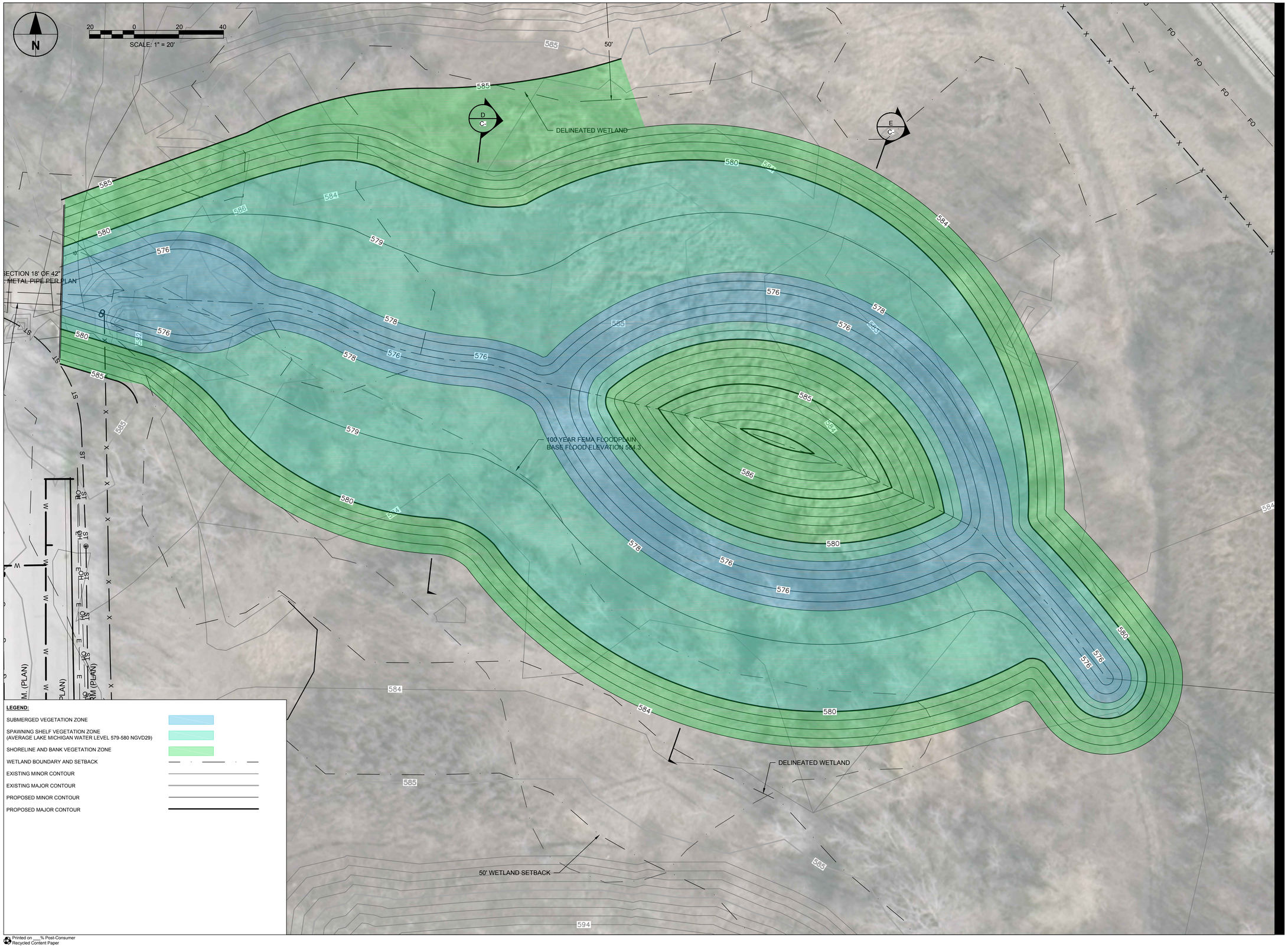

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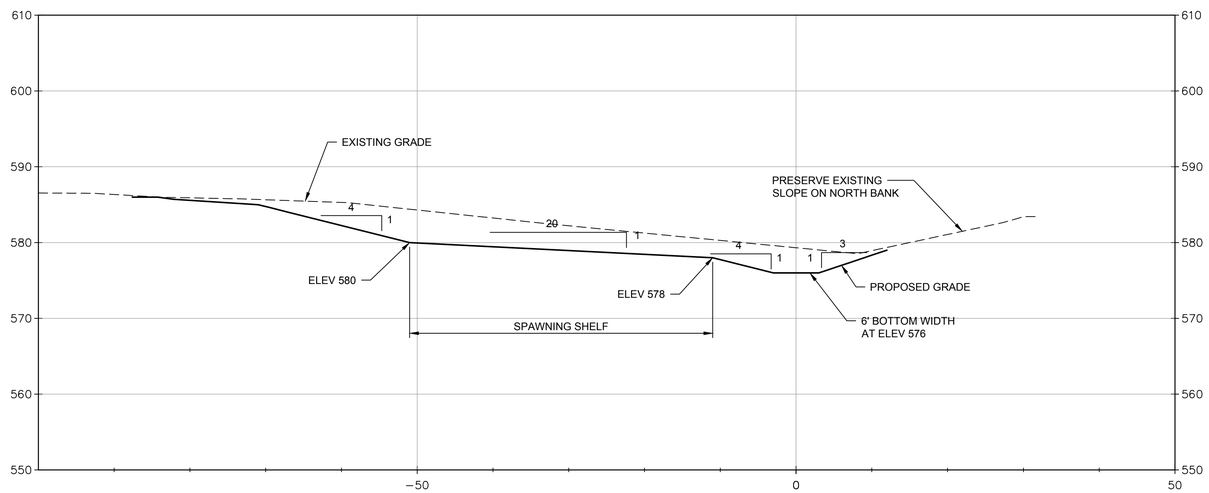

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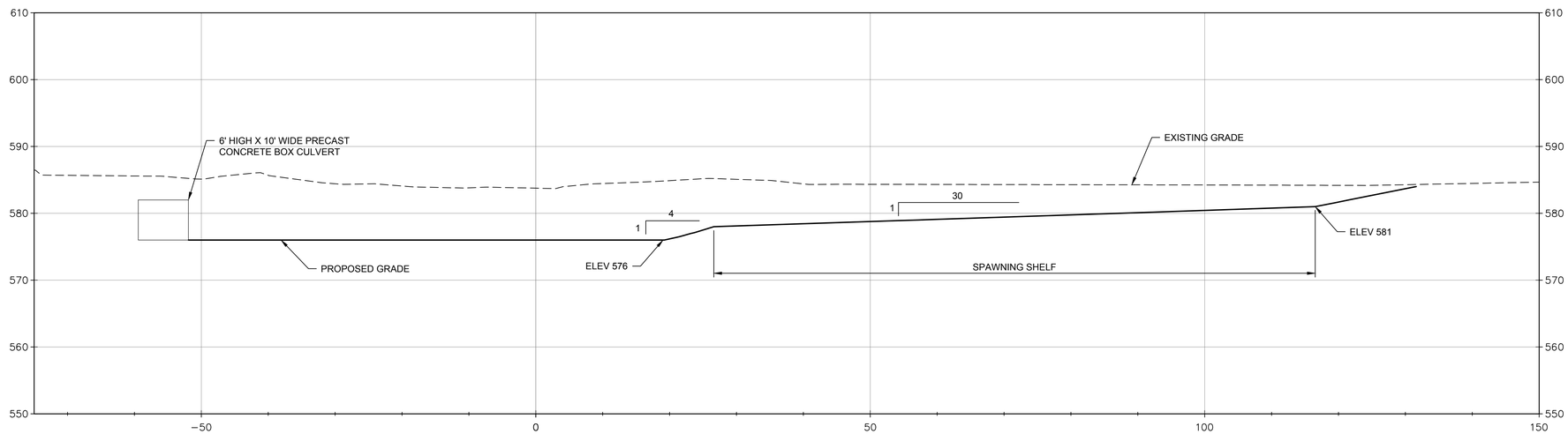

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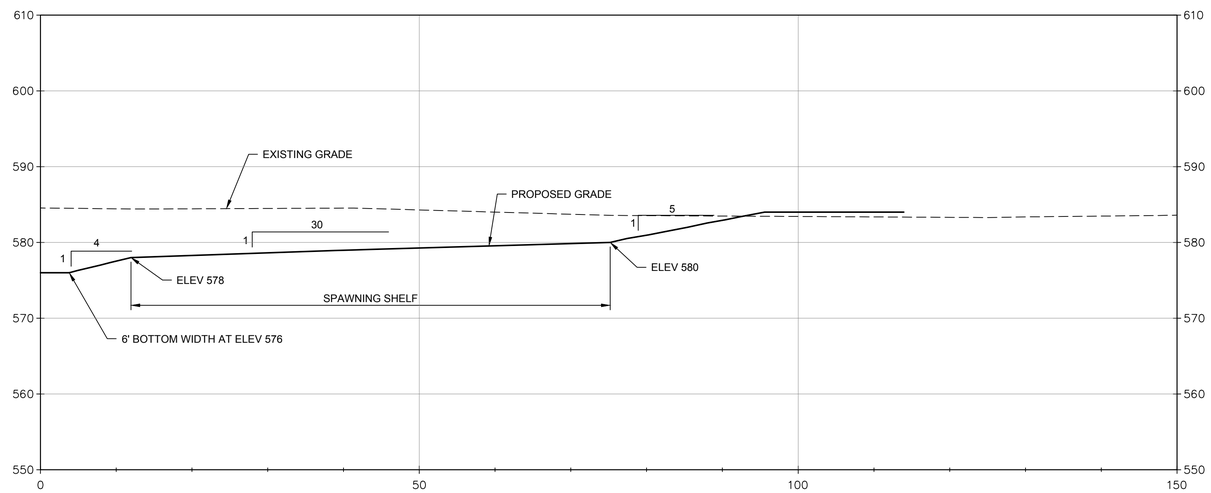

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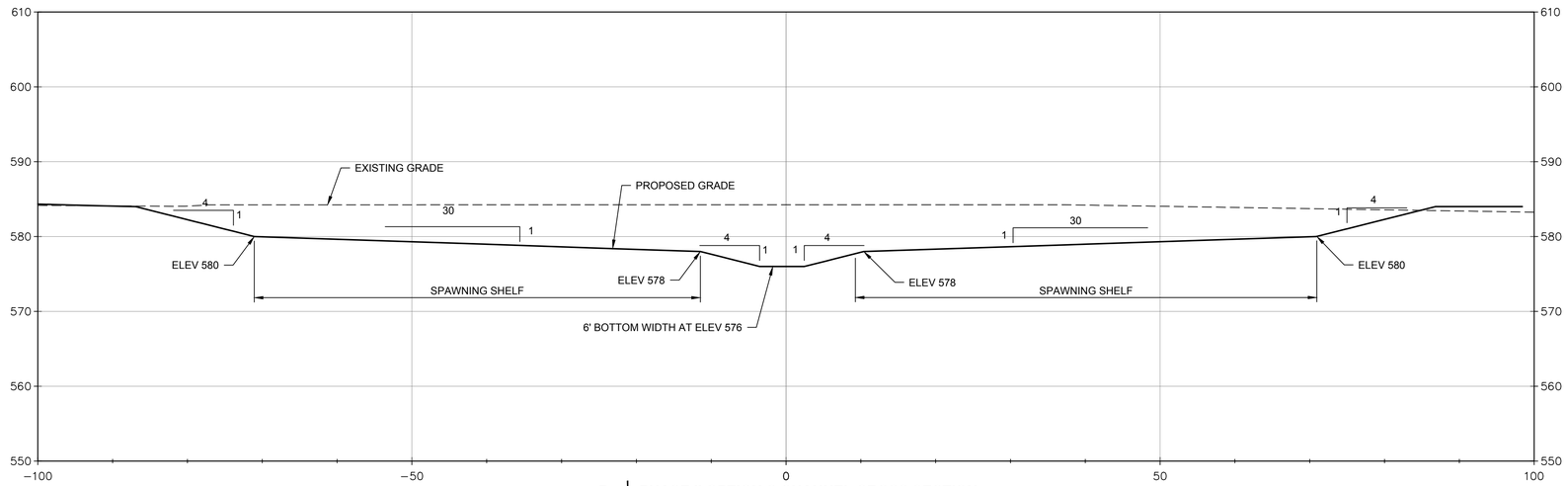

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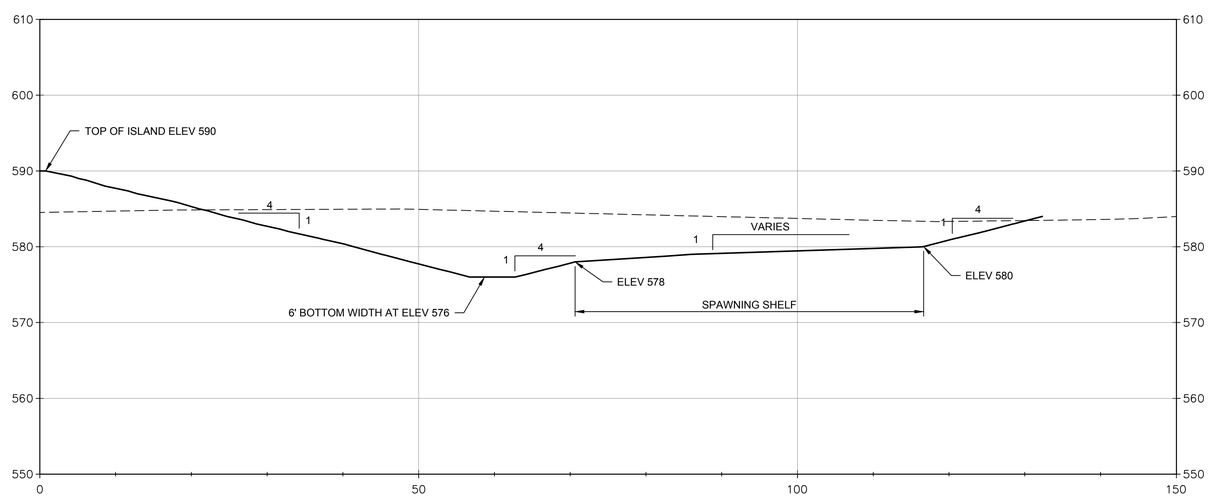

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Appendix B

40% Milestone Meeting Handouts

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- SPAWNING SHELF VEGETATION ZONE (AVERAGE LAKE MICHIGAN WATER LEVEL 579-580 NGVD29)
- WETLAND BOUNDARY AND SETBACK
- FEMA FLOODWAY BOUNDARY
- EXISTING MINOR CONTOUR
- EXISTING MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED MAJOR CONTOUR

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REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
2	2016-09-20	FOR 40% MEETING
1	2016-06-08	FOR 25% MEETING

KEY PLAN

PROJECT NUMBER

60490610

SHEET TITLE

ALTERNATIVE 1 PLAN -- WEST CHANNEL UNIFORM SIDE SLOPE

DRAWING NUMBER

C-01

Grand Trunk Wetland – South Channel Fish Spawning and Bank Improvements Planting List
Revised September 13, 2016

Aquatic/Submerged– plant 576.5 to 579.5
Transition - plant 579.5 to 583.0
Upper Bank/Buffer - plant 583 to top of bank (approx. 585.0)

Species	Common Name	Associate Planting Species	Notes	Spawning Shelf	Lower Shoreline	Bank/ Buffer
Aster laevis	smooth blue aster	Include in bank/buffer mix				X
A. lanceolatus	aster simplex	Include in bank/buffer mix				X
A. novae-angliae	New England aster	Include in bank/buffer mix	Good soil stabilizer			X
Bidens cernua	nodding beggarstick	Include in shoreline and bank/buffer mix			X	X
B. frondosa	common beggarsticks	Include in shoreline and bank/buffer mix			X	X
Carex species	The following Carex species should be considered, with final choice dependent upon availability					
Carex bebbi	Bebb's sedge	Include in shoreline mix	Forms clumps/tufts		X	
Carex comosa	bristly sedge	Include in shoreline mix	Dense growth makes good shoreline stabilizer		X	
C. hystericina	bottlebrush sedge	Include in shoreline and bank/buffer mix	Good soil stabilizer because of bunching characteristics		X	X
C. lacustris	lake sedge	Include in shoreline and bank/buffer mix	Spreads strongly by rhizomes, good soil stabilizer		X	X
C. stipata	awl-fruited sedge	Include in shoreline and bank/buffer mix	Bunching character provides soil stabilization		X	X
C. vulpinoidea	fox sedge	Include in shoreline and bank/buffer mix	Good streambank stabilizer, forms clumps		X	X
Eleocharis obtusa	blunt spike rush	Include in shoreline and bank/buffer mix	Spreads by rhizomes, good for erosion control		X	X
E. smallii	creeping spike rush	Include in shoreline and bank/buffer mix	Spreads by rhizomes, good for erosion control		X	X
Elymus canadensis	nodding wild rye	Include in bank/buffer mix				X

E. virginicus	Virginia wild rye	Include in bank/buffer mix				X
Juncus effusus	common rush	Include in shoreline mix	Soil stabilizer, forms clumps		X	
J. torreyi	Torrey's rush	Include in shoreline mix	Rhizomatous root system that stabilizes soil well		X	
Panicum virgatum	switch grass	Include in bank/buffer mix	Clump forming, erosion control, excellent soil stabilizer			X
Pontederia cordata	pickereleweed	plant alone on one spawning shelf only	Can become aggressive	X		
Ratibida pinnata	yellow cone flower	Include in bank/buffer mix	Extensive fibrous root systems used to stabilize soil on slopes			X
Rudbeckia hirta	black-eyed Susan	Include in bank/buffer mix	Extensive fibrous root systems used to stabilize soil on slopes			X
Sagittaria latifolia	broadleaf arrowhead	Plant with *Scirpus fluviatilis* and *Sparganium eurycarpum* on one spawning shelf only	Withstands waves Can become aggressive	X		
Scirpus acutus	hardstem bulrush	Plant with *S. validus* and *S. atrovirens* on one spawning shelf	Can help limit the invasive qualities of cattails Withstands waves	X	X	
S. atrovirens	green bulrush	Plant with *S. acutus* and *S. validus* on one spawning shelf	Well suited to controlling erosion at shorelines	X	X	
Scirpus fluviatillis	river bulrush	Plant with *Sagittaria latifolia* and *Sparganium eurycarpum* on one spawning shelf only	Good erosion control at water's edge Can become aggressive	X	X	
Scirpus validus	soft-stem bulrush	Plant with *S. acutus* and *S. atrovirens* on one spawning	Good soil stabilizer, withstands waves	X		

		shelf				
Solidago rigida	stiff goldenrod	Include in bank/buffer mix				X
Sparganium eurycarpum	common bulreed	Plant with *Sagittaria latifolia* and *Scirpus fluviatilis* on one spawning shelf only	Often outcompetes cattails Withstands waves Can become aggressive	X		

LEGEND:

- SPAWNING SHELF VEGETATION ZONE (AVERAGE LAKE MICHIGAN WATER LEVEL 579-580 NGVD29)
- WETLAND BOUNDARY AND SETBACK
- FEMA FLOODWAY BOUNDARY
- EXISTING MINOR CONTOUR
- EXISTING MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED MAJOR CONTOUR

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PROJECT

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Grand Trunk Rail Road

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KEY PLAN

PROJECT NUMBER

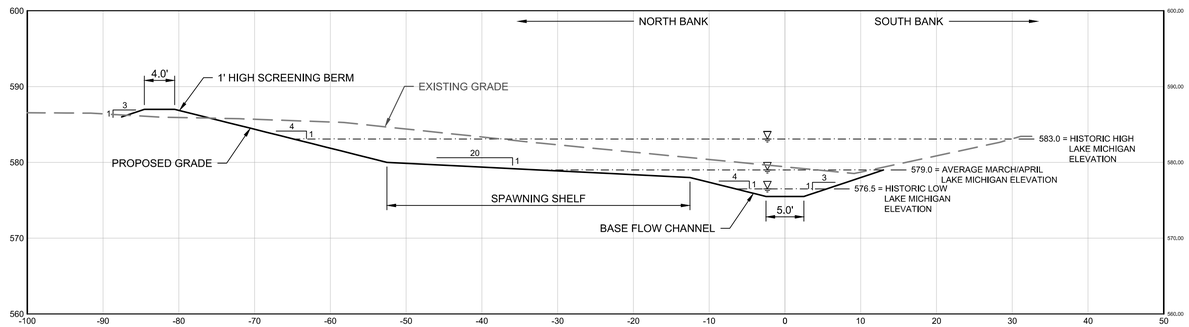
60490610

SHEET TITLE

ALTERNATIVE 2 PLAN -- WEST CHANNEL STEPPED SIDE SLOPES

DRAWING NUMBER

C-02



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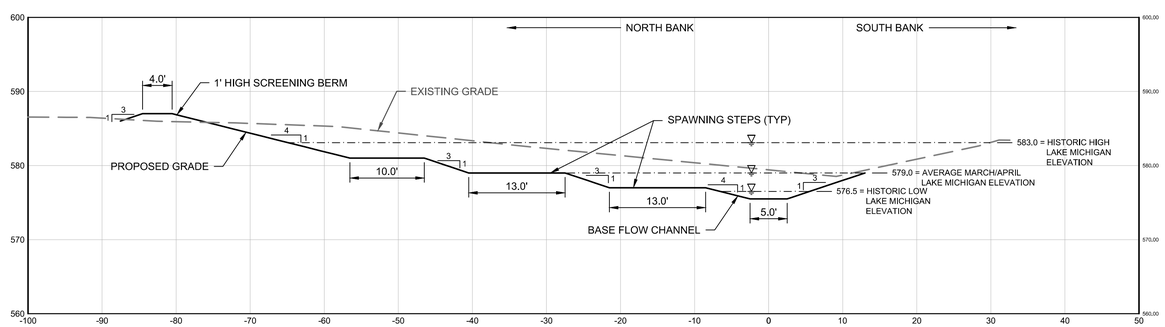
C-03 | Scale 1" = 10'



B | **ALTERNATIVE 2 CROSS SECTION**
C-03 | Scale 1" = 10'

	West Branch Spawning Area				
	Alternative 1		Alternative 2		
Water Elevation (ft)	Spawning area (ft)	Spawning Area (acres)	Spawning area (ft)	Spawning Area (acres)	Description
583.0	10.5	0.10	20.5	0.19	Record High Water
582.5	10.5	0.10	21.5	0.20	
582.0	10.5	0.10	19.5	0.18	
581.5	18.5	0.17	9	0.08	
581.0	26.5	0.24	9	0.08	
580.5	34.5	0.32	22	0.20	
580.0	34.5	0.32	22	0.20	
579.5	26.5	0.24	9	0.08	
579.0	18.5	0.17	9	0.08	Average Water
578.5	10.5	0.10	22.5	0.21	
578.0	10.5	0.10	23	0.21	
577.5	15.5	0.14	15.5	0.14	
577.0	12	0.11	12	0.11	
576.5	8.5	0.08	8.5	0.08	Record Low Water

Note: Spawning Area in Acres is calculated for a representative 400' length for the typical section.

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SHEET TITLE

ALTERNATIVE 1 AND 2 CROSS SECTIONS

DRAWING NUMBER C-03 **SHEET NUMBER** OF

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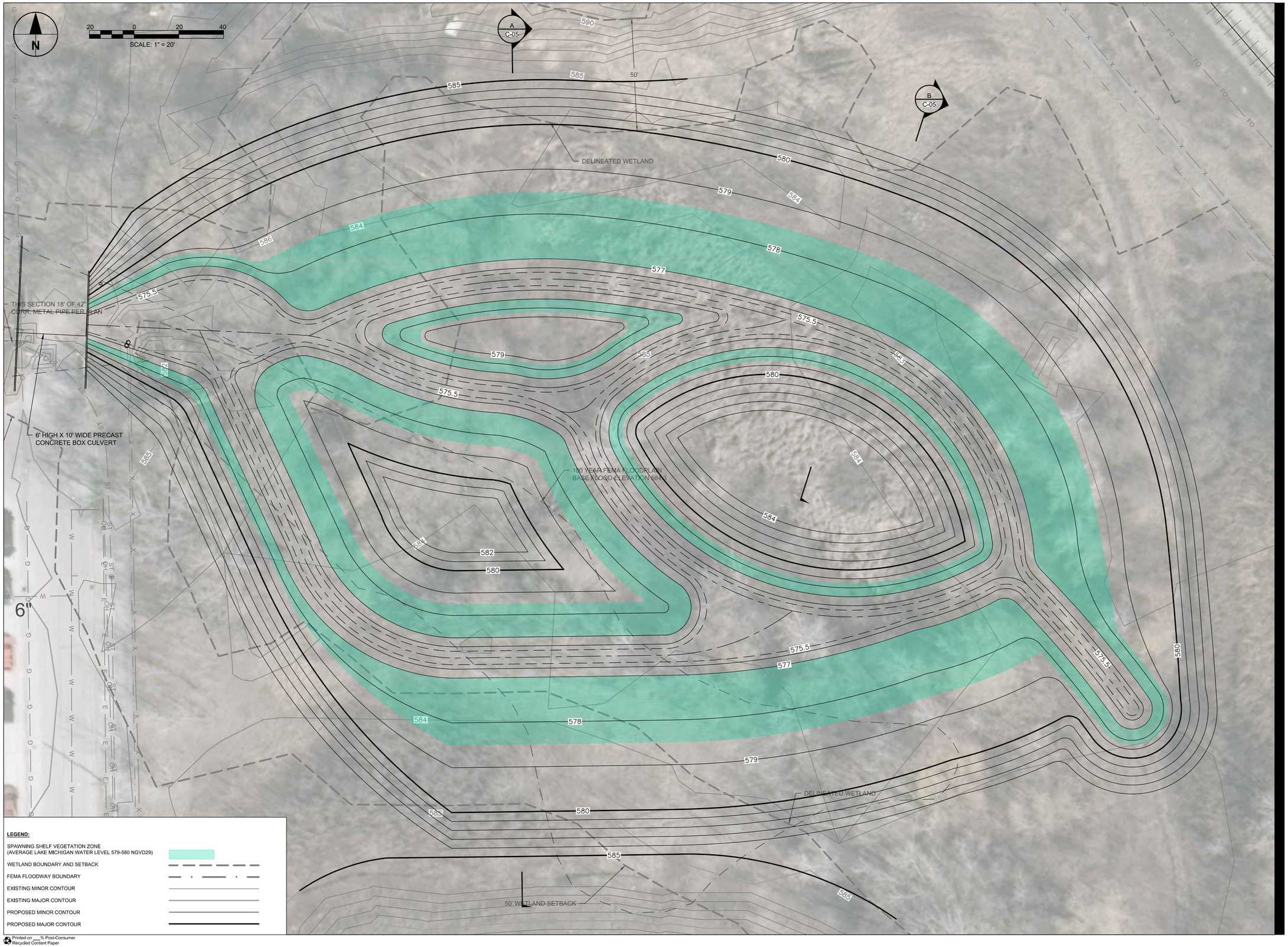

LEGEND:

SPAWNING SHELF VEGETATION ZONE (AVERAGE LAKE MICHIGAN WATER LEVEL 579-580 NGVD29)	
WETLAND BOUNDARY AND SETBACK	
FEMA FLOODWAY BOUNDARY	
EXISTING MINOR CONTOUR	
EXISTING MAJOR CONTOUR	
PROPOSED MINOR CONTOUR	
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PROJECT NUMBER

60490610

SHEET TITLE

ALTERNATIVE 3 PLAN -- EAST CHANNEL UNIFORM SIDE SLOPES

DRAWING NUMBER

C-04

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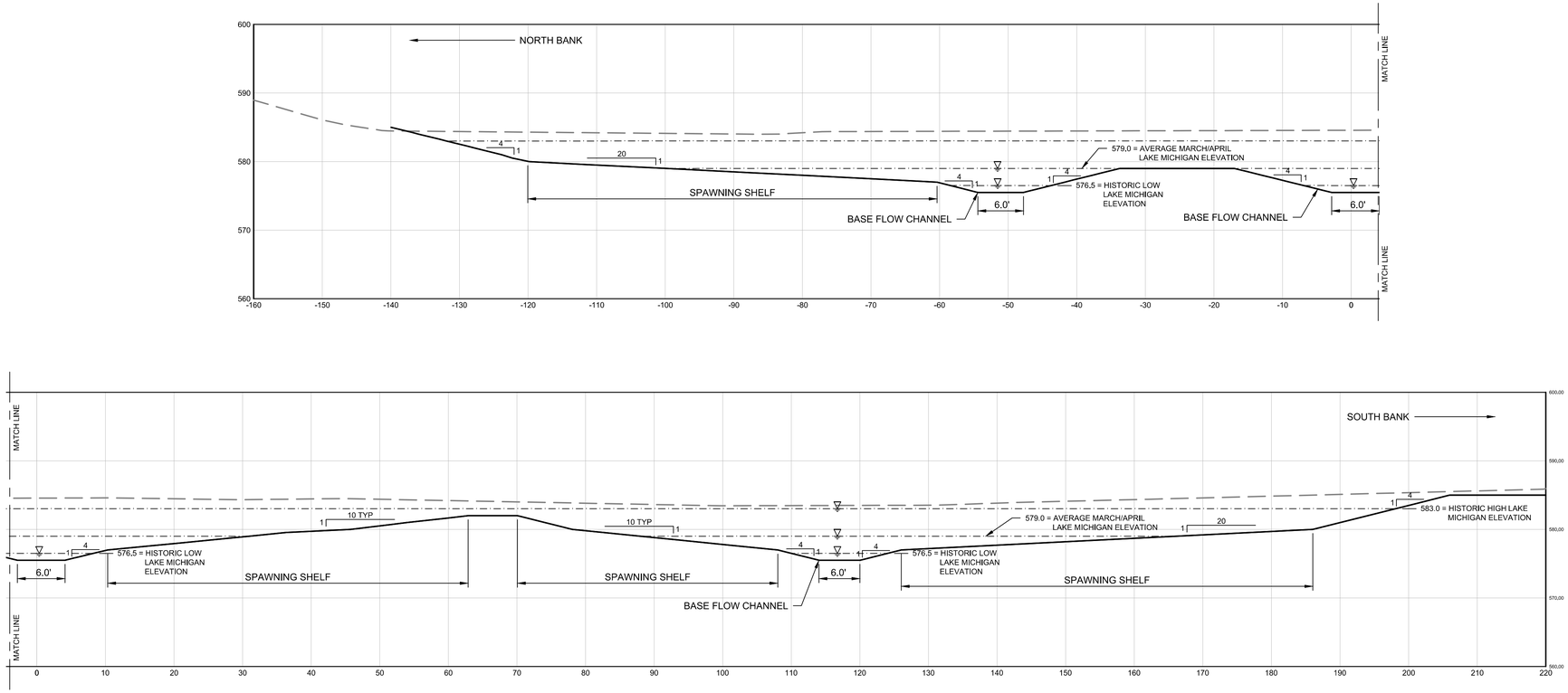

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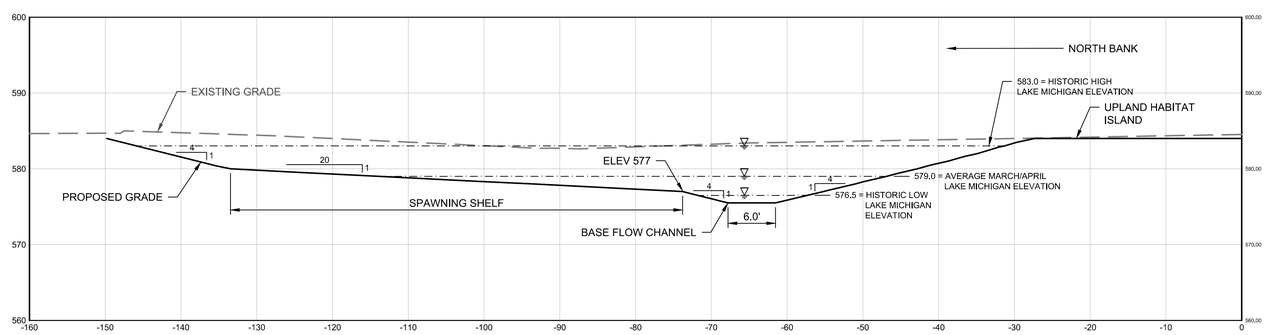

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SHEET TITLE

ALTERNATIVE 3 CROSS SECTIONS

DRAWING NUMBER

C-05

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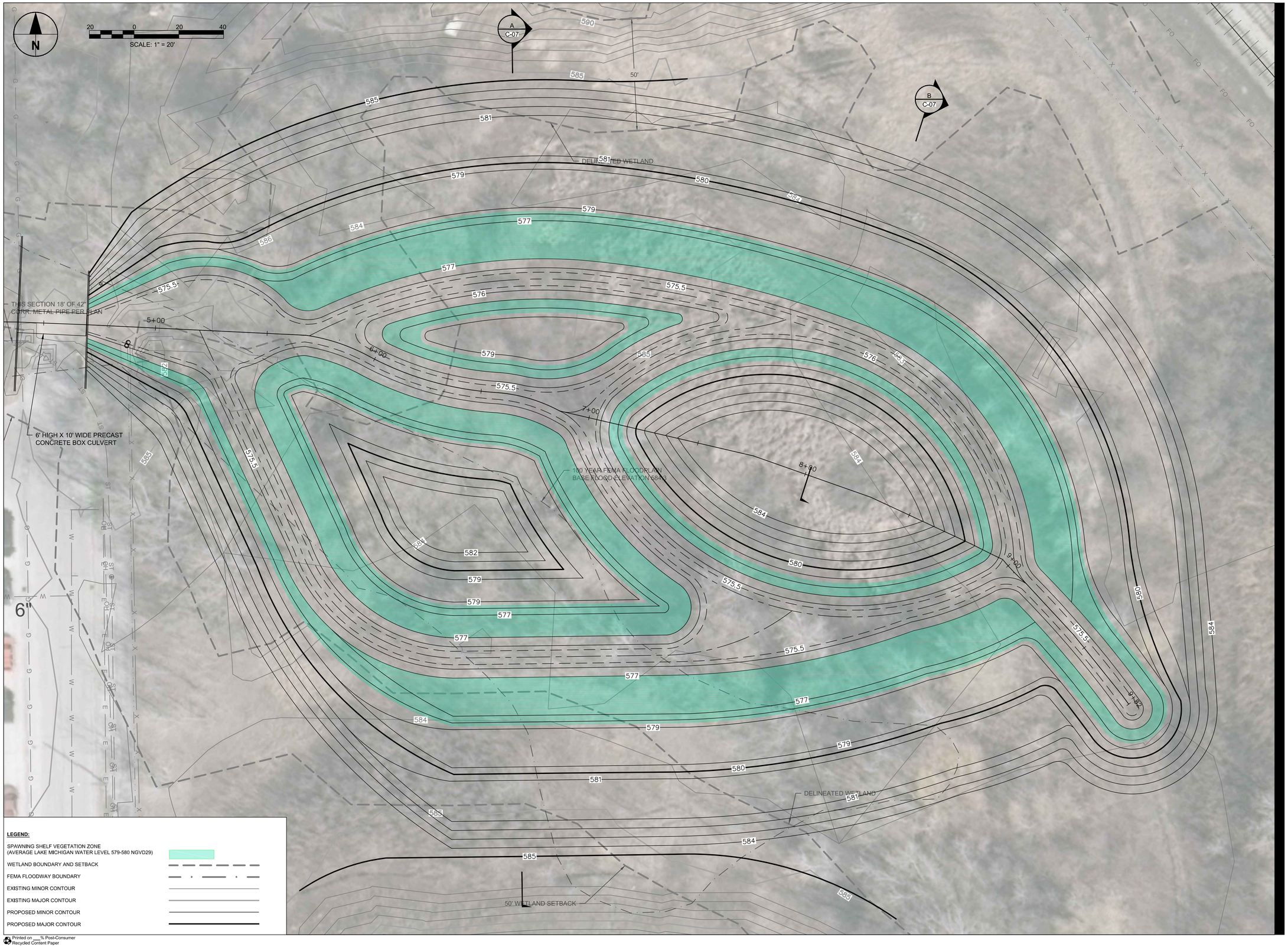

LEGEND:

SPAWNING SHELF VEGETATION ZONE (AVERAGE LAKE MICHIGAN WATER LEVEL 579-580 NGVD29)	
WETLAND BOUNDARY AND SETBACK	
FEMA FLOODWAY BOUNDARY	
EXISTING MINOR CONTOUR	
EXISTING MAJOR CONTOUR	
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SHEET TITLE

ALTERNATIVE 4 PLAN -- EAST CHANNEL STEPPED SIDE SLOPES

DRAWING NUMBER

C-06

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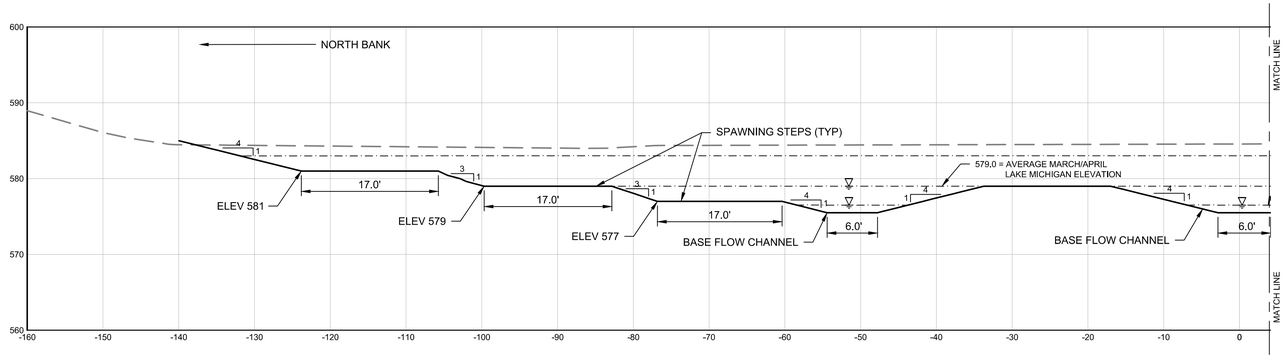

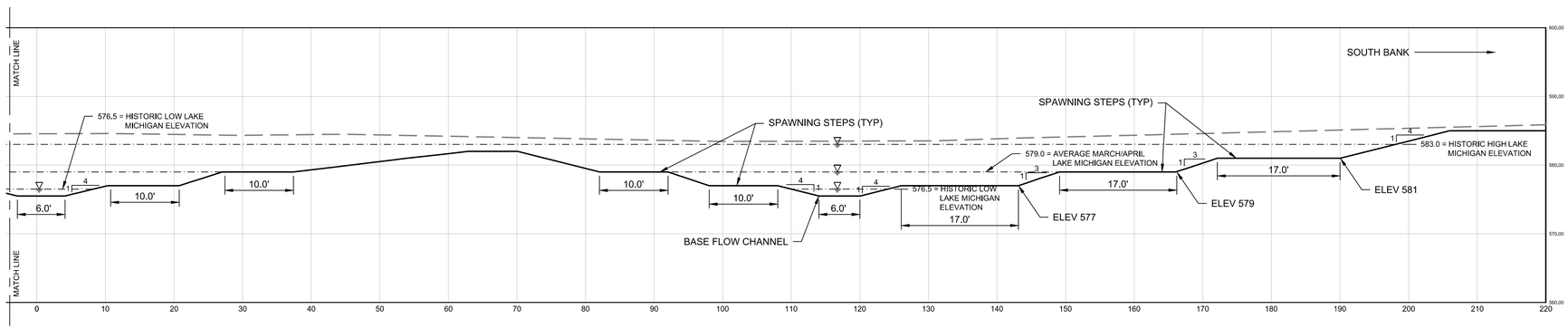

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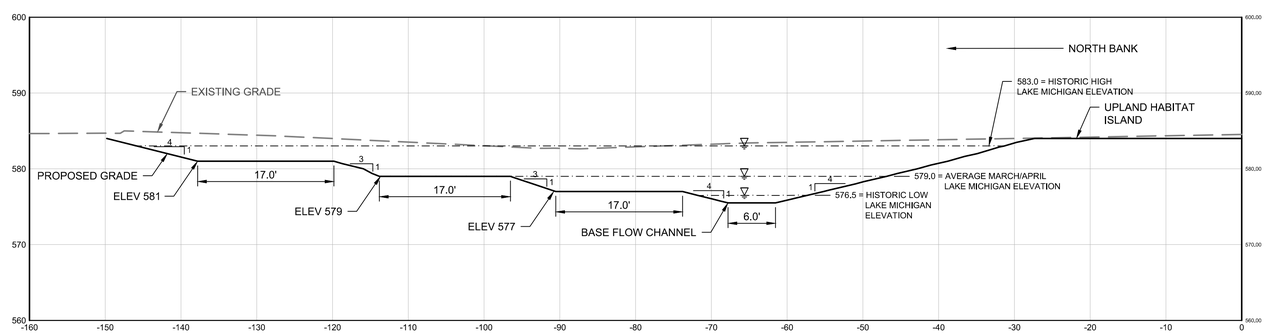

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SHEET TITLE

ALTERNATIVE 4 CROSS SECTIONS

DRAWING NUMBER

C-07

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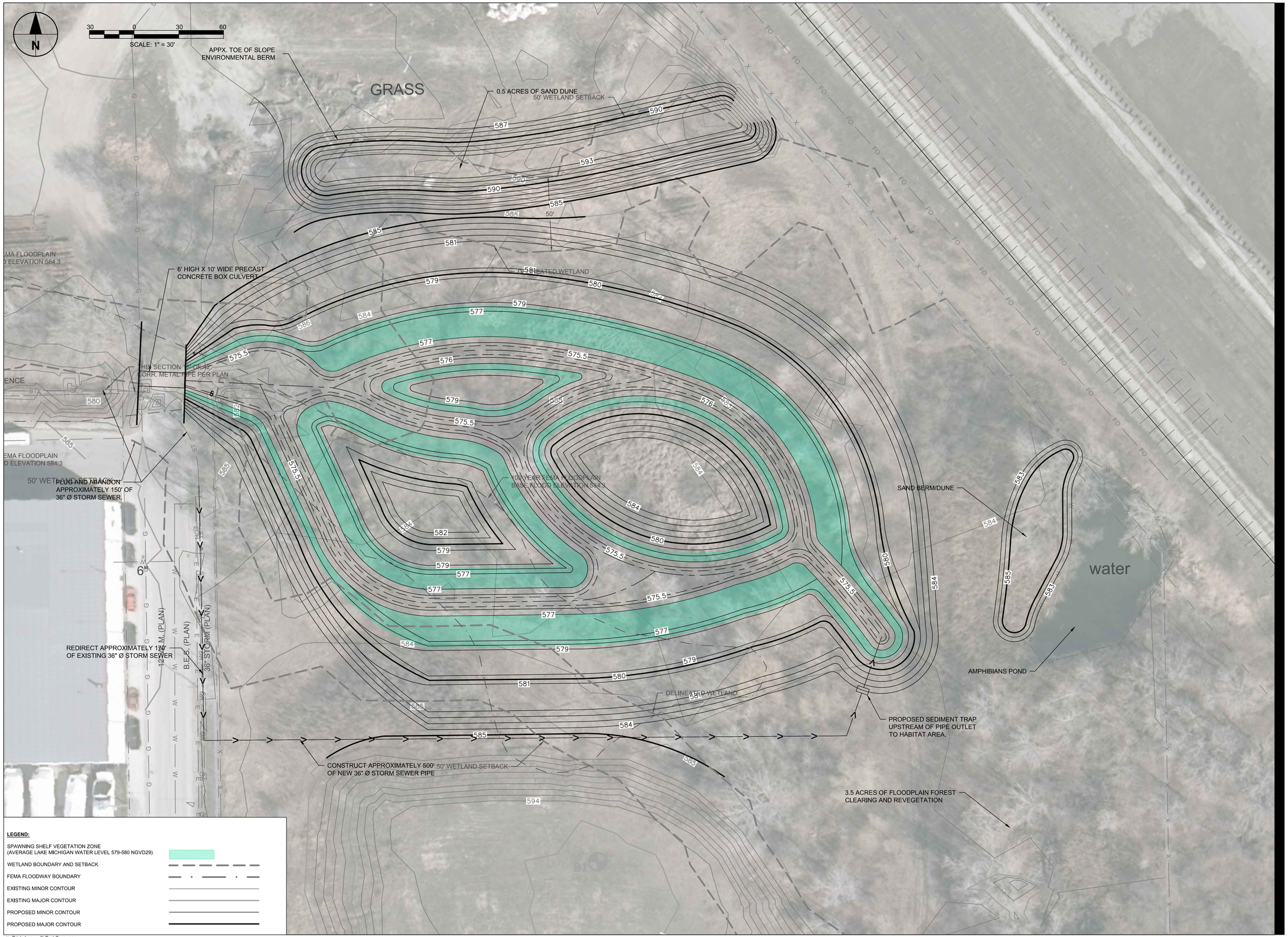

LEGEND:

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FEMA FLOODWAY BOUNDARY	
EXISTING MINOR CONTOUR	
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PROJECT NUMBER

60490610

SHEET TITLE

ALTERNATIVE 5 PLAN -- UPLAND IMPROVEMENT & STORMWATER MANAGEMENT

DRAWING NUMBER

C-08

Appendix C

60% Milestone meeting Handouts

AECOM
303 E. Wacker Suite 1300
Chicago, Illinois 60601
www.aecom.com

312.373.7700 tel
312.373.6800 fax

Memorandum

To: File

From: Dan Veriotti, PE
Date: August 24, 2016

RE: Bay View Wetland Restoration, River Hydrology and Water Levels

I. Overview

The site is under the backwater influence of Lake Michigan; in other words, the Kinickinnic River (KK River) water level is controlled by Lake Michigan. The KK River has a very low base flow and flashy hydrology (short response to rainfall storm events). Periodic dredging is conducted in the KK River to maintain navigable water depths due to sedimentation. Understanding the water level variations, river hydraulics and sediment transport are key components to the project restoration goals.

A detailed review of existing data and reports was performed, along with an analysis to define the design conditions (range of high and low water levels) to be adopted for the project. This memorandum summarizes the results of AECOM's review and preliminary analyses to define the project background information and the adopted water level design conditions.

There are some key limitations in our study as follows:

- There are no dredging records for the South and North Channels; based on personal communications with Skipper Buds representatives, the south channel/slip area was not dredged in the last several years;
- There is no information regarding measured river discharge velocities in the project area; based on anecdotal (visual observations), the velocities in the project area are not significant;
- There is some uncertainty in the Vertical Datums and conversions used in the previous surveys, but this is a relatively minor issue. The Southeastern Wisconsin Regional Planning Commission (SEWRPC) published the calculated conversion as shown in Figure 1. For clarity, all Lake Michigan water levels reference the International Great Lakes Datum of 1985 (IGLD 85), while all the land-based elevations reference the National Geodetic Vertical Datum of 1929 (NGVD29) with the following conversion relationships:
    - IGLD85 LWD (Low Water Datum)=577.5 feet=0.0 feet LWD;
    - IGLD85=NGVD29 - 0.53 feet.

II. Summary of Information Provided and Reviewed

- NOAA water gauge, Station 9087057, Milwaukee, WI;
- NOAA water gauge, Station 9087044, Calumet Harbor, IL;
- The Bay View Wetland, Milwaukee - Master Plan, 2013;
- Kinnickinnic River Flushing Station Improvements Study, HNTB, 2014;
- Kinnickinnic River Sediment Transport Planning Study, Tetra Tech, 2010;
- Design Water Level Determination on the Great Lakes, USACE 1993;
- Post Remediation Assessment for the Kinnickinnic River, AECOM, 2016.

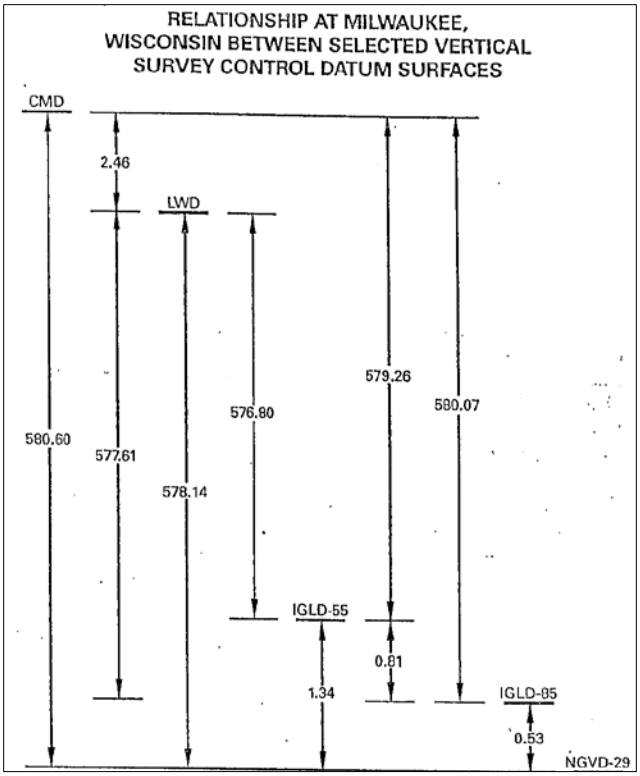

Figure 1. Milwaukee Vertical Datums Conversion

III. Kinnicknnic River and Lake Michigan Water Conditions

Kinnickinnic River

- The Kinnickinnic River water level at the project site location is controlled by the Lake Michigan water level (still water level and superimposed storm surges during significant wave events);
- The Kinnickinnic River was historically dredged for navigation access (from Lincoln Avenue to S. Kinnickinnic Avenue), with target dredging water depths of 21 feet below Lake Michigan Low Water Datum (LWD, or 577.5 feet Vertical Datum IGLD85); dredging was discontinued in the 1940's due to decreased commercial traffic;
- USACE currently maintains a navigation channel downstream of S. Kinnickinnic Avenue to the Milwaukee Harbor;
- The long-term (1944 to 2002) sedimentation ranged between eight feet (W. Becher Street to S. First Street) and 12 feet (S. First Street to S. Kinnickinnic Avenue); the deposited material was primarily fine sands and silts; on an annual basis, this translates to a range of two to five inches per year;
- The USEPA and USACE removed approximately 170,000 cubic yards of contaminated sediment in 2009 in a 0.4 mile-long stretch of the KK River between W. Becher Street and S. Kinnickinnic Avenue; the dredged area was provided with a clean cap (coarse sand and gravel);
- A bathymetric survey of the project area was performed in October 2009, following the completion of dredging; the typical average water depths in the project area at the time of the survey varied between 9 and 13 feet (river banks and bulkheads) and 20 to 24 feet (river centerline) at LWD.

The river centerline water depths were consistent with the historic range of channel maintenance dredging.

- AECOM conducted a post-dredging remediation assessment study between 2014 and 2016. A comprehensive field sampling and analysis program was conducted, and a new bathymetric survey was performed in 2015. The typical average water depths in the project area at the time of the survey varied between 7.5 and 12.5 feet LWD (river banks and bulkheads) and 17.5 to 20 feet LWD (river centerline);
- A computer volumetric difference calculation was performed, which showed a net 30,000 cubic yards of sediment accumulation in the area between S. Kinnickinnic Avenue and W. Becher Street between 2009 and 2015. On an annual basis, this accounts for an average of approximately 5,000 cubic yards of accumulation/sedimentation at a rate up to 2 feet/year;
- The river has a lack of base flow and the direction of the flow frequently reverses based on the hydraulic gradient (Lake Michigan water level);
- The flow velocity rapidly increases during a significant storm event, and is expected to mobilize river bed deposited sediment in the upper reaches upstream of S. Kinickinnic Ave;
- The upstream reaches of the river do not have the hydraulic capacity to convey the 100-Year storm flow. Bank flooding occurs frequently, increasing the potential of entraining various pollutants from upstream sources. There are eroding, unlined channels and tributaries upstream of W. Becher Street. The condition of the lined channels in this section of river is poor;
- There is on-going bed and bank erosion contributing to the river sediment transport. It was estimated that on an annual basis, the river conveys approximately 14,000 cubic yards of sediment;
- The water depths have historically been shallow upstream of W Becher Street (average 4 to 4.5 feet at LWD);
- The level of urbanization within the watershed resulted in flash flooding and bank/bed erosion, increasing the sediment transport;
- Based on the river flow and stage records provided by the United States Geological Survey (USGS) gauge 04087159 located at S. 6th and subsequently at 11th Street, the river has historically been subject to flash hydrology (short response to significant storms). On a monthly basis, the long-term (1982 to 2015) average flow rates varied between 15 to 38 cfs, suggesting the river has a low base flow.
- The estimated river flow (at 6th St) is approximately 3,200 cubic feet per second (cfs) for the 2-Year, and 8,000 cfs for the 100-Year storms, respectively;
- Based on a numerical modeling analysis performed with a Lake Michigan boundary water level condition of 580.0 feet NGVD29 and storms with intensities between and 1.5 YR and 100 YR, the water surface elevation does not start increasing until W Becher Street for all storms considered, for a distance of approximately 5,000 feet from the river mouth-see Figure 2;
- The average river velocity between the river mouth and S Kinnickinnic varies between 0.75 and 5 feet per second, and peaks at S 6th St (over 25 feet per second), as shown in Figure 3; the river velocities in the main channel area by the Grand Trunk wetland are estimated to vary between 0.75 and 1.5 feet per second for the 2- and 100-Year events, respectively;
- The lower section of Kinnickinnic River has adequate capacity to convey the 100-YR storm flow.

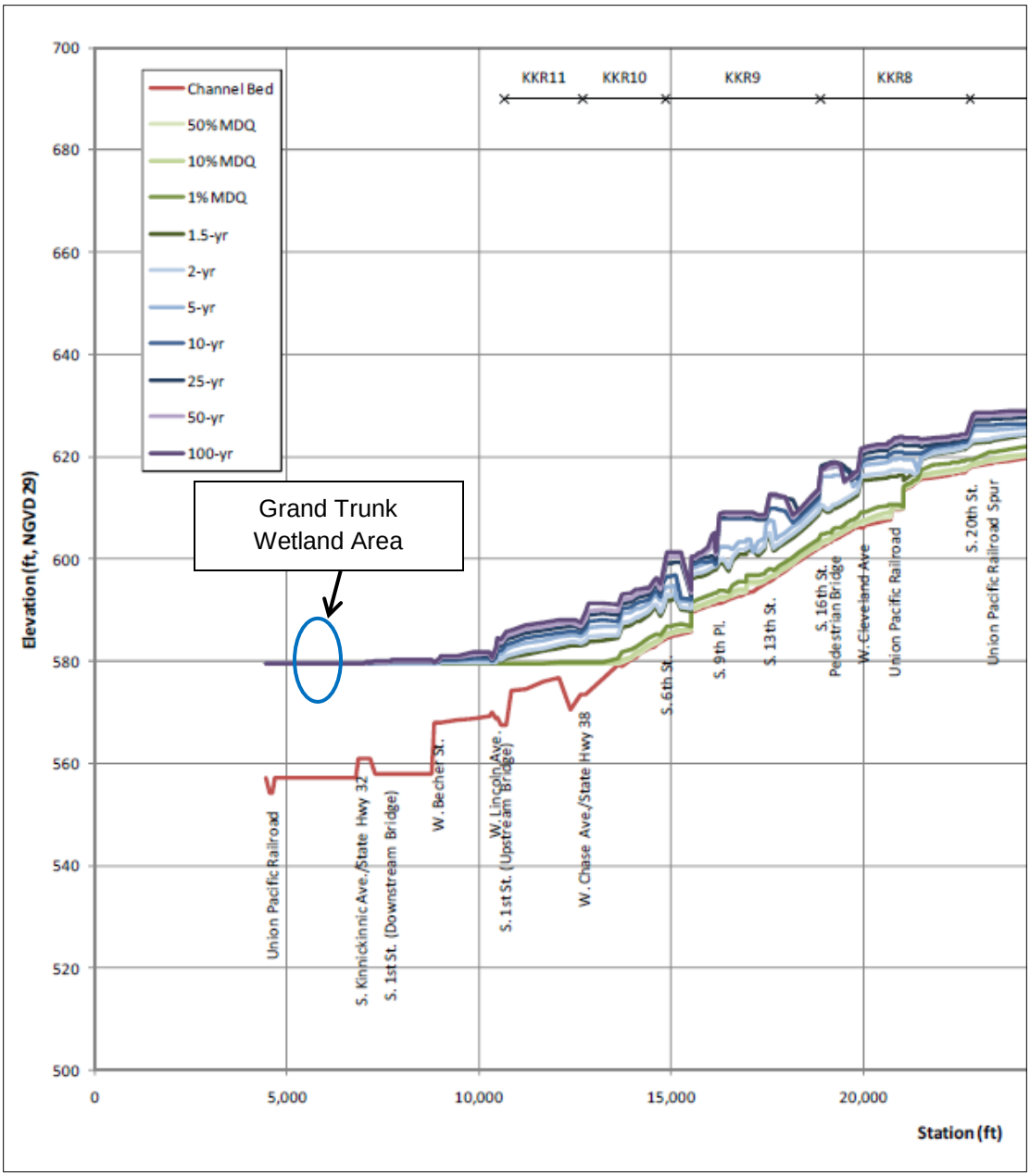

Figure 2. Kinnicinnic River Computed Water Surface Elevations

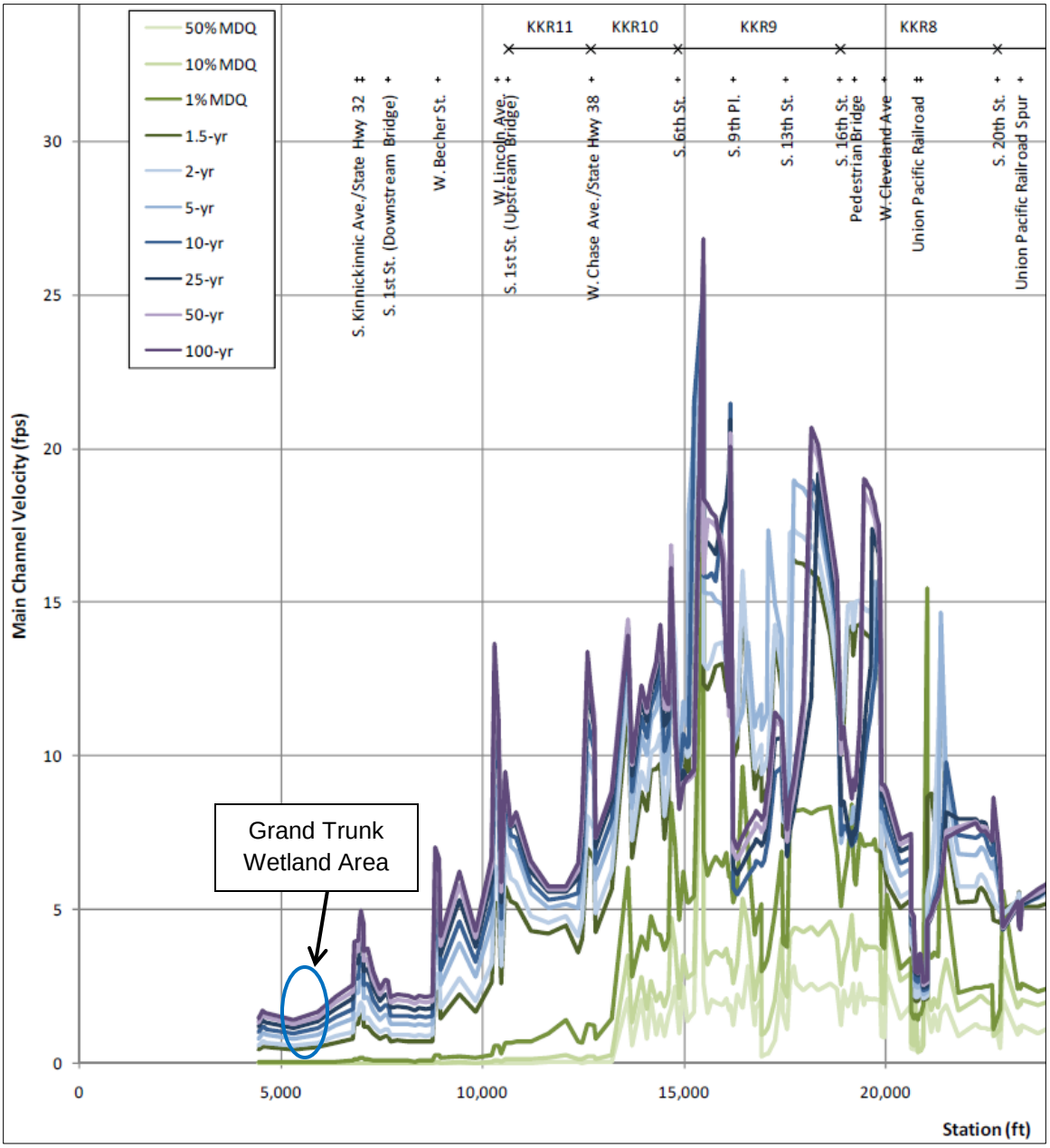

Figure 3. Kinnickinnic River Computed Average Velocities

Lake Michigan

The Lake Michigan water levels vary on different temporal scales, based on precipitation and evaporation levels (long-term), along with locally-induced storm systems (short term). The local Milwaukee gauge (National Oceanic and Atmospheric Administration Station 9087057) has been recording the Lake Michigan water level data at 6-minute intervals since 1970; and replaced the previous NOAA Station 9087058 (with 1860-1969 data). The water level data is stored and then processed as daily and monthly statistics (average, low and high). Other locations such as Calumet Harbor, IL (NOAA Station 9087044) have been recording data over a continuous longer timeframe (1903-current). A comparison of the average monthly recordings at the Milwaukee and Calumet Harbor gauges is presented below:

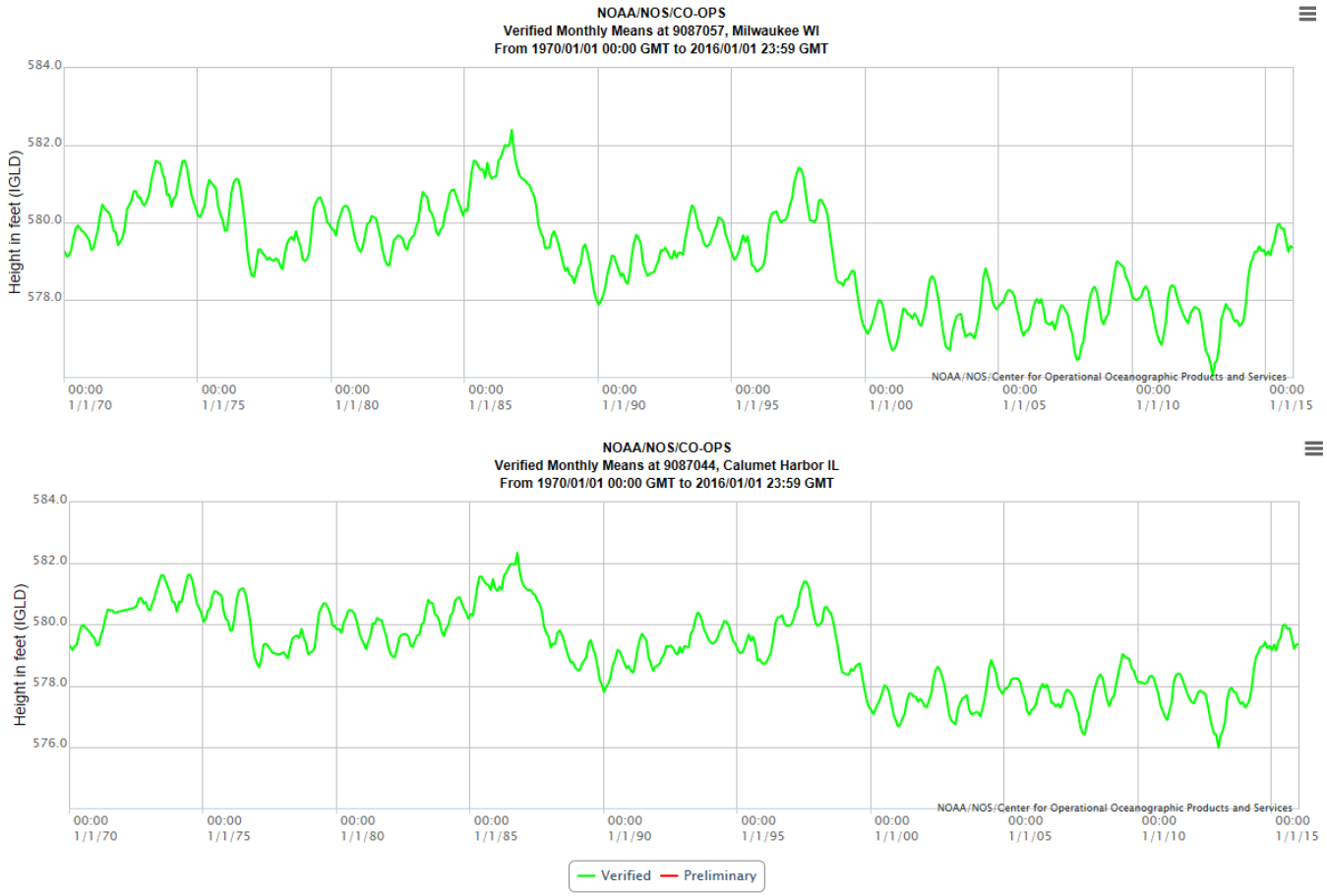

Figure 4. Lake Michigan Water Levels-Milwaukee and Calumet Harbor

In order to better define the water level variations, trends and design conditions, the data for both gauges were used. As Figure 4 shows, there are very close similarities between these two gauges. Figure 5 shows the long-term monthly water level variation for the Calumet Harbor gauge.

The maximum water level occurred in October 1986 (582.3 feet, or +4.8 LWD), while the minimum level occurred in January-March 1964 (576.0, or -1.5 ft LWD)-this is valid for both Calumet and Milwaukee locations. Periods of high or low water levels tend to persist for several years. A 19-year period of high water levels occurred between 1970 and 1988; a 14-year period of low levels occurred between 1999 and 2013. At this time, the lake level is approximately 2.5 ft LWD, which is 1.1 ft above the long-term recorded historic average of 1.4 ft LWD. The 2016 monthly average data is above the historic average; we are now in a period of high water levels. USACE predicts high water levels for the next 6 months (August 2016 to January, 2017), approximately 1 foot higher than the long-term historic average.

As shown in the grey shaded areas shaded in Figure 5, the water level variation from low to high is a relatively slow process. The maximum recorded rate of water level rise/fall is approximately 1.5 to 2.0 feet per year. A summary of the probability analyses conducted to define the Lake Michigan high water levels (combined storm surges and still water) by return period is presented in Table 1. This is based on USACE (1993 and 2013) data for Milwaukee and Highland Park, IL. As a reference, a 100-Year high water level has a 1% annual probability of occurrence.

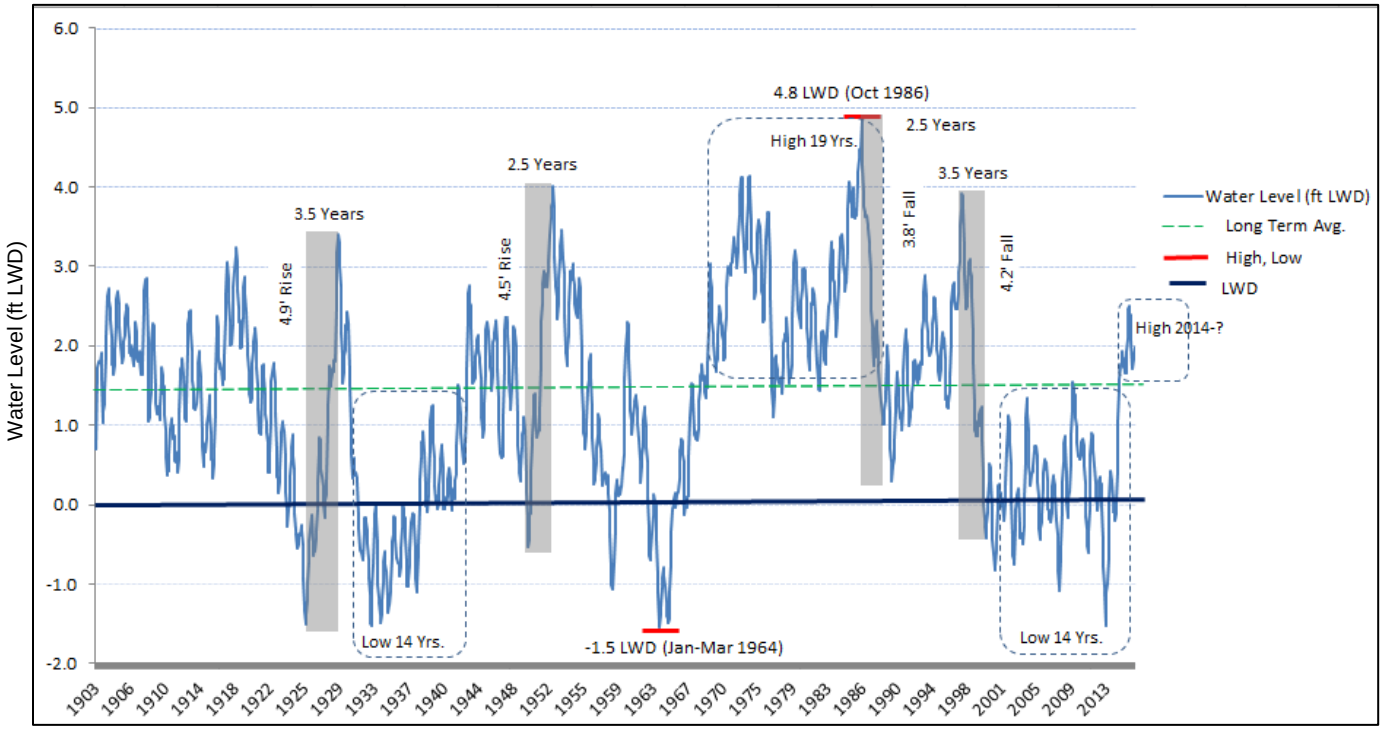

Figure 5. Lake Michigan Long-Term Water Levels

Return Period (Years)	**Water Levels (ft LWD)**		
	USACE (1993)-Milwaukee	USACE (2013)-Highland Park, IL	Adopted Level
5	--	+4.5	+4.5
10	+4.7	+5.0	+4.7
30	+5.3	--	+5.3
50	+5.6	+5.6	+5.6
100	+6.0	+5.8	+6.0

Table 1. Return Frequency-High Water Levels

An analysis conducted for the long-term recorded water level for March-April (corresponding to the typical pike spawning timeframe) shows the following:

Month	**Water Levels (ft LWD)**		
	Low	High	Average
March	-1.4	+3.6	+0.9
April	-1.3	+4.1	+1.2

Table 2. March-April Water Levels

Approximately 90% of the data is represented by a water level variation of (-0.6 to +2.7 feet LWD).

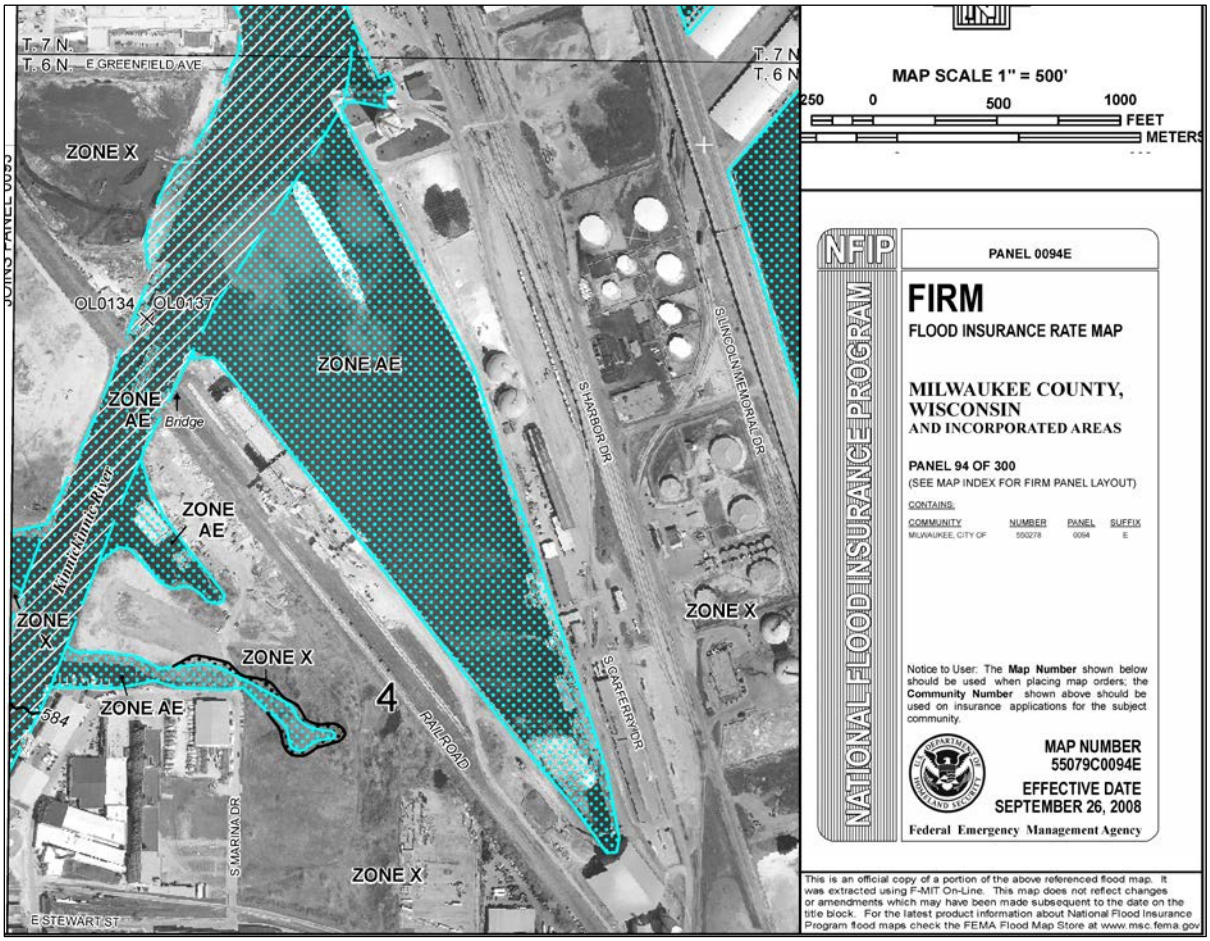

Figure 6. FEMA-FIRM Map

A review of the most current FEMA FIRM map shows the extents of the 100-YR water level, floodplain and floodway lines-see Figure 6. The 100-YR listed elevation is 584.0 NGVD29, which corresponds to 583.5 ft IGLD85, or +6 LWD, providing great correlation with the Lake Michigan calculated 100-YR water level.

Summary-KK River Hydraulics

The KK River has a low base flow and flashy hydrology, with calculated hydraulic properties below.

	Water Levels (ft LWD)		
Return Period (Years)	Flow (cfs)	Main Channel Velocity (ft/s)	Lake Michigan Water Elevation (ft LWD)
5	4,600	0.7	+4.5
50	7,000	1.3	+4.6
100	8,000	1.5	+6.0

Table 3. KK River Summary

IV. Overview Of Other Studies

System-wide, the Great Lakes water levels are highly dynamic and vary on different temporal scales, based on precipitation and evaporation levels (long-term), along with locally-induced storm events (short term). The issue of water level fluctuations (particularly those in Lake Michigan-Huron) has been a long-standing one; studies and discussions have taken place for decades.

Concerns have been exacerbated by the pronounced increase in lake levels in the 1980s, a precipitous drop in the level of Lake Michigan-Huron in the late 1990s, and an extended period of lower trending levels after that time. This fluctuating trend is expected to continue, while recognizing that short-term surges will be observed given the dynamic nature of the system. The genesis of this trend can be found, in part, in man-made structural changes to the St. Clair River due to factors such as navigational dredging and extraction of aggregates over an extended, multi-decadal period.

Water levels tend to reach a maximum in the summer months and minimum in the winter months, with a long-term seasonal variation of approximately one to two feet. Recorded water level fluctuations sometimes exceed this range. For example, over the past 100 years, the annual average lake level rise or fall for Lake Michigan-Huron is between one and two feet, but the maximum range in fluctuation (maximum to minimum) is approximately seven feet.

High water levels exacerbate concerns over coastal erosion and increased shoreline maintenance requirements, while low levels prompt concerns over adverse impacts on commercial and recreational navigation as well as beach quality and coastal wetlands.

Connecting channels play a vital role in water level fluctuations. The Great Lakes have significant storage capacity; if the connecting channels have a restricted outfall, then large variations to the lakes supply will be compensated by the regulated outfalls, resulting in controlling lakes levels.

Dredging and deepening of the St. Clair River dates back to the1850s, and the subsequent increase in available flow area and river conveyance has resulted in a permanent change in the water level relationship between Lake Michigan-Huron and Lake Erie.

This change, as well as lake level fluctuations at the system-wide level, has prompted a number of studies and legislative initiatives over the years. Among many others, this has included lake level references by the International Joint Commission (IJC, 2012),a Georgian Bay Forever (GBF)-funded study of the St. Clair River (2005), and a (long-standing yet dormant) U.S. Congressional authorization for compensating works in the St. Clair and Detroit Rivers.

Most recently, the IJC's Upper Great Lakes Study (UGLS) documented the historical significance of climate-induced lake level impacts on Lake Michigan-Huron and suggested that mitigative measures might include new structures in the St. Clair and/or Niagara Rivers.

The following represents a summary of some of the documents reviewed regarding Great Lakes current and water level forecasting:

- Bruxer, J. and Carlson, C. (Environment Canada), "Review of Past Studies on Further Regulation and Compensation in the Great Lakes-St. Lawrence River System, 2010.
- International Great Lakes Levels Board "Regulation of Great Lakes Water Levels", Report to the International Joint Commission, 1973.

- International Joint Commission, “Methods of Alleviating the Adverse Consequences of Fluctuating Water Levels in the Great Lakes-St. Lawrence River Basin”, 1993.
- Upper Great Lakes Study, “Options for Restoring Lake Michigan-Huron Water Levels: An Exploratory Analysis”, Final Report to the International Joint Commission, 2011.
- International Upper Great Lakes Study, “Impacts on Upper Great Lakes Water Levels: St.Clair River Summary Report”, Final Report to the International Joint Commission, 2009.
- International Upper Great Lakes Study, “Lake Superior Regulation: Addressing Uncertainty in Upper Great Lakes Water Levels”, Final Report to the International Joint Commission, 2012.
- Levels Reference Study Board, “Levels Reference Study: Great Lakes –St. Lawrence River

Key Points-Water Levels

In general, all studies agree that:

- There is considerable uncertainty in predicting future water supplies and corresponding water levels in the Great Lakes as a result of man-made actions and natural climate variability;
- The evaporation for the Great Lakes basin is increasing; *for Lake Michigan-Huron this has been largely offset by an increase in the precipitation*. However, for Lake Superior, this has not been adequately compensated. Water supply conditions for Lake Superior are expected to decline.
- *For the next 30 years, the Lake Michigan-Huron variations are not predicted to be extreme, and remain within the historical recorded range.*
- Glacial isostatic adjustments (earth’s crust elevation changes) add uncertainty to future water level predictions past the next 30 years.
- Water Level control plans by the IJC (Canadian and US Governments) will continue to formulate and adopt solutions to maintain the Great Lakes water levels to targeted desired levels.

V. Summary and Recommendations

Based on the results presented above and the historic recorded highs and lows, we have adopted a design high water level of +5.0 ft LWD (historic high), and a low of -1.5 ft LWD (historic low), as summarized below:

Design High	IGLD85	NGVD29
+5.0 LWD	582.5	583.0

Design Low	IGLD85	NGVD29
-1.5 LWD	576.0	576.5

Table 4. Design Water Level Summary

The bottom of the channel for hydraulic connectivity between the South Channel and the east wetland area is selected to be 575.5 NGVD29, in order to provide minimum 12 inches of water depth at the design low water level for fish spawning and wetland water supply.

LEGEND:

- SPAWNING SHELF VEGETATION ZONE (AVERAGE LAKE MICHIGAN WATER LEVEL 579-580 NGVD29)
- WETLAND BOUNDARY AND SETBACK
- FEMA FLOODWAY BOUNDARY
- EXISTING MINOR CONTOUR
- EXISTING MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED MAJOR CONTOUR

Printed on ___% Post-Consumer Recycled Content Paper

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AECOM

PROJECT

BAY VIEW WETLAND RESTORATION

Grand Trunk Rail Road

CLIENT

REDEVELOPMENT AUTHORITY OF THE CITY OF MILWAUKEE

809 NORTH BROADWAY
MILWAUKEE, WI 53202

CONSULTANT

AECOM TECHNICAL SERVICES, INC.
1555 Rivercenter Drive, Suite 214
Milwaukee, WI 53212
414 944 6080 tel 414 944 6081 fax
www.aecom.com

REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
3	2016-11-29	FOR 60% MEETING
2	2016-09-20	FOR 40% MEETING
1	2016-06-08	FOR 25% MEETING

KEY PLAN

PROJECT NUMBER

60490610

SHEET TITLE

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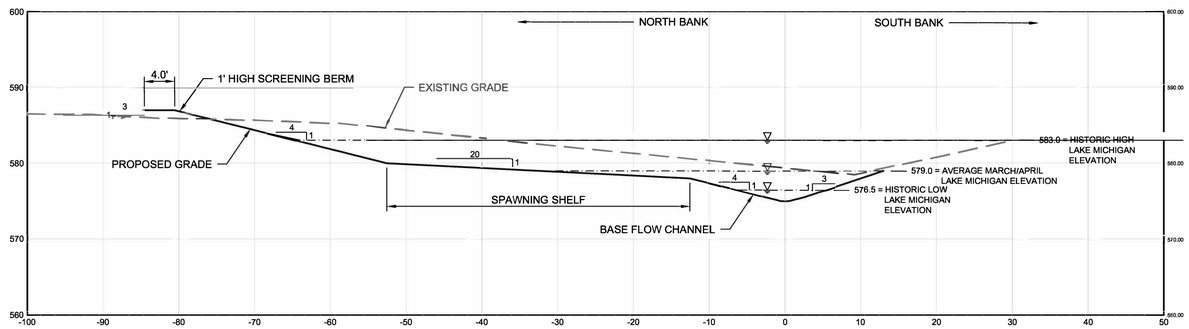
DRAWING NUMBER

C-01



A | **ALTERNATIVE 1 CROSS SECTION**

C-03 | Scale 1" = 10'

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BAY VIEW WETLAND RESTORATION

Grand Trunk Rail Road

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I/R	DATE	DESCRIPTION
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2	2016-09-20	FOR 40% MEETING
1	2016-06-08	FOR 25% MEETING

KEY PLAN

PROJECT NUMBER

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SHEET TITLE

WEST CHANNEL CROSS SECTION

DRAWING NUMBER

C-02

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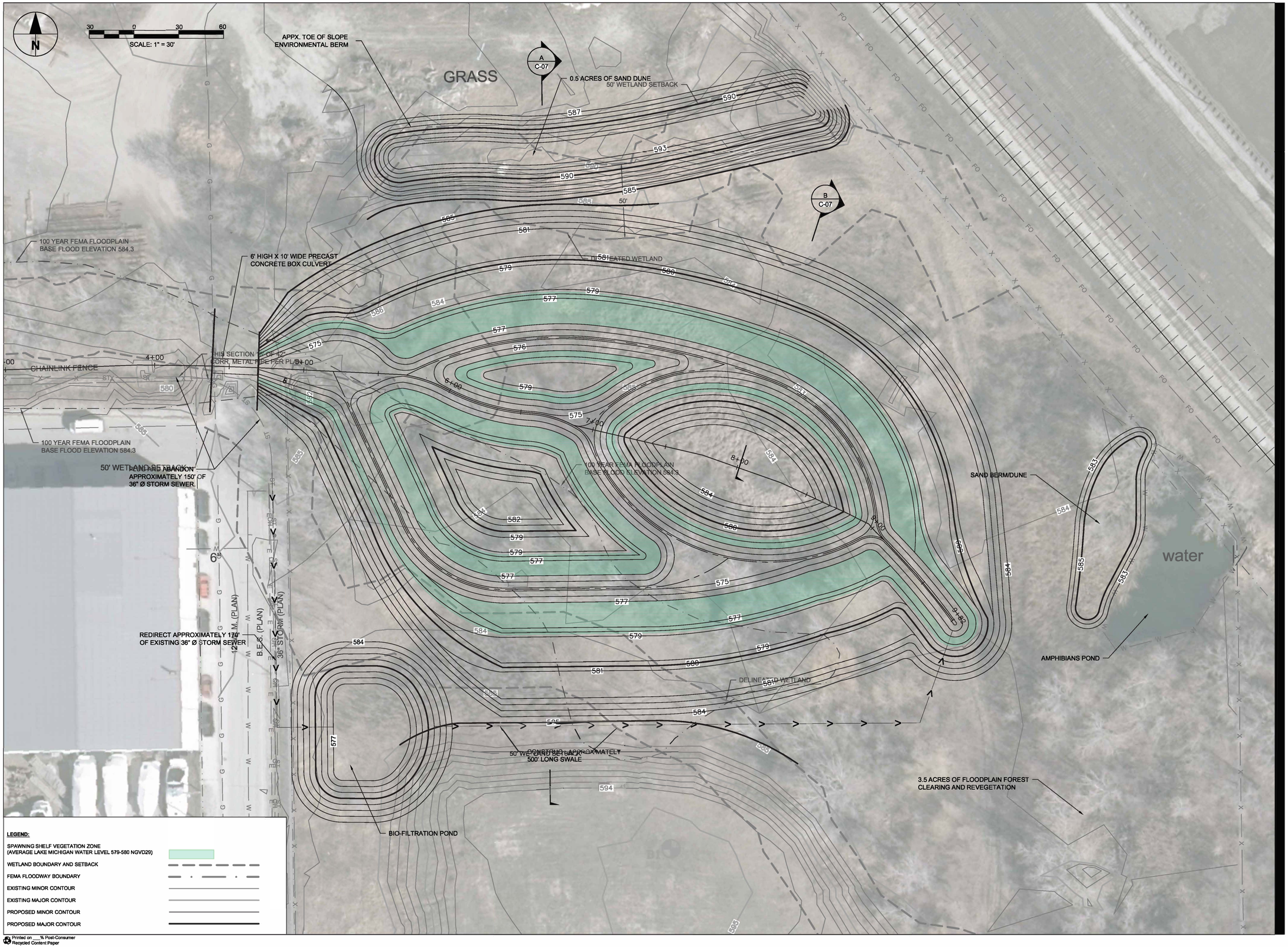

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2	2016-09-20	FOR 40% MEETING
1	2016-06-08	FOR 25% MEETING

KEY PLAN

PROJECT NUMBER

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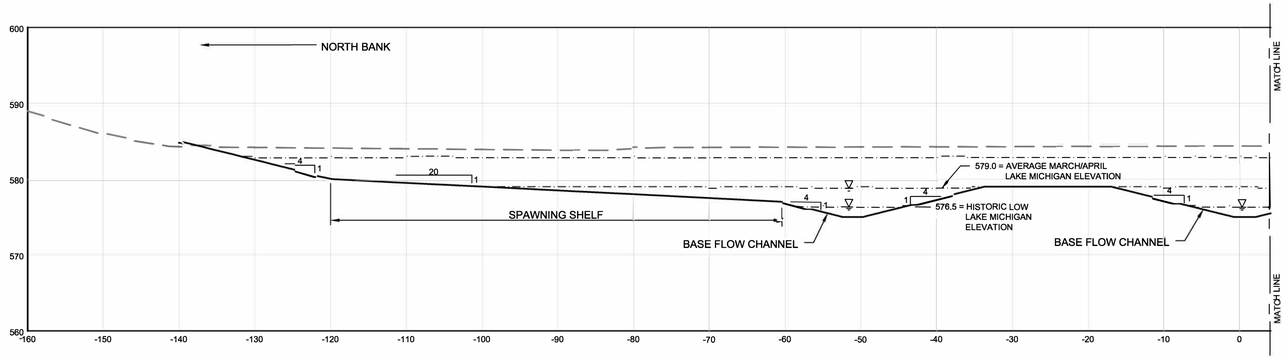

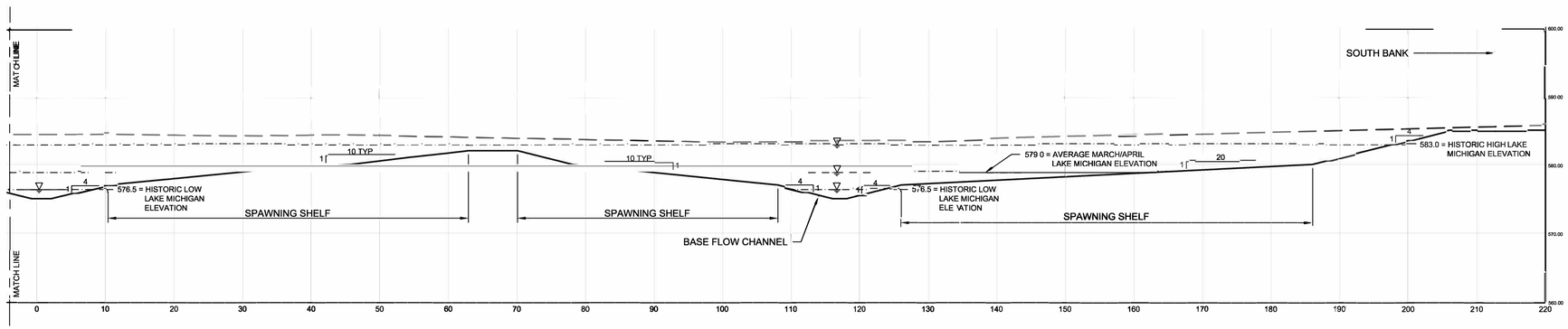

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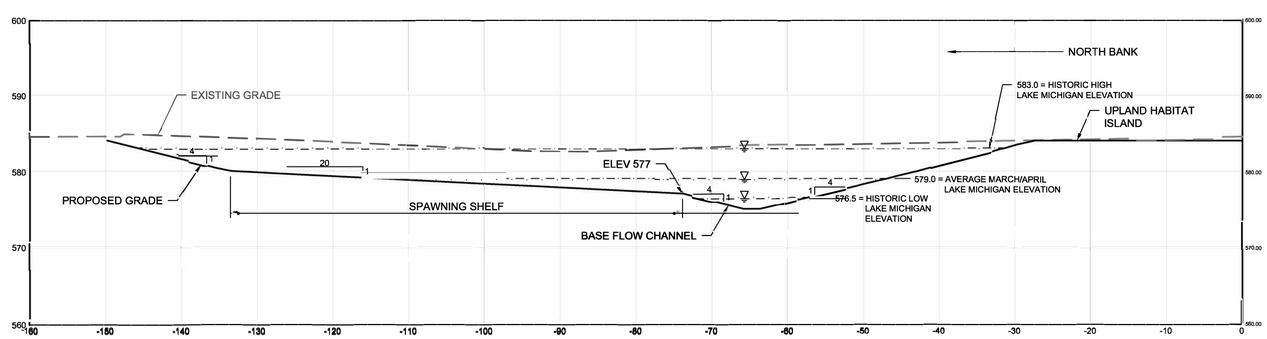

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2	2016-09-20	FOR 40% MEETING
1	2016-06-08	FOR 25% MEETING

KEY PLAN

PROJECT NUMBER

60490610

SHEET TITLE

EAST CHANNEL CROSS SECTIONS

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Project Management Initials: Designer: SP Checked: JH Approved: DV ARCH D 24" x 36"

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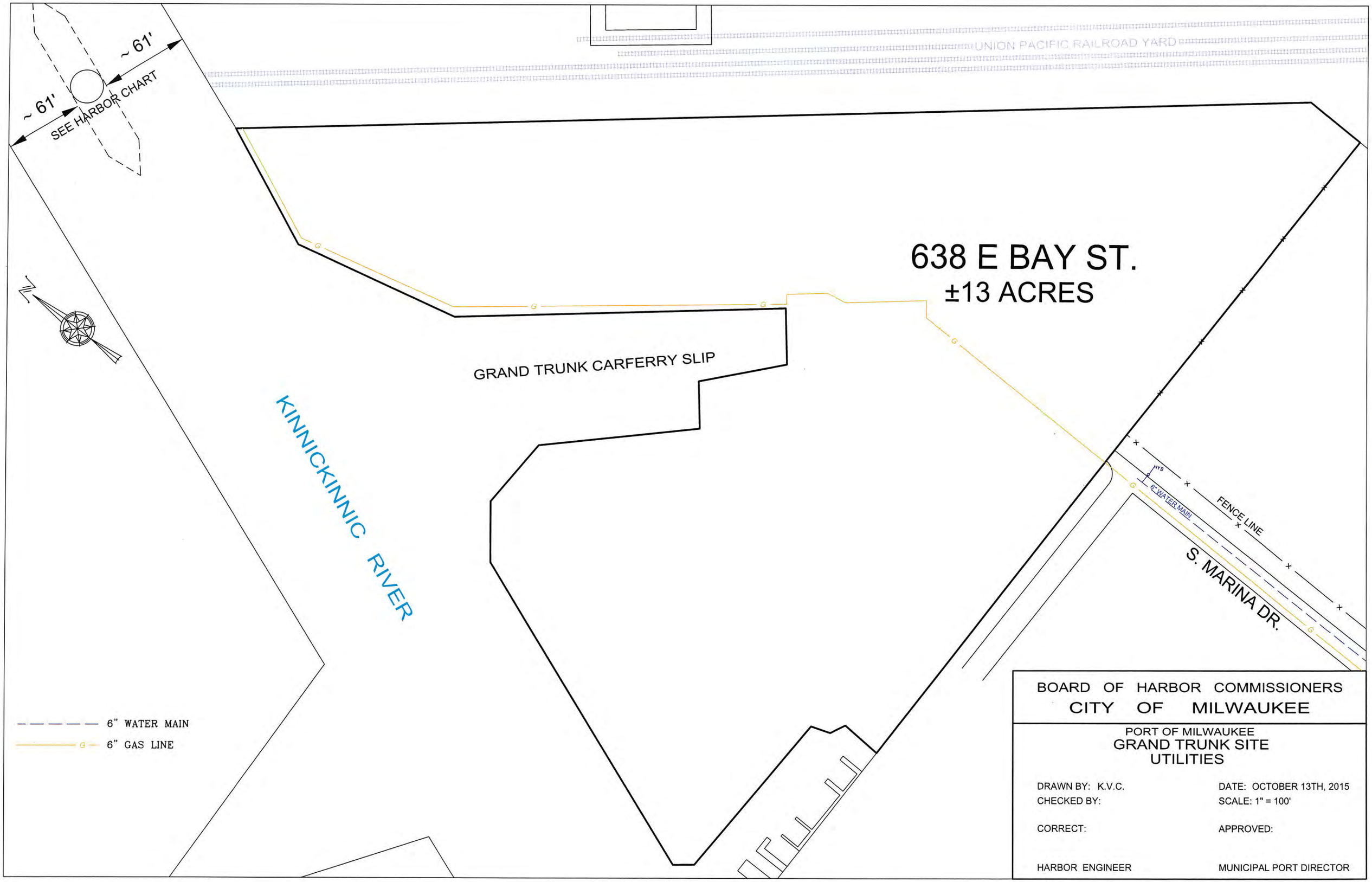
Appendix D

Utility Information

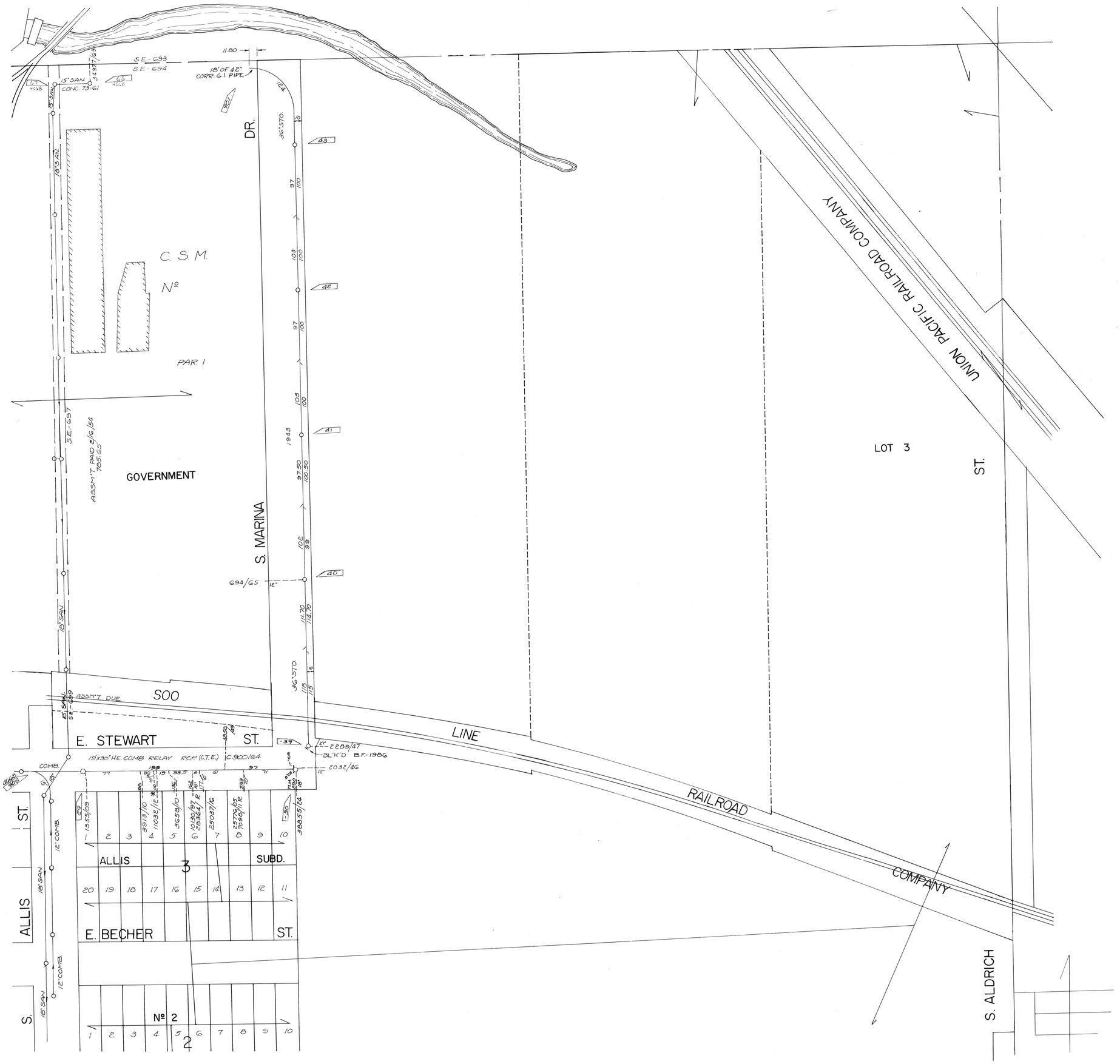

UNION PACIFIC RAILROAD YARD
~ 61'
~ 61'
SEE HARBOR CHART
638 E BAY ST.
±13 ACRES
GRAND TRUNK CARFERRY SLIP
KINNICKINNIC RIVER
FENCE LINE
6" WATER MAIN
S. MARINA DR.
6" WATER MAIN
6" GAS LINE
BOARD OF HARBOR COMMISSIONERS
CITY OF MILWAUKEE
PORT OF MILWAUKEE
GRAND TRUNK SITE
UTILITIES
DRAWN BY: K.V.C.
DATE: OCTOBER 13TH, 2015
CHECKED BY:
SCALE: 1" = 100'
CORRECT:
APPROVED:
HARBOR ENGINEER
MUNICIPAL PORT DIRECTOR

THE
GTW MILWAUKEE
0
60
120
Feet
APPLIED
ECOLOGICAL
SERVICES
River
Kinnickinnic
River
S Marina Dr
E Stewart St

Recd 6/83
RRK

D4-9-18-1
(SHEET 1)

NOTE: SEWER CHARGE DUE AGAINST
10/1/62 GRAND TRUNK WEST RAILROAD
$1.00 EA.
SEE LETTER E.H. TO R.R. DATED 10/11/62
FILE # 96-200 PAID 6/7/63



SCANNED DATE_____ MICROFILMED DATE_____

4	463D	4
6	466A	6
6		5
B	466D	B

THIS INFORMATION HEREBY GIVEN TO YOU IS BASED UPON THE BEST AVAILABLE RECORDS. HOWEVER WE DO NOT GUARANTEE THE CORRECTNESS OR ACCURACY OF THE SAME.

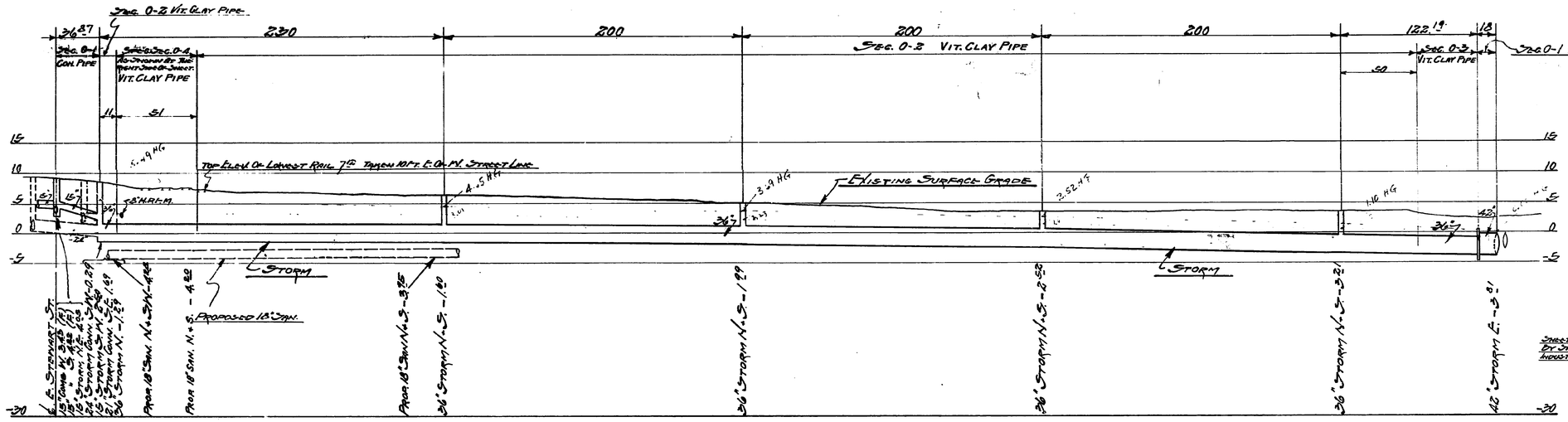
City of Milwaukee, DPW
Sanitary & Storm Sewer
System Micro Station Map

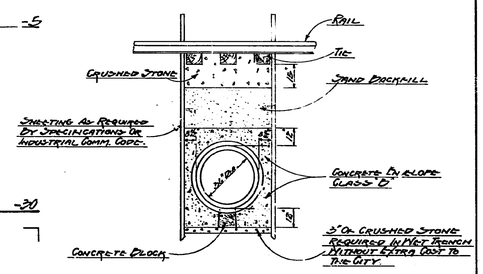
NOTE! THE CITY HAS BEEN UNOFFICIALLY ADVISED THAT SOME TRACKS MAY BE TEMPORARILY PUT OUT OF SERVICE TO ALLOW CONSTRUCTION, OR SEWER WITHOUT SPECIAL TRACK SUPPORTS PROVIDED THAT THE R.R. CO. BY LETTER, AUTHORIZES THE DISCONTINUANCE OF SUCH TRACKS.

THE OTHER TRACKS MUST BE SUPPORTED BY THE CONTRACTOR OR BY THE R.R. CO. AT THE EXPENSE OF THE CONTRACTOR, AND ALL TO THE SATISFACTION OF THE C.M.ST.P & P. R.R. CO.

THE COST OF ALL WORK INVOLVED IN CONNECTION WITH TRACK SUPPORTS OR WORK ON THE R.R. RIGHT OF WAY SHALL BE INCLUDED IN THE UNIT PRICE BID FOR THE SEWER AND BIDDERS MUST SECURE INFORMATION REGARDING TRACK SUPPORT REQUIREMENTS AND COSTS INVOLVED FROM THE R.R. CO. BEFORE SUBMITTING BIDS.

THE CONTRACTOR SHALL NOTIFY THE C.M.ST.P & P.R.R CO. 10 DAYS BEFORE BEGINNING WORK AT THE R.R. CROSSING.





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TO BE USED AT R.R. CROSSING
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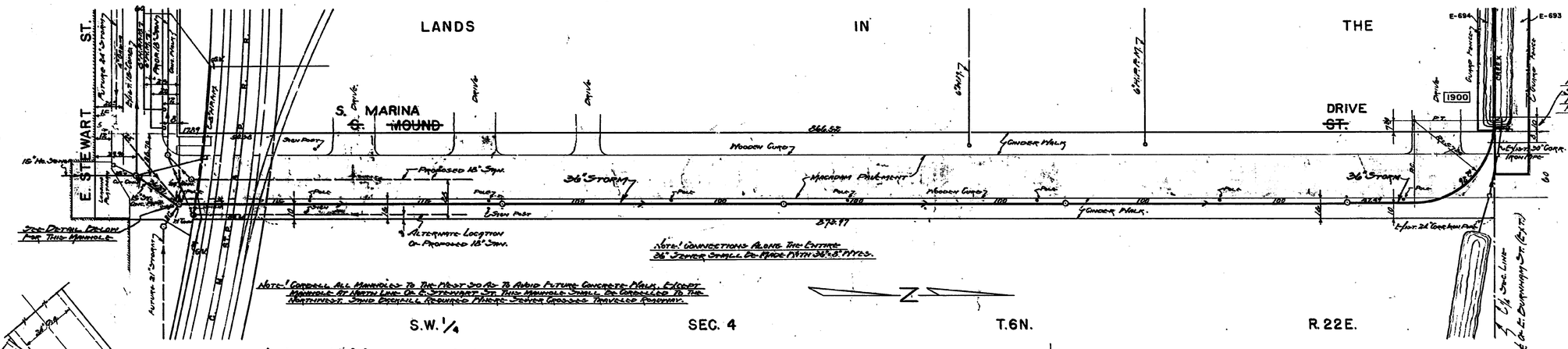

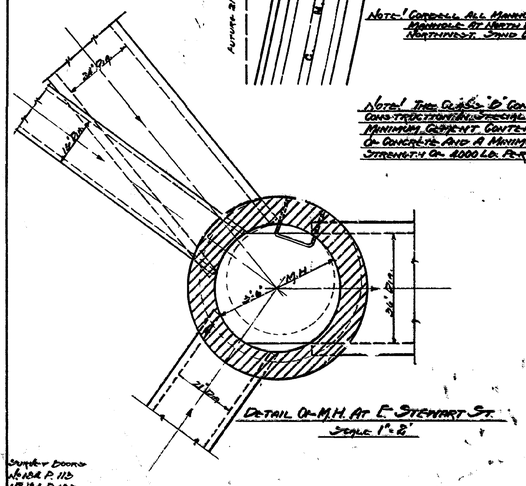

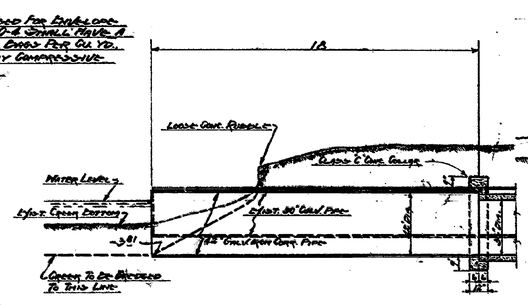

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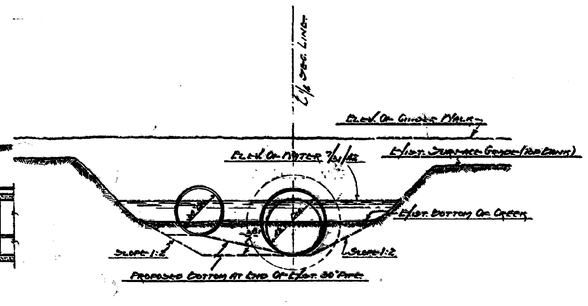

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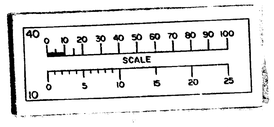


NOTE! THE CLASS "D" CONCRETE USED FOR ENVELOPE CONSTRUCTION IN SPECIAL SECTION 0-4 SHALL HAVE A MINIMUM CEMENT CONTENT OF 6.6 BAGS PER CU. YD. OF CONCRETE AND A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4000 LB. PER SQ. INCH.

Sunker Boons
N.A.R. P. 113
N.P. 184 P. 182
CONNED ARE

MICROFILMED 4-17-86

BUREAU OF SEWERS
DEPARTMENT OF PUBLIC WORKS
MILWAUKEE, WISCONSIN

PLAN OF SEWER

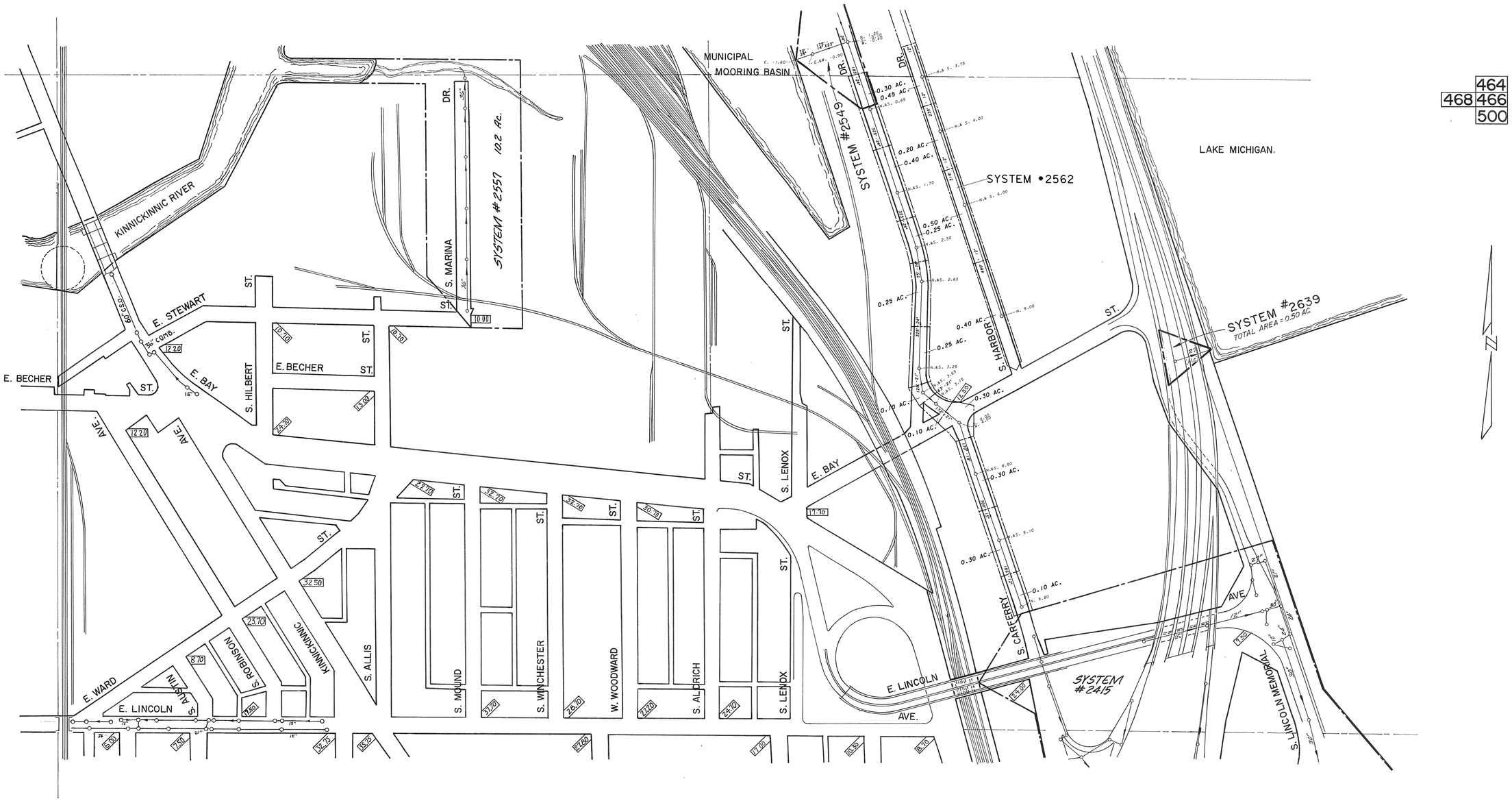
IN— ~~S. MOUND ST.~~ S. MARINA DRIVE
FROM— E. BURNHAM ST. EXT.
TO— E. STEWART ST.

SCALE — VERT. — 1" = 10' HOR. — 1" = 10'
EASEMENT NO. — E-693-694
SHEET NO. — 1 OF 1
DESIGNED BY — Ochwal TRACED BY — Ochwal
DRAWN BY — Ochwal CHECKED BY — Ochwal
S - W - NPFM - 1 - FT - E - ST - 16 - 17 - WU -
DIVE
APPROVED H.R. Hedemann 8-23-82 9/1/82
APPROVED Chief Sewer Engineer
APPROVED Commissioner of Public Works
APPROVED Martin M. Smith 9/7/82 City Engineer

ESTIMATE OF QUANTITIES
813 L.F. OF 36" STORM, SEC. 0-2 V.C.P.
51 L.F. OF 36" STORM SPEC. SEC. 0-4
18 L.F. 42" GALV. IRON CORR. PIPE, SEC. 0-1 Con. Pipe
33 L.F. OF 15" STORM, SEC. 0-1 Con. Pipe
72 L.F. OF 36" STORM, SEC. 0-2 V.C.P.
5 - 3'-6" DIA. STORM M.H.

PLAN DATE — AUG. 31, 1982

FILE NO. 65-3



UPDATED: 6-4-13

SYSTEM UPDATE	

SEWER ENGINEERING DIVISION

BUREAU OF ENGINEERS
DEPARTMENT OF PUBLIC WORKS
MILWAUKEE, WISCONSIN

PLAN OF STORM SEWER SYSTEMS

NORTH OF E. LINCOLN AVE. TO E. BURNHAM AVE.

WEST OF LAKE MICHIGAN TO S. KINNICKINNIC AVE.

SYSTEM NUMBERS

APPROVED DATE

ENGINEER IN CHARGE

SCALE 1" = 200

FILE NO. 466

B/P INC.

Map Milwaukee: Property Information

City of Milwaukee, Wisconsin

- Legend -

- City limits
- Parcels
- Freeways
  - Freeways
  - Exit ramps
  - Entry ramps
  - Ramps
- Major streets
- Streets
- Waterways
- 2015 COLOR
  - Red: Band_1
  - Green: Band_2
  - Blue: Band_3
- Watersheds
- Sub-Basins
- Combined sewer area

- Notes -

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Map Milwaukee: Property Information
Disclaimer
3/22/2016

Map Scale: 1: 13,129

1,094.1 0 547.04 1,094.1 Feet

City of Milwaukee

Department of Administration - ITMD

Appendix E

Engineer’s Estimate of Probable Construction Cost

AECOM

Engineer's Estimate of Probable Construction Cost
Grand Trunk - Bay View Wetland, Engineered Design Feasibility Report
November 2017

Line No.	Description	Quantity	Units	Unit Cost	Sub-Total	Remarks
1	**Mobilization**	1	LS	$ 50,000	$ 50,000	Mob/demob for project
2	**East Work Zone**					
3	Site Preparation					
4	Erosion Control	1	LS	$ 10,000	$ 10,000	silt fencing, tracking pads, etc.
5	Clear & Grubbing	5.74	AC	$ 10,000	$ 57,400	chip wood products and leave on-site
6	Debris Removal & Disposal (1%)	300	CY	$ 25	$ 7,500	e.g. concrete, asphalt, rubbish, assumes 1% of fill volume
7	Monitoring Well Abandonment	1	LS	$ 2,500	$ 2,500	only wells w/in work zone.
8	Dewatering					
9	Cofferdam	-	---	$ -	$ -	no cost, use current roadway/culvert as cofferdam
10	Treatment System	1	LS	$ 35,000	$ 35,000	pumping & TSS filtration only, shared cost with West Work Zone
11	Disposal Fees	900	kGAL	$ 5	$ 4,500	dispose treated water under permit to sanitary sewer, 30kgal/day, 30 day
12	Excavation					
13	Fill Soil Excavation & Transport - remove islands	33,100	CY	$ 9	$ 297,900	ground surface to bottom of elev of pond including remove islands
14	Fill Soil Excavation & Transport, 2 ft offset for cap/cover	13,500	CY	$ 9	$ 121,500	2 ft below bottom elevation of pond, including below islands
15	Fill Soil Disposal[1]	79,220	TN	$ 32	$ 2,535,040	Sub-Title D landfill, direct disposal, including islands, 1.7 tn/cy
16	Cap/Cover Construction[2]					
17	Clay Soil Cap	6,750	CY	$ 20	$ 135,000	assume 1 ft thick, provide & place
19	Screened Soil & Sand for Sediment Cap	6,750	CY	$ 25	$ 168,750	assume 1 ft thick, provide & place
18	Soil for Islands[3]	6,100	CY	$ 8	$ 48,800	use Marquette fill pile, move & place
20	Storm Sewer Diversion					
21	Pond Construction	1,000	CY	$ 50	$ 50,000	excavation, transportation, disposal
22	Piping	500	LF	$ 30	$ 15,000	pipe from storm pond to head of wetland
23	Structures	1	LS	$ 20,000	$ 20,000	4 total, manhole, storm pond inlet, storm pond outlet, discharge structure
24	**West Work Zone**					
25	Site Preparation					
26	Erosion Control	1	LS	$ 5,000	$ 5,000	silt fencing, tracking pads, etc.
27	Clear & Grubbing	0.6	AC	$ 10,000	$ 6,300	chip wood products and leave on-site, N bank only
28	Debris Removal & Disposal (5%)	120	CY	$ 25	$ 3,000	e.g. concrete, asphalt, rubbish, assumes 5% of fill volume
29	Fence Removal & Disposal	250	LF	$ 10	$ 2,500	cyclone fencing w/in channel
30	Remove Rail Trestle Pilings & Disposal	1	LS	$ 15,000	$ 15,000	south bank, may require ROE
31	Utility Abandonment	1	LS	$ 10,000	$ 10,000	natural gas, san-sewer, water
32	Storm Sewer By-Pass, during construction[4]	1	LS	$ 5,000	$ 5,000	storm sewer discharge from S Marina Dr
33	Dewatering					
34	Cofferdam	2,800	SF	$ 35	$ 98,000	temp. sheet piling across channel, approx. 140 LF
35	Treatment System	1	LS	$ 35,000	$ 35,000	pumping & TSS filtration only, shared cost with East Work Zone
36	Disposal Fees	900	kGAL	$ 5	$ 4,500	dispose treated water under permit to sanitary sewer, 30kgal/day, 30 day
37	Excavation					
38	Sediment Excavation & Transport	1,300	CY	$ 5	$ 6,500	excavate in the dry, below OHWM to el. 575.0, transport 1.2 miles by truck
39	Sediment Excavation & Transport, 2 ft offset for cap/cover	1,600	CY	$ 5	$ 8,000	excavate in the dry, 2 ft below el. 575.0, transport 1.2 miles by truck
40	Sediment Disposal	2,900	CY	$ -	$ -	no fee disposal at Jones Island CDF
41	Fill Soil Excavation & Transport	2,300	CY	$ 9	$ 20,700	excavate in the dry, behind OHWM, north bank only
42	Fill Soil Excavation & Transport, 2 ft offset for cap/cover	2,100	CY	$ 9	$ 18,900	excavate in the dry, behind OHWM, north bank only, 2 ft below bank
43	Fill Soil Disposal[1]	7,480	TN	$ 32	$ 239,360	Sub-Title D landfill, direct disposal, including islands, 1.7 tn/cy
44	Cap/Cover Construction[2]					
45	Clay Soil Cap	1,050	CY	$ 20	$ 21,000	assume 1 ft thick, provide & place
46	Screened Soil & Sand for Sediment Cap	1,050	CY	$ 25	$ 26,250	assume 1 ft thick, provide & place
47				Estimated Sub-Total	$ 4,083,900	
48				Construction Contingency, 10%	$ 408,390	
49				Estimated Total*	$ 4,492,290	

NOTES:
Estimated opinion of cost is based on AECOM's 60% design for construction work. See text of report for limitations on scope of work and cost assumptions.
1 - Fill Soil Disposal assumes $32/ton for direct disposal and $17/ton for disposal as daily cover.
2 - Cap design is preliminary and does not have regulatory approval at this time. Design assumes a 2 ft thick cap, 1 ft with clay and 1 ft with top soil/sand mixture.
3 - Marquette fill pile will require characterization prior to use.
4 - Storm sewer discharges into west work zone. Work will require by-pass pumping during rain events.
* The engineer's opinion of probable construction cost is based on the engineer's experience and judgement. The engineer cannot control the cost of labor, materials, equipment, and services provided by others or the means and methods of construction. Actual costs will only be determined upon receipt of construction bids for the work.

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