Draft Final Design Report

Menominee River Sediment Removal Project adjacent to Tyco Fire Products LP Facility, Marinette, WI

Prepared for

Tyco Fire Products LP

January 2012

CH2MHILL®

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Project Manager Date

Executive Summary

This Draft Final Design Report summarizes the results of the pre-design investigations of arsenic contamination in Menominee River sediments adjacent to the Tyco Fire Products LP Facility, Marinette, Wisconsin; delineates remediation areas; and describes remedial approaches and technologies.

Following the completion of the Preliminary Basis of Design (CH2M HILL 2011), and through an iterative process of addressing key technical and implementation issues, this Draft Final Design (90 percent design phase equivalent) presents the remedial actions required to meet the U.S. Environmental Protection Agency (USEPA)-approved Sediment Removal Work Plan (SRWP) (CH2M HILL 2010).

This Draft Final Design Report is organized as follows:

1. Introduction
2. Conceptual Site Model
3. Menominee River Sediment Removal Plan
4. Corrective Action Design—Project Delivery Strategy
5. Design Approach, Assumptions, and Parameters
6. Compliance with Applicable Requirements
7. Performance Monitoring Requirements
8. Preliminary Construction Schedule
9. Biddability, Constructability, and Operability Review

The 2009 Administrative Order on Consent (AOC) contains specific goals for the remedial action within the Menominee River and sets forth a remedial strategy to achieve these goals. This Draft Final Design Report includes new information developed during analyses conducted in the remedial design process that requires modification to the original remedial strategy. These modifying factors and subsequent adjustments to the remedial actions are discussed in Section 9 of this document. In summary, they include: the elimination of the dry excavation approach for a portion of the project area due to significant groundwater treatment requirements; construction of the temporary water treatment facility at the 6th Street Slip area as opposed to the Tyco property; and "the issues relating to" the potential need for temporary bulkhead support to facilitate dredging.

The modeling and analyses of the groundwater intrusion into the previously USEPA-approved SRWP dry excavation areas is described in Section 9, but a comprehensive technical memorandum (white paper) will be provided to USEPA to present the groundwater modeling parameters and results, water treatment calculations, and correlating cost estimates. Final design addressing the issue of bulkhead stability will be determined based on further evaluation and discussion with the regulatory agencies.

This Draft Final Design document contains text, designs, and specifications consistent with the Final Decision, AOC, approved SRWP, and the USEPA letter dated December 21, 2011.

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Acronyms and Abbreviations

3D	three-dimensional
AOC	Administrative Order on Consent
BER	Bureau of Endangered Resources (WDNR)
BMP	best management practice
CCRG	Commonwealth Cultural Resources Group
CFR	Code of Federal Regulations
CSM	conceptual site model
CSP	Confirmation Sampling Plan
CWA	Clean Water Act
EVS	Environmental Visualization System
facility	Tyco Fire Products LP manufacturing facility in Marinette, Wisconsin
ft	feet
GIS	geographic information system
GLAOC	Great Lakes Area of Concern
GLWQA	Great Lakes Water Quality Agreement
gpd	gallons per day
gpm	gallons per minute
GPS	global positioning system
GWCT	groundwater collection and treatment
HFB	horizontal flow barrier
IMI	interim measures investigation
JPA	Joint Permit Application
K&K	K&K Integrated Logistics
MF	microfiltration
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MMC	Marinette Marine Corporation

MNR	monitored natural recovery
msl	mean sea level
NHPA	National Historic Preservation Act
NRHP	National Register of Historic Places
NWP	Nationwide Permit
PBOD	Preliminary Basis of Design
PM_{10}	particulate matter finer than 10 micrometers in diameter and smaller
ppb	parts per billion
QA	quality assurance
QC	quality control
RA	remedial action
RCRA	Resource Conservation and Recovery Act
RFI	Resource Conservation and Recovery Act facility investigation
RO	reverse osmosis
SCM	semi-consolidated material
site	Tyco Fire Products LP manufacturing facility in Marinette, Wisconsin
SRWP	Sediment Removal Work Plan
SWAC	surface weighted average concentration
TCLP	toxicity characteristic leaching procedure
TSS	total suspended solids
Tyco	Tyco Fire Products LP
URS	URS Corporation
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VBW	vertical barrier wall
VSEP	Vibratory Shear Enhanced Processing
WDNR	Wisconsin Department of Natural Resources

WPDES	Wisconsin Pollutant Discharge Elimination System
WSHS	Wisconsin State Historical Society
yd^3	cubic yards
yd^3/hr	cubic yards per hour

SECTION 1

Introduction

This Draft Final Design Report summarizes the results of pre-design investigations, and describes remedial approaches and technologies that will be applied to address impacted sediment present at the Tyco Fire Products LP (Tyco) manufacturing facility in Marinette, Wisconsin (hereafter referred to as the "site" or "facility"). This Draft Final Design Report also responds to direction provided by the U.S. Environmental Protection Agency (USEPA) in letters to Tyco dated August 29, 2011, and December 21, 2011. The report presents activities that will be undertaken to accomplish sediment cleanup work as set forth in the Sediment Removal Work Plan (SRWP) Tyco submitted to USEPA on December 1, 2010 (CH2M HILL 2010), in accordance with the requirements set forth in the Administrative Order on Consent (AOC) between Tyco and USEPA, dated February 26, 2009. The SRWP was formally approved by the agency with conditions in a letter dated June 1, 2011 (USEPA 2011).

The sediment removal activities described in this Draft Final Design Report will conform to the SRWP and additional conditions outlined in the June 1, 2011 approval letter and the Preliminary Basis of Design (PBOD) January 21, 2011 letter, with one exception. The exception is that rather than removing sediment in dry conditions in the Transition Area and South Channel, these sediments will be removed by wet excavation. The change is the result of our analysis indicating a potentially excessive volume of water would need to be pumped and treated to perform this work under dry conditions. Also, maintaining a dry excavation would pull in groundwater from the ThyssenKrupp Waupaca Foundry property to the north of the South Channel and might require removal of other contaminants in the water treatment process that have not been identified.

1.1 Site Description and History

The site is an active manufacturing facility in the city of Marinette in northeastern Wisconsin, adjacent to the southern shore of the Menominee River (Figure 1). The property is bordered by the Menominee River to the north; the 6th Street Slip and City of Marinette property to the east; Water Street, City of Marinette property, Marinette School District property, and residential properties to the south; and Stanton Street and Marinette Marine Corporation to the west.

The facility consists of approximately 63 acres, including a manufacturing area on the western part of the property and an undeveloped area to the east, referred to as the "wetlands area." A fence surrounds both parts of the facility, and access is restricted. The facility began operations in 1915, and manufacturing entities acquired by Tyco in the 1990s produced cattle feed, refrigerants, and specialty chemicals. Arsenic-based agricultural herbicides were manufactured at the facility between 1957 and 1977. A byproduct of the manufacturing of these herbicides was a salt that contained approximately 2 percent arsenic by weight and was stockpiled at several locations on the property. Some of this arsenic subsequently entered site soil and groundwater. By 1978, the facility ceased production of arsenic-based herbicides, and since 1983 has produced only fire extinguishers and fire suppression systems.

1.2 Previous Facility Investigations and Corrective Actions

1.2.1 Investigation Activities

Investigations of environmental conditions at the facility began in 1974. Subsequently, five detailed investigations have been performed to characterize arsenic in sediment of the Menominee River adjacent to the facility. The first was a sediment site assessment conducted in October 1996 (Dames & Moore 1996). The purpose of the assessment was to evaluate potential impacted sediment in the 8th Street Slip, the 6th Street Slip, the Turning Basin, and adjacent areas of the Menominee River. Elevated arsenic levels were detected in the sampled areas, with sediment containing arsenic concentrations up to 22,300 milligrams per kilogram (mg/kg) in the 8th Street Slip. Based on the results of this investigation, and following discussions with USEPA, Tyco subsequently removed sediment within the 8th Street Slip that contained the highest arsenic concentrations.

The second sediment investigation was performed in 2000 as part of an interim measures investigation (IMI) and is summarized in the final IMI report appended to the *Summary of Findings Report* (URS Corporation [URS] 2001). The IMI included the following activities:

- Performing a hydrographic survey and sub-bottom profile survey of sediment in the Menominee River
- Advancing and logging 20 borings to bedrock within the Menominee River to assess total arsenic concentrations in soft sediment, semi-consolidated material (SCM), and glacial till units (The borings were continuously sampled, with samples for laboratory analysis of arsenic collected from each 2-foot interval.)
- Collecting soft sediment samples at 24 locations within the Menominee River, the Turning Basin, and the South Channel to assess total arsenic concentrations (These samples were collected at 0- to 0.5-foot intervals, with additional samples collected to the bottom of the soft sediment over 2-foot intervals. Soft sediment was defined operationally as sediment that could be sampled using vibracoring equipment.)
- Collecting surface water samples at the 24 soft sediment sampling locations to assess arsenic concentrations in the water column, with samples collected at the surface, mid-depth, and bottom of the water column
- Collecting sediment pore water samples to assess total arsenic concentrations at the 24 soft sediment sampling locations
- Performing arsenic speciation analyses on the soft sediment and pore water samples from the SCM
- Collecting geotechnical and geochemical data to evaluate how site conditions affect the movement of arsenic throughout the Menominee River

A third investigation was performed in late 2001 to fill data gaps for the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI; URS 2002). RFI activities related to the Menominee River included the following:

- Collecting and analyzing eight soft sediment samples from two locations adjacent to the 6th Street Slip to determine whether a former channel was present adjacent to the slip (Samples were collected from the 0- to 0.5-foot depth interval and then over 2-foot intervals to the base of the soft sediment.)
- Collecting and analyzing 13 soft sediment samples from five locations within the Turning Basin to further characterize sediment for a Wisconsin Department of Natural Resources (WDNR) dredging permit (Samples were collected from the 0- to 0.5-foot depth interval and then over 2-foot intervals to the base of the soft sediment.)
- Collecting groundwater samples from 16 locations in the Menominee River (Groundwater samples were collected at 5-foot intervals, beginning at a depth of 5 feet below the sediment/water interface and continuing to the top of bedrock at each location.)

A fourth investigation was performed in June 2004 to further evaluate groundwater conditions below the Menominee River (URS 2004). Sixty groundwater samples were collected from 10 locations within the river, with sampling depth intervals ranging from 5 to 40 feet below the sediment surface. Groundwater samples were analyzed for total and dissolved arsenic.

The fifth investigation was conducted in May and June 2010—the results of which are reported in the PBOD document. Soft sediment, SCM, and groundwater samples were collected to complete this pre-design investigation, filling in data gaps remaining after the June 2004 investigation. A total of 722 samples were collected and submitted for analysis of total arsenic. Sample locations are shown on Figure 2. Subsets of these samples also were submitted for arsenic speciation, the State of Wisconsin NR374 parameters (to support a dredge permit application), geotechnical analyses, and moisture content. Appendix A includes results for all samples collected and analyzed. The conceptual site model (CSM) describing the nature and extent of arsenic and the basis for remedial actions at the site (provided in Section 2) was developed based on data collected from the 2010 pre-design investigation.

1.2.2 Corrective Measures in the Resource Conservation and Recovery Act Program

Tyco has implemented a number of corrective measures through the RCRA program. Between 1999 and 2000, interim site corrective actions were completed, including constructing a slurry wall and sheet pile sections around the Salt Vault and 8th Street Slip (Figure 1), respectively, to contain groundwater with elevated arsenic concentrations. (These site features are now enclosed/contained and no longer used for their original purposes; therefore, they are referred to as the former Salt Vault and the former 8th Street Slip.) Following placement of the slurry wall and sheet pile wall, an interim corrective action was conducted in the former 8th Street Slip, including removal of the soft sediments, de-watering the slip area, filling the slip and covering with asphalt. A groundwater monitoring program was initiated to document containment of the groundwater in the area. Based on the results of the monitoring program, USEPA agreed to cease monitoring within these contained areas because the long-term effectiveness of the barriers had been well established.

Investigations conducted since 2006 have provided the information necessary to design corrective actions for the rest of the manufacturing area and the wetlands area at the site. The culmination of these investigations has been the identification of additional corrective and remedial measures that have been implemented at the facility property as required by the AOC, including installing a vertical barrier wall (VBW) system to surround the facility (Figure 1), a groundwater collection and treatment (GWCT) system to prevent flooding within the VBW, and a network of phyto-pumping tree plantings to remove additional water.

1.3 Menominee River Great Lakes Area of Concern

In 1987, the federal governments of the United States and Canada adopted amendments to the Great Lakes Water Quality Agreement (GLWQA). One of these amendments, called "Annex 2 of the 1987 Protocol," directed the two countries to identify areas of concern that did not meet the objectives of the GLWQA. The Lower Menominee River was identified as being one of the 43 Great Lakes Areas of Concern (GLAOCs).

Long-term goals for the Menominee River GLAOC include (USEPA 2010):

- Protecting the aquatic ecosystem of the Menominee River and Harbor from the effects of toxic and conventional pollutants
- Maintaining a balanced aquatic and terrestrial community to ensure long-term health of the ecosystem
- Maintaining and enhancing recreational and commercial uses of the Menominee River and Harbor, consistent with the long-term maintenance of the natural resource base and a healthy economy

This Draft Final Design Report and the SRWP were developed in consideration of these long-term goals.

SECTION 2

Conceptual Site Model

This section briefly describes key components of the CSM, including the nature and extent of arsenic concentrations in soft sediment, SCM, and glacial till units beneath the Menominee River, along with a summary of contaminant transport mechanisms and the basis for remedial action at the site. For organizational purposes, the river adjacent to the facility is divided into the following seven subareas, as indicated on Figure 1:

- Main Channel
- Turning Basin
- South Channel
- Transition Area 1
- Transition Area 2
- Transition Area 3
- 6th Street Slip

2.1 Generalized Stratigraphy and Groundwater Flow Direction

In general, four material types (or layers) are present in the upland portion of the site (Figure 3). The upper soil layer is generally comprised of fill (sand and gravel with cinders, wood chips, brick, and glass). Beneath the fill is a layer of loose to medium-dense alluvial deposits of fine- to coarse-grained sand and gravel with varying amounts of silt (alluvium). Underlying the sand is a layer of dense to extremely dense silty sand to sandy silt (compacted glacial "till" deposit). Below the dense silty sand/sandy silt is dolomitic bedrock.

In the Menominee River, typical water depths range between a few feet in the South Channel and 26 feet in the Main Channel. Soft sediment thickness ranges between less than 1 foot in the Main Channel and 8 feet in the Turning Basin (with the greatest soft sediment thicknesses occurring outside the federally authorized navigation channel), Transition Area 1, and the 6th Street Slip (Figure 4). SCM (as evidenced by its higher blow count) underlies the soft sediment, and the thickness of this layer ranges from 2 feet in the Turning Basin to 27 feet in Transition Area 3 (Figure 5). The glacial till layer beneath the SCM ranges between 0.5 foot and 7 feet thick (Figure 6). The northern portion of the river (along the shoreline outside of the Main Channel) was dredged down to bedrock in 2002, so SCM and glacial till are not present in this area. The elevations of the top of bedrock range from a low of 539.1 feet (North American Vertical Datum of 1988) at sample location SD556 within the Main Channel northeast of the Turning Basin, to a high of 562.6 feet at sample location SD501 in the western portion of the Turning Basin, directly adjacent to the southern shoreline of the Menominee River. The bedrock surface slopes east-northeast downward toward the Main Channel.

Portions of the Main Channel and Turning Basin fall within the federally authorized navigation channel. The authorized dredging depth in the federally authorized navigation channel is 21 feet below the Lake Michigan low water datum of 577.5 feet above mean sea level (ft msl) referenced to the International Great Lakes Datum of 1985. While the entire federally authorized navigation channel has not been dredged for decades to the full authorized depth, historical dredging by the U.S. Army Corps of Engineers (USACE) in the Turning Basin and Main Channel appears to have removed some of the SCM layer, and soft sediment subsequently has deposited through natural accretion directly on the surface of the till and, in areas where it remains, on top of the SCM. The outline of the approximate limits of the federally authorized navigation channel is shown on Figure 1.

Regional groundwater flow beneath the facility is generally northeast toward the Menominee River. The VBW, which was completed in fall 2010, influences the direction of groundwater flow in the vicinity of the facility. Regional groundwater flow outside the facility boundaries likely will remain generally toward the river but will be diverted around the VBW directly south of the facility.

2.2 Historical Sources of Arsenic

Arsenic concentrations in groundwater at the facility are highest in the vicinity of the former 8th Street Slip and former Salt Vault areas because of historical storage of the salts in these areas. Three primary historical transport mechanisms may have released arsenic from the former salt piles that were situated near the river. These transport mechanisms include:

- Overland transport via surface water and stormwater runoff into the Menominee River
- Windblown transport of salt into the river and surrounding environment
- Dissolution and infiltration into groundwater beneath the site with subsequent subsurface transport to the river; arsenic accumulations within the SCM primarily are attributable to this historical subsurface transport mechanism, which has since been controlled through RCRA corrective measures (see Section 1.2.2)

Figure 7 shows a conceptual depiction of these transport mechanisms.

2.3 Sediment Characterization

Several figures were prepared to depict features within the individual sediment investigation study areas. The top of the soft sediment elevation contour map is shown on Figure 8 and is based on bathymetry data collected in April and May 2010. The thickness of this soft sediment is shown on Figure 4. The soft sediment in the lower velocity areas of the river consists of highly organic silt and detritus. Soft sediment in the portions of the river with higher flow velocity also includes loosely consolidated sand and gravel. The underlying SCM unit is comprised of fine- to medium-grained sand. The elevation contour map for the top of SCM beneath the soft sediment (Figure 9) shows that the SCM unit is highest in elevation near the southern shoreline of the Turning Basin and the Transition Areas, and gradually decreases in elevation toward the northern portion of the Main Channel of the Menominee River. The thickness of the SCM is shown on Figure 5.

The glacial till situated beneath the SCM is described as dry to moist, hard silt with small to medium pebbles; firm to hard sandy silt with some gravel; and fine-grained, hard silty sand with trace gravel. The elevation of the top of the glacial till is shown on Figure 10—with a shallower elevation near the southern shoreline of the Turning Basin and becoming deeper toward the northern shore of the Menominee River, sloping in a north-northeast direction. The glacial till thickness is shown on Figure 6.

2.3.1 Main Channel

The soft sediment in the northern portion of the Main Channel of the Menominee River is comprised of loosely consolidated sands and gravel. Soft sediment in the southern portion of the Main Channel is comprised of soft, moist clay/silt with a trace to minor fine-grained sand component and a medium-grained, dark brown to dark gray sand with a minor fines component. Soft sediment deposits within the Main Channel are relatively thin, ranging from 0.3 foot to 5 feet thick.

The SCM thickness ranges from 2.5 to 16 feet in borings advanced in the Main Channel, with glacial till thickness ranging from 0.5 foot to 7 feet (Figure 5).

2.3.2 Turning Basin

Since this area has a relatively slow water velocity, soft sediment within the Turning Basin is comprised of clay/silt with a trace to minor fine-grained sand component and a medium-grained, dark brown to dark gray sand with a minor fines component. Soft sediment thickness in the Turning Basin ranges from 0.5 foot to approximately 8 feet, with most locations in the central area of the Turning Basin approximately 4 to 5 feet thick (Figure 4).

The SCM thickness ranges from 2 to 25.3 feet in borings within the Turning Basin (Figure 5). The thickest sequences of the SCM within the Turning Basin are in the eastern portion, outside the federally authorized navigation channel. The glacial till thickness within the Turning Basin ranges from 1 foot to 6.2 feet (Figure 6).

2.3.3 Transition Areas

The Transition Areas also are a slower-velocity environment, with soft sediment being comprised of soft, moist clay/silt with a trace to minor fine-grained sand component and a medium-grained, dark brown to dark gray sand with a minor fines component. Sediment thickness in the Transition Areas appears to be relatively uniform, with most locations exhibiting approximately 5 feet of soft sediment (Figure 4).

The SCM thickness ranges from 8 to 26.8 feet in borings within the Transition Areas, with the majority of the borings indicating a thickness of 25 to 26.8 feet (Figure 5). The observed glacial till thickness in the Transition Areas ranges from 0.5 foot to 2.5 feet (Figure 6).

2.3.4 6th Street Slip

Soft sediment in the 6th Street Slip is comprised of soft, moist clay/silt with a trace to minor fine-grained sand component and a medium-grained, dark brown to dark gray sand with a minor fines component. Sediment thicknesses in the 6th Street Slip range from 4 to 8 feet.

2.3.5 South Channel

Another slow-velocity environment, soft sediment in the South Channel exhibits similar characteristics as soft sediment in the 6th Street Slip and Transition Areas. The river bottom in the South Channel is largely covered with wood, wood chips, bark, and other debris from the former lumber operations in the area. The soft sediment thickness within the South

Channel ranges from 0.3 foot to 5 feet, with the thickest deposits occurring at the western end of the channel (Figure 4).

2.4 Sediment Arsenic Concentrations

The 2010 sediment investigation analytical data were used to define the lateral and vertical extents of the elevated arsenic concentrations. A detailed geostatistical analysis of these data was used to develop the dredge plans (see Section 3.3.4).

Table A1 in Appendix A summarizes sediment total arsenic concentrations measured in samples collected by CH2M HILL in April 2010 (CH2M HILL 2010). The summary statistics of the arsenic concentration by area and zone (soft sediment, SCM, glacial till, and weathered bedrock) are provided in Table 1, including the number of samples collected in each area and within each zone. Discussions for each layer and observations for concentrations between layers are discussed below. The areas requiring removal based on the analysis are shown on the dredge plans in Appendix B.

2.4.1 Soft Sediment

Within the central and western part of the Turning Basin, maximum arsenic concentrations within the soft sediment unit were greater than 500 mg/kg. However, locations in the eastern portion of the Turning Basin, adjacent to Transition Areas 1 and 2 (that is, mostly outside the federally authorized navigation channel), do not exhibit arsenic concentrations above 20 mg/kg. The highest concentrations in the Turning Basin are detected within the center of the Turning Basin and adjacent to the shoreline. Soft sediment collected from the Main Channel has concentrations exceeding 500 mg/kg adjacent to the Turning Basin. However, concentrations in soft sediment collected from the Main Channel decrease to the east and west of the Turning Basin.

Maximum concentrations of arsenic in soft sediment exceed 50 mg/kg near the southern shoreline, within the 6th Street Slip, and in the South Channel. The 50 mg/kg concentration also is in exceedance at sample locations SD533 and SD534 in Transition Area 2, and sample location SD554 in the Main Channel. Arsenic concentrations exceed 500 mg/kg in the southern portion of the site adjacent to Transition Area 3 and the former 8th Street Slip.

The soft sediment samples collected in the 6th Street Slip contained maximum arsenic concentrations above 50 mg/kg.

2.4.2 Semi-Consolidated Material

Maximum arsenic concentrations in the SCM within the Turning Basin follow a similar pattern as those found in the soft sediment. The highest concentrations (greater than 500 mg/kg) in this layer are adjacent to the southern shoreline and extend outward into the Turning Basin and the western portions of Transition Areas 2 and 3. Along the southern shoreline of the Turning Basin, the highest arsenic concentrations are in the top intervals of the SCM and concentrations generally appear to decrease with depth (Appendix B).

The zone where maximum arsenic concentrations exceed 50 mg/kg extends beyond the greater than 500 mg/kg zone, just a bit farther into the Menominee River.

2.4.3 Glacial Till

Shallow water conditions in the project area restricted access during sampling activities. As a result, a total of 28 locations were sampled in the glacial till. Arsenic concentrations for the samples collected in the glacial till ranged from less than 50 mg/kg to 300 mg/kg.

2.4.4 Comparisons across Layers

When viewing concentration results for total arsenic in the various layers, several areas exist where the arsenic concentrations are relatively low in the shallower sediment deposits, but increase at relatively deeply buried depths within the sediment column. This information is summarized in Table 2, which contains a subset of the information provided in Appendix A. The region summarized in Table 2 includes sample locations SD515, SD519, SD562, and SD574. Each of these locations is situated at least 100 feet from the southern shoreline of the Menominee River. These data suggest arsenic in this area of the semi-consolidated zone has been transported by groundwater from the site rather than originating from soft sediment at the surface.

SECTION 3

Menominee River Sediment Removal Plan

3.1 Project Objectives

Consistent with the SRWP (CH2M HILL 2010), soft sediment and SCM containing total arsenic concentrations greater than or equal to 50 mg/kg will be removed from the Menominee River adjacent to the facility, and monitored natural recovery (MNR) will be used to address sediment with total arsenic concentrations between 20 and 50 mg/kg.

3.2 SRWP Corrective Action Plan

Data from the 2010 pre-design investigation, as well as previous investigations, were used to develop this Draft Final Design. As described in Section 3.3.4, the physical and chemical site characterization data were evaluated and input into a three-dimensional (3D) model, with kriging methodology used to interpolate the arsenic sample data set.

The model was used to determine dredge removal prisms and to calculate associated volumes. This was an iterative process between the PBOD figures with generalized representations of the contaminated areas and the more refined Draft Final Design dredge prisms.

This section describes the SRWP approach for removal, stabilization, and disposal of the targeted sediment. After USEPA reviews the Draft Final Design, Tyco will implement corrective activities as appropriate.

Dredging, stabilization, and disposal corrective actions will be implemented in phases. During the corrective action activities, some phases may be performed simultaneously with others. The sediment remediation preliminary design drawings in Appendix B provide additional details regarding the corrective activities. Phases also are depicted in the Plans and Specifications included in Appendix B. The proposed construction phases include the following:

1. **Phase I (Mechanical Dredging of Contaminated Soft Sediment in the Turning Basin)**: Soft sediment containing total arsenic concentrations greater than or equal to 50 mg/kg that is located within the Turning Basin and small portions of the Main Channel and Transition Area 2 will be mechanically dredged using an environmental clamshell bucket and stabilized onsite. The stabilization process will reduce the concentration of leachable arsenic in the sediment such that it passes the toxicity characteristic leaching procedure (TCLP) test with less than 5 milligrams per liter (mg/L) of total arsenic. The stabilized soft sediment then will be transported for disposal at an offsite RCRA Subtitle D (nonhazardous) landfill.
2. **Phase II (Mechanical Dredging of Contaminated SCM in the Turning Basin):** The SCM that underlies the soft sediment dredged in Phase I containing total arsenic concentrations greater than or equal to 50 mg/kg will be mechanically dredged using a

standard clamshell bucket and, if necessary, stabilized onsite. The stabilized SCM then will be transported for disposal at an offsite RCRA Subtitle D landfill. Some mechanical dredging of SCM also will be performed in the Main Channel and small portions of Transition Areas 2 and 3. The lateral extent of Phase II is shown in Appendix B.

3. **Phase III (Mechanical Dredging of Contaminated Soft Sediment in the Transition Areas and 6th Street Slip):** Soft sediment located within the remaining Transition Areas and the 6th Street Slip containing total arsenic concentrations greater than or equal to 50 mg/kg will be mechanically dredged using an environmental clamshell bucket and will be stabilized onsite. The stabilized soft sediment then will be transported for disposal at an offsite RCRA Subtitle D (nonhazardous) landfill.

4. **Phase IV (Mechanical Dredging of Contaminated SCM in the Transition Areas):** The SCM that underlies the soft sediment dredged in Phase III and/or that contains total arsenic concentrations greater than or equal to 50 mg/kg will be mechanically dredged using a standard clamshell bucket and, if necessary, stabilized onsite. The stabilized SCM then will be transported for disposal at an offsite RCRA Subtitle D landfill.

5. **Phase V (Mechanical Dredging of Contaminated Soft Sediment in the South Channel):** The soft sediment located within the South Channel with total arsenic concentrations greater than or equal to 50 mg/kg will be excavated. Due to the significant amount of debris within the South Channel, an environmental bucket will not be utilized. Soft sediment will be mechanically removed with a standard clamshell bucket or excavator, and if necessary, stabilized onsite. The stabilized soft sediment then will be transported for disposal at an offsite RCRA Subtitle D landfill.

6. **Phase VI (Monitoring Natural Recovery):** Sediment containing arsenic concentrations between 20 and 50 mg/kg will be left in place. These and other sediment areas at the site will be monitored to verify anticipated natural recovery. Monitoring activities will be described under a separate plan. It is anticipated that sufficient MNR data will be collected within 10 years following implementation of Phases I through V to permit a review of the remedy’s effectiveness.

The corrective activities consist of the key components outlined in the subsection that follow.

3.2.1 Pre-Dredging Activities

- Mobilizing equipment and personnel
- Completing minor improvements to the existing asphalt surface in the former Salt Vault area for use as a staging pad
- Demarcating roads on the existing asphalt surface for trucks to travel
- Constructing a temporary mooring structure along the shoreline of the facility
- Installing a temporary water treatment system and other temporary infrastructure at the Facility and 6th Street Slip area
- Installing turbidity monitoring equipment in the river

- Developing the relationship between turbidity and total suspended solids (TSS)
- Performing a bathymetric survey to document the pre-dredge sediment elevations
- Installing turbidity control devices (such as silt curtains) in the river

3.2.2 Phase I Activities (Mechanical Dredging of Contaminated Soft Sediment in the Turning Basin)

- Mechanically dredging approximately 43,300 cubic yards (yd^3) of soft sediment in the Turning Basin that contains arsenic equal to or greater than 50 mg/kg using an environmental bucket[1], following best management practices (BMPs), and loading the sediment into watertight hopper barges (This volume includes 6 inches of overdredge allowance, calculated to compensate for inaccuracies of the dredging process and hydrographic surveying, which results in an additional 1,300 yd^3 of soft sediment that will be potentially removed in areas not underlain with SCM targeted for removal in Phase II.)
- Transporting sediment loaded hopper barges to the offloading area adjacent to the facility
- Pumping free water off the dredged material to the temporary water treatment system
- Offloading dredged material from the hopper barges (Free water that drains from the offloaded, dredged material that is stockpiled before stabilization will be pumped to the temporary water treatment facility. Active dewatering of the dredged material is not planned.)
- Stabilizing the dredged material with suitable reagents to reduce leachable arsenic, eliminate free water, and provide strength gain
- Handling and processing of debris for inclusion with the soft sediment being disposed offsite
- Allowing sufficient time for reagents added to the sediment to react sufficiently to meet landfill acceptance criteria
- Placing the stabilized sediment into lined trucks
- Covering the truck bed and decontaminating the exterior of the trucks
- Transporting the sediment to an offsite RCRA Subtitle D landfill
- Collecting and treating wastewater through the temporary water treatment system
- Performing ongoing monitoring activities consisting of monitoring dredge-generated turbidity in the river, arsenic concentrations in the water treatment system effluent, and stabilized sediment disposal parameters (that is, TCLP, paint filter, and field soil strength testing), and fugitive dust emissions from the in situ stabilization activities

[1] Environmental bucket and best management practices are defined in Sections 5.3.1 and 5.8.1, respectively.

- In areas where no SCM will be excavated below the soft sediment, performing confirmation sampling to document remaining arsenic concentrations for the final surface weighted average concentration (SWAC) calculations
- If necessary, removing additional soft sediment based on the initial confirmation sampling, followed by additional confirmation sampling
- Performing a bathymetric survey to document the post-Phase I subsurface elevations

3.2.3 Phase II Activities (Mechanical Dredging of Contaminated SCM in the Turning Basin)

- Mechanical dredging of approximately 77,600 yd^3 (including 6-inch overdredge) of SCM in the Turning Basin that contains arsenic in concentrations greater than or equal to 50 mg/kg using a standard clamshell bucket, and loading the material into watertight hopper barges (NOTE: The environmental bucket used during Phase 1, soft sediment removal, will be utilized initially to the extent practicable during dredging of the SCM. The dredger will switch to the standard clamshell bucket as production rates decline.)
- Transporting sediment loaded hopper barges to the mooring area adjacent to the facility
- Pumping free water off the dredged material to the temporary water treatment system
- Offloading dredged material from the hopper barges (Free water that drains from offloaded, dredged material that is stockpiled before stabilization will be pumped to the temporary water treatment facility. Active dewatering of the dredged material is not planned.)
- Stabilizing, as necessary, the dredged material with suitable reagents to reduce leachable arsenic and eliminate free water
- Handling and processing of debris for inclusion with the SCM being disposed offsite
- Allowing sufficient time for reagents added to the material to react sufficiently to meet landfill acceptance criteria
- Placing the stabilized material into lined trucks
- Covering the truck bed and decontaminating the exterior of the trucks
- Transporting the stabilized material to an offsite RCRA Subtitle D landfill
- Collecting and treating wastewater through the temporary water treatment system
- Performing ongoing monitoring activities consisting of monitoring dredge-generated turbidity in the river, arsenic concentrations in the water treatment system effluent, and stabilized sediment disposal parameters (that is, TCLP, paint filter, and field soil strength testing), and fugitive dust emissions from the in situ stabilization activities
- Performing confirmation sampling to document remaining arsenic concentrations for the final SWAC calculations, and/or that glacial till has been reached
- Performing a bathymetric survey to document the post-Phase II subsurface conditions

3.2.4 Phase III Activities (Mechanical Dredging of Contaminated Soft Sediment in the Transition Areas and 6th Street Slip)

- Mechanical dredging of approximately 42,000 yd^3 (including 6-inch overdredge) of soft sediment in the Transition Areas that contain arsenic equal to or greater than 50 mg/kg using an environmental bucket[2], following BMPs, and loading the sediment into watertight hopper barges
- Transporting loaded hopper barges to the mooring area adjacent to the facility
- Removal and transport of debris separate from the sediment
- Pumping free water off the dredged material to the temporary water treatment system
- Offloading dredged material from the hopper barges to a temporary stockpile or, depending on available stabilization capacity, directly to the stabilization process (Free water that drains from the offloaded, dredged material that is stockpiled before stabilization will be pumped to the temporary water treatment facility. Active dewatering of the dredged material is not planned.)
- Stabilizing the dredged material with suitable reagents to reduce leachable arsenic, eliminate free water, and provide strength gain
- Handling and processing of debris for inclusion with the soft sediment being disposed offsite
- Allowing sufficient time for reagents added to the sediment to react sufficiently to meet landfill acceptance criteria
- Placing the stabilized sediment into lined trucks
- Covering the truck bed and decontaminating the exterior of the trucks
- Transporting the stabilized sediment to an offsite RCRA Subtitle D landfill
- Collecting and treating wastewater through the temporary water treatment system
- Performing ongoing monitoring activities consisting of monitoring arsenic concentrations in the water treatment system effluent, stabilized sediment disposal parameters (that is, TCLP, paint filter, and field soil strength testing), and fugitive dust emissions from the in situ stabilization activities
- In areas where no SCM will be excavated below the soft sediment, perform confirmation sampling to document remaining arsenic concentrations that will be used in the final SWAC calculations, and a bathymetric survey to document the post-Phase III subsurface conditions

[2] Environmental bucket and best management practices are defined in Sections 5.3.1 and 5.8.1, respectively.

3.2.5 Phase IV Activities (Mechanical Dredging of Contaminated SCM in the Transition Areas)

- Mechanical dredging of approximately 76,400 yd^3 (including 6-inch overdredge) of SCM in the Transition Areas that contain arsenic concentration greater than or equal to 50 mg/kg using a standard clamshell bucket, and loading the material into watertight hopper barges (NOTE: The environmental bucket used during Phase 1, soft sediment removal, will be utilized initially to the extent practicable during dredging of the SCM, switching to the standard clamshell bucket as production rates decline.)
- Transporting loaded hopper barges to the offloading area adjacent to the facility
- Pumping free water off the dredged material to the temporary water treatment system
- Offloading dredged material from the hopper barges to a temporary stockpile or directly to the stabilization process depending on available capacity (Free water that drains from offloaded, dredged material that is stockpiled before stabilization will be pumped to the temporary water treatment facility. Active dewatering of the dredged material is not planned.)
- Stabilizing, as necessary, the dredged material with suitable reagents to reduce leachable arsenic and eliminate free water
- Handling and processing of debris for inclusion with the SCM being disposed offsite
- Allowing sufficient time for reagents added to the material to react sufficiently to meet landfill acceptance criteria
- Placing the stabilized material into trucks
- Covering the truck bed and decontaminating the exterior of the trucks
- Transporting the stabilized material to an offsite RCRA Subtitle D landfill
- Collecting and treating wastewater through the temporary water treatment system
- Performing ongoing monitoring activities consisting of monitoring arsenic concentrations in the water treatment system effluent and stabilized material disposal parameters (that is, TCLP, paint filter, and field soil strength testing)
- Performing confirmation sampling to document remaining arsenic concentrations for the final SWAC calculations, and/or that glacial till has been reached
- Performing a bathymetric survey to document the post-Phase IV subsurface conditions

3.2.6 Phase V Activities (Mechanical Dredging of Contaminated Soft Sediment in the South Channel)

- Mechanical dredging of approximately 11,000 yd^3 (including overdredge) of soft sediment in the Turning Basin that contains arsenic equal to or greater than 50 mg/kg using a standard clamshell bucket or excavator, following BMPs, and loading the sediment into watertight hopper barges

- Transporting sediment loaded hopper barges to the mooring area adjacent to the facility
- Removal and transport of debris separate from the sediment
- Pumping free water off the dredged material to the temporary water treatment system
- Offloading dredged material from the hopper barges (Free water that drains from offloaded, dredged material that is stockpiled before stabilization will be pumped to the temporary water treatment facility. Active dewatering of the dredged material is not planned.)
- Stabilizing, as necessary, the dredged material with suitable reagents to reduce leachable arsenic, eliminate free water, and provide strength gain
- Allowing sufficient time for reagents added to the material to react sufficiently to meet landfill acceptance criteria
- Placing the stabilized material into lined trucks
- Covering the truck bed and decontaminating the exterior of the trucks
- Transporting the stabilized material to an offsite RCRA Subtitle D landfill
- Collecting and treating wastewater through the temporary water treatment system
- Performing ongoing monitoring activities consisting of monitoring dredge-generated turbidity in the river, arsenic concentrations in the water treatment system effluent, and stabilized material disposal parameters (that is, TCLP, paint filter, and field soil strength testing)
- Performing confirmation sampling to document remaining arsenic concentrations for the final SWAC calculations
- Performing a bathymetric survey to document the post-Phase V subsurface conditions

3.2.7 Post-Dredging Activities (Demobilization and Site Restoration)

Upon completing all remedial work at the project site, demobilize equipment and restore the site. Demobilization and Site Restoration activities will include the following:

- Decontamination and dismantlement of all equipment used for dredging, sediment processing, and water treatment
- Teardown, removal, and offsite disposal of temporary infrastructure built on the Tyco property and offsite property
- Restoring the Tyco property and offsite property to pre-corrective action conditions, to the extent practical; the South Channel restoration activities are presented in Section 5.8.1
- Demobilizing equipment and personnel

3.2.8 Phase VI Activities (Monitoring Natural Recovery)

Soft sediment and SCM containing arsenic at concentrations between 20 and 50 mg/kg will be left in place, and MNR will be implemented for approximately 10 years following dredging activities. An MNR monitoring plan will be submitted separately in accordance with the AOC.[3]

3.3 Design Components

This section describes the major components of the Draft Final Design.

3.3.1 Bathymetric and Sediment Thickness Surveys

A bathymetric survey of the 2010 sediment investigation area within the Menominee River, including the Main Channel, Turning Basin, Transition Areas, 6th Street Slip, and the South Channel areas, was completed in April 2010 (CH2M HILL 2010). Additionally, water depth and sediment thickness data were collected during the May-June 2010 sediment sampling events. These data were combined to establish the estimated soft sediment surface elevations.

Before performing in-water work, a pre-dredge bathymetric survey will be performed that covers all areas to be dredged. A post-dredge bathymetric survey will be performed at the conclusion of each phase of mechanical dredging activities (Phases I, II, III, IV, and V) to document post-dredge conditions and establish payment quantities.

3.3.2 Bulkhead/Shoreline Stability

The VBW installed along the shoreline adjacent to the facility as a waterfront bulkhead structure, a critical component of the upland remedy, consists of steel sheet piling, most of which was installed in 2010. In addition, a cofferdam was installed around the former 8th Street Slip in the late 1990s. Some of the sheet piling is supported with tieback anchors (deep water), and other segments are entirely cantilever-supported (shallow water).

As previously described in the SRWP (CH2M HILL 2010), removing impacted SCM adjacent to the older sheet pile wall (in the vicinity of the former 8th Street Slip) was presented as technically impractical, because removing all of the SCM with arsenic concentrations greater than or equal to 50 mg/kg would result in failure of the sheet pile wall.

As part of the iterative design process between the PBOD and this Draft Final Design, CH2M HILL determined that bulkhead stability is also a serious issue for the VBW sheet piling installed in 2010. As-builts of the waterfront bulkhead sheet piling were evaluated against the anticipated dredging depths of material with concentrations greater than or equal to 50 mg/kg. The sheet piles for the bulkhead structure were designed with a minimum 13-foot embedment into dense soils to provide adequate support (AECOM, 2008). Figures 11A through 11K show the as-built toe depth of the individual sheets compared to the potential dredge depths. The resultant embedment after dredging is well below the minimum 13-foot requirement. If dredging is required in this area, in order to prevent failure of the sheet pile wall, temporary supports would have to be installed prior to

[3] "Respondent shall submit the monitoring plans for the monitored natural recovery and barrier wall monitoring 90 days before completion of construction of these components [90 days prior to completion of sediment removal]" per Attachment 2, Section IV.A, 2nd paragraph, of the AOC.

dredging, and backfill will need to be placed adjacent to the sheet piling after dredging and prior to removal of the temporary supports.

Serious technical, engineering, and schedule concerns exist about whether temporary shoring would be safe and effective in many of these areas. Further concerns exist about potentially compromising the integrity of the upland remedy's VBW. In addition, the cost to construct temporary shoring for both bulkheads is anticipated to be over $6 million. Consequently, full dredging up to the bulkheads is of great technical concern, as well as cost-prohibitive.

Best management practices at numerous other completed dredging projects have recognized the concerns over bulkhead stability and have relied on capping as a practical, implementable workaround. Such caps include appropriate slopes (typically a ratio of 4 horizontal to 1 vertical) and armor stone, if necessary, based on hydrodynamic and prop wash considerations.

CH2M HILL recommends utilizing BMPs to address the bulkhead shoring infeasibility and cost issues. The final design for addressing issues related to bulkhead stability will be further evaluated and discussed with the Agencies. The final design on this issue will be completed prior to mobilization for spring 2012 work.

3.3.3 Utilities

Thew Associates performed a utility survey in April 2010 prior to CH2M HILL conducting subsurface investigation activities. A buried high-density polyethylene waterline crossing the South Channel was identified at two spots during the April-May 2010 work, as well as an electrical line associated with the bridge at Ogden Street. It is unlikely that soft sediment removal in the South Channel will come close to these utilities, but this will be verified during remediation. Before beginning work, the presence and locations of utilities will be verified, including buried and overhead utilities that may affect implementation of the work.

3.3.4 Extent of Arsenic Requiring Sediment Remediation

3.3.4.1 Geostatistical Modeling Interpolation Method

A 3D interpolation method was used to delineate total arsenic concentrations in the soft sediment, SCM, and glacial till units. The model was used to aid in developing the dredge plans and associated volumes. The computer application, Environmental Visualization System (EVS)-Pro Version 9.4 (Environmental Visualization System, produced by C-Tech Development Corporation) was used to interpolate arsenic concentrations from individual sampling points to a dense 3D mesh. The general procedures for mesh generation and for selecting the interpolation parameters are outlined below.

Key attributes of the EVS-Pro-based interpolation approach for delineating the arsenic extent include the following:

- The physical data set includes sediment thickness data collected during sediment core sampling and drill rig sampling collected by CH2M HILL during April-May 2010 (CH2M HILL 2010). The physical data set was used to develop the model's vertical extent represented by each of the geologic layers (soft sediment, semi-consolidated material, and glacial till).

- The analytical dataset used includes results from sediment core sampling and drill rig sampling collected by CH2M HILL during April-May 2010 (CH2M HILL 2010) and was used to determine the horizontal and vertical extent of various arsenic isosurface concentrations within each of the geologic layers through the 3D modeling process. Analytical results from quality assurance (QA)/quality control (QC) samples, such as field duplicate results, were excluded.
- Arsenic concentrations were represented as point values located at corresponding horizontal coordinates (for example, northing and easting) for each sample location. The vertical position was represented by the middle of the sampling interval.
- Each zone-specific model was built on rectilinear-bounded grids limited to the areal extent of each subzone. An X and Y axis cell resolution of 35 by 25 feet was utilized. The Z axis mesh spacing is 35, which represents a maximum Z-spacing of 1.0 foot to represent the analytical sample interval resolution at the maximum sediment thickness value (35 feet).
- The arsenic concentration distribution was modeled within the 3D mesh using a geostatistical process called kriging. The interpolation process utilized the adaptive gridding option. Adaptive gridding automatically refines gridding in the cells surrounding measured samples to ensure the interpolated results and isosurfaces accurately honor measured sample data.

3.3.4.2 Results

Determination of the volume of sediment requiring remediation was based on a criterion of 50 mg/kg total arsenic, applied on a geostatistical basis as outlined above. Based on data collected during May-June 2010, approximately 250,000 yd^3 of arsenic-contaminated material (including an estimated average 6-inch overdredge allowance) will require remediation. Of this total, 96,000 yd^3 is present as soft sediment and 154,000 yd^3 is present as SCM. These volumes include the same average 6-inch overdredge depth, as well as a 4:1 (horizontal to vertical) sideslope stability allowance for soft sediment removal.

SECTION 4

Corrective Action Design—Project Delivery Strategy

4.1 Preliminary Design

The objectives of the preliminary design were to define, in detail, the technical parameters upon which the design was based, develop the conceptual site remediation strategies for review with the agencies, and, to the extent possible, finalize the strategies so the Draft Final Design may proceed with minimal changes (for example, minimal cost and schedule impacts). The PBOD document represented a refinement of the preliminary design as originally proposed in the SRWP in December 2010 (CH2M HILL 2010), and reflected implementation details developed through ongoing discussions between USEPA and Tyco.

4.2 Draft Final Design

The Draft Final Design is presented herein. Specifically, the design details and conceptual remediation strategies developed during the preliminary design and described in the PBOD (CH2M HILL 2011) were expanded into a set of Draft Final Design documents consisting of the following:

- Design report
- Specifications
- Drawings
- Site-specific plans
- Biddability, operability, and constructability reviews
- Revised project delivery strategy

Detailed design drawings and specifications were prepared for all key project components. Design drawings and specifications are included in Appendix B. There are two separate packages included; one package is for the dredging, stabilization/solidification, and disposal work, and the other package is for setup and operation of the water treatment system. The successful bidder of the first package will become the dredging subcontractor, and the successful bidder of the second package will become the water treatment subcontractor. These subcontractors will be required to develop a detailed work plan, describing how the work will be executed to meet the requirements of the plans and specifications.

SECTION 5

Design Approach, Assumptions, and Parameters

This Design Report includes a description of the mechanical dredging support facilities, equipment, and activities. This approach will be submitted as part of the permitting process. During the bid process, bidders for the work will be required to provide a general description of their proposed site layout, dredging equipment, water treatment system, and procedures, so that significant proposed modifications can be discussed and evaluated before award of the contract. In addition, before starting the work, the dredging subcontractor will provide a detailed work plan that will describe the specifics of the proposed mechanical dredging activities.

5.1 Minimizing Environmental and Public Impacts

One of the primary objectives of the dredging operations is to minimize environmental and public impacts. This is achieved through permitting and planning during the design phase, as well as adherence to environmental controls and monitoring while executing the dredging project. Permitting details are presented in Section 6.

5.1.1 Execution of Dredging Activities

Project information will be communicated with local property owners and other members of the general public before and during the corrective activities to limit the impacts of the project to residents and commercial and recreational activities.

During dredging activities, BMPs will be employed to control the resuspension of sediment; BMPs are described in Section 5.6.1. Turbidity will be monitored continuously and a site-specific relationship between turbidity and TSS will be developed. Exceedances will be communicated to the dredging subcontractor so modifications to the process or equipment can be made as necessary, as described in Section 7. It is important to note that control of sediment resuspension does not correlate with control of potential dissolved arsenic release, and based on preliminary water quality modeling, exceedances of Wisconsin's acute toxicity water quality criterion for arsenic in surface water could occur even with implementation of all practicable BMPs. Air monitoring, post-dredging confirmation sampling, and post-dredging bathymetric surveys will be conducted as described in Section 7.

5.2 Site Preparation and Mobilization

5.2.1 Site Preparation and Mobilization Activities

Before mobilization to the site, the dredging subcontractor will verify necessary permits have been obtained and that corrective activities will be in compliance with the requirements of these permits. In addition, the dredging subcontractor will deliver necessary preconstruction submittals to Tyco for approval before mobilization.

Before mechanical dredging, the dredging subcontractor will perform site preparation activities at the Tyco property used for the mechanical dredging and stabilization activities as shown on the drawings in Appendix B). These activities are necessary to allow heavy equipment to access all of the portions of the site and to ensure protection of the environment during the dredging activities. The former Salt Vault area (asphalt pad) and the former 8th Street Slip will be used as the staging, stockpiling, and stabilization areas. The 6th Street Slip area will be used for setup of the water treatment system. Mobilization and site preparation activities will include the following:

- Mobilization of equipment and personnel
- Establishment of physical construction limits at the site with temporary fencing or other means of demarcation
- Construction of barriers to contain onsite storm water, decontamination rinse water, and process water on the former 8th Street Slip and 6th Street Slip areas, including construction of sumps and pipelines to collect and convey the water to the water treatment system
- Establishment of storm water pollution prevention and erosion control features along all disturbed areas of the site
- Set up of site trailers for the water treatment and dredging subcontractors and the oversight contractor
- Construction of temporary partitions on the existing asphalt surface in the former Salt Vault and former 8th Street Slip to create areas for staging, stabilization, and stockpiling
- Construction of a temporary mooring structure at the shoreline of the site
- Construction of a temporary water treatment system
- Installation of turbidity monitoring equipment in the river

5.2.2 Asphalt Pad and Site Access Roadways

The corrective activities described in this Design Report require expanding the existing asphalt pads at the 6th Street and former 8th Street Slips to accommodate the required equipment and allow truck access. The drawings (Appendix B) include an overall site plan and details. Separate areas will be established on the asphalt surface near the former Salt Vault to accommodate the reagent storage, dredged material stabilization, pre- and post-stabilized material temporary stockpiling, and decontamination for trucks hauling stabilized sediment offsite. Designated haul routes will be demarcated on the existing asphalt areas. A description of each of these items is included below.

5.2.2.1 Asphalt Concrete Pads—Former Salt Vault and Former 8th Street Slip Areas

The existing asphalt surfaces in the former Salt Vault and the former 8th Street Slip areas will be used as the staging/soil stabilization areas. In the former Salt Vault area, there is an existing 250-foot–by-250-foot asphalt concrete staging pad with 2-foot-high sealed concrete sidewalls along with a 1 percent slope toward the drain outlet on the west sidewall. The pad area consists of a 6-inch-thick asphalt concrete layer constructed over a compacted fill and a gravel layer. In the former 8th Street Slip area, there is a 4-inch-thick asphalt concrete layer constructed over a layer of compacted imported sand. The northeast corner of this area will be expanded to accommodate stabilization material deliveries. This additional area will be removed at the completion of the work and restored to the original grade and seeded.

The area of the 8th Street Slip adjacent to the turning basin will be used for treating the dredged sediments. Dredged material will be unloaded from barges, screened, and stabilized in a pugmill. The stabilization process is described in the following sections.

The stabilized material will be placed in individual bays and allowed to cure. These curing bays are located on asphalt pavement in the Salt Vault area and the center of the slip area. Each bay is design to contain approximately 1 day's volume of stabilized dredge material. The stabilization testing (Appendix C) indicates up to 7 days could be needed to cure the stabilized material, and since the TCLP test has a 4-day turnaround, a total of 11 curing bays are shown on the site plan.

The southern portion of the site contains areas for truck decontamination, tarping, inspection, scales, and office trailers. Access to the work site will be controlled at all times by fencing and locked gates or security personnel.

The perimeter boundary of the site will have a temporary water containment barrier. The purpose of the barrier is to contain any storm water that potentially comes in contact with contaminated dredge material. The containment barrier will be designed to handle the runoff generated by a storm with a 25-year return period, which is estimated to be 4.24 inches (MCC Research Report 92-01). The containment barrier will also contain decontamination water and water from the unloading or stabilization process. The water will be collected in the sump of the former Salt Vault and a catch basin installed at the low point of the site. This water will be pumped to the project water treatment facility at the 6th Street Slip. Infiltration in the area will be minimal because the surface is asphalt concrete. Water that does seep through the asphalt concrete pad will be contained onsite by the VBW, and extracted and treated by the permanent site GWCT system.

5.2.2.2 Asphalt Concrete Pad—6th Street Slip Area

The 6th Street Slip area will be closed to the public and used for the temporary water treatment system. The current paved area is approximately 100 feet wide by 450 feet long. The paved area of the site will be widened by approximately 50 feet to accommodate the planned treatment system and vehicle traffic. The treatment system will be located on the eastern side of the site. City of Marinette facilities (pavilion, boat dock) will be protected in place or removed, stored, and re-installed at the completion of the project.

A temporary security fence will be installed around the perimeter of the 6th Street Slip to control access. Although the water treatment is self-contained and storm water contact with contaminated material is not anticipated, a perimeter containment barrier will be installed as a precaution. This barrier will contain storm water onsite. A catch basin will be installed in the northeast corner of the site to collect any storm water. The water will be pumped to the water treatment system for treatment and disposal.

5.2.2.3 Temporary Access Roads

There is an existing gravel road between the former 8th Street Slip and the 6th Street Slip areas located on Tyco property. The roadway will be improved by the addition of a woven geotextile and compacted aggregate base material. Trucks delivering material or transporting stabilized material for disposal will enter the site at 6th Street and follow the access to the 8th Street site. This allows for one-way traffic flow and staging of trucks off of city streets. The planned onsite traffic routes are shown on the remediation plans in Appendix B. A security fence will be installed along this road to control site access and improve safety. For the safety of site personnel, traffic cones, barrels, or signage will be used to demarcate travel areas for trucks hauling materials to and from the site to keep truck traffic confined to these areas.

5.2.2.4 Asphalt Concrete Pad and Temporary Access Road Removal and Disposal

Once the dredging activities are completed, all equipment will be cleaned and removed from site. The asphalt concrete surfaces will be washed off, and the resulting wastewater will be captured and treated in the temporary onsite water treatment system. The areas that were expanded and paved will have the pavement removed, the site graded to pre-construction contours, and the area seeded with grass. Project areas where the existing asphalt concrete surface has been damaged by the remediation activities will be repaired and resurfaced.

Any gravel or other materials placed for temporary access roads will be removed and disposed offsite. The area will be graded to pre-construction contours and the site seeded with grass.

5.3 Mechanical Dredging

Approximately 96,000 yd^3 of soft sediment and 154,000 yd^3 of SCM containing arsenic greater than or equal to 50 mg/kg (including overdredge) will be mechanically dredged from the river using the approach as shown on the drawings in Appendix B. The thickness of soft sediment to be mechanically dredged ranges from less than 1 foot to a maximum of 8 feet. The contaminated SCM thickness within the mechanical dredging area ranges from 6 to 25 feet. Water depth below low-water datum within the mechanical dredging areas is up to 21 feet deep adjacent to the Main Channel. The water depth in the Transition Area ranges between 1 and 5 feet. The water depth in the South Channel subarea is between 1 and 2 feet.

The performance standards for the mechanical dredging consist of the following:

- Removing soft sediment to specified elevations
- Removing SCM to specified elevations
- Minimizing sediment resuspension below the specified TSS standard

The dredging subcontractor will perform bathymetric surveys before and after dredging. These bathymetric surveys will be used to determine if the specified dredge cuts have been achieved, as well as to provide a final dredged sediment volume for payment.

5.3.1 Dredging Equipment

Mechanical dredging of contaminated soft sediment will be performed with a crane and environmental clamshell bucket having the following capabilities and characteristics:

- Provides a level cut during the closing cycle
- Completely encloses the dredged sediment and water captured

- Has escape valves or vents that close when the bucket is withdrawn from the water
- Has a smooth cut surface, with no teeth
- Is controlled by the operator using global positioning system (GPS) equipment with integrated software that allows:
  - The bucket position to be monitored in real time
  - The specified horizontal and vertical accuracy requirements to be met
  - The operator to control bucket penetration to avoid overfilling and minimize sediment resuspension

An environmental bucket will be used to dredge the soft sediment and as much SCM as readily possible. However, the consolidated nature of the SCM, as evidenced by its high blow count, is expected to preclude the use of an environmental bucket for mechanical dredging. Therefore, most, if not all, of the SCM will be dredged with a conventional clamshell bucket with teeth having the following capabilities and characteristics:

- Can cut into the densely compacted SCM
- Is controlled by the operator using GPS equipment with integrated software that allows:
  - The bucket position to be monitored in real time
  - The specified horizontal and vertical accuracy requirements to be met

5.3.2 Dredging Sequence

The sequence of mechanical dredging and other corrective activities were described in Section 3.2. Phases also are shown in the project plans in Appendix B.

5.3.3 Dredging, Offloading, and Stabilization Processes

The mechanical dredging, offloading, and stabilization processes described in this section are intended to demonstrate one possible way of performing these activities. The dredging subcontractor will propose a specific approach, which will include a description of proposed site layout, equipment, stabilization and solidification reagents, and sequencing. The dredging subcontractor will implement its approach if, after an evaluation by the oversight contractor, the proposed process is cost-effective and can reasonably be expected to meet performance criteria such as production rates and TSS standards, and new or revised permits can be obtained without negatively affecting the schedule.

Solidification and stabilization of dredged materials will be performed to meet the following performance metrics: (1) allow the materials removed from the river to be classified as non-hazardous based on the TCLP test for arsenic (criterion of 5 mg/L); (2) remove free water from the materials to enable them to pass the USEPA Paint Filter Test; and (3) give the materials sufficient strength so they can be accepted by the landfill for disposal (shear strength value to be determined by the landfill and will be provided to bidders upon receipt).

The dredging subcontractor has some latitude in selection of dredging and excavation equipment and methods, but the general process of removing contaminated materials from the river is described here. The majority of materials will be removed from the river by mechanical dredging using a crane with an environmental clamshell bucket or a standard clamshell bucket. The exception to this is material removed from the South Channel, which will likely require removal via an amphibious or barge-mounted tracked excavator. Mechanically dredged materials will be loaded into hopper barges (with an estimated capacity of 550 yd^3), and filled barges will be moved adjacent to a support barge along the western side of the former 8th Street Slip for subsequent decanting of excess dredge water and offloading operations.

Materials from the South Channel will be placed in a rolloff container staged on modular barges. When the rolloff container is full, it will be moved over to a dedicated hopper barge staged on the eastern side of the former 8th Street Slip, where the rolloff container will be unloaded into the hopper barge by pumping the material. Two rolloff containers on barges will be used to keep the South Channel excavation process moving. These barges will require only 3.0 feet of draft once the rolloff container is filled. Each barge assembly will be equipped with an integrated hydraulic barge pusher unit to eliminate the need for a pushboat.

There are four categories of materials that will be removed from the river, as shown in the table above. Three of these types of materials, mechanically dredged soft sediment, South Channel soft sediment, and higher contamination SCM, will need to go through a pugmill and be stabilized with reagents. The other material, lower contamination SCM, will likely not need stabilization. The handling and stabilization processes for these materials are described below. Similar to the dredging, even though specific equipment and reagents are described here, the dredging subcontractor will provide his own stabilization process/equipment/reagents to conduct the work. Due to the close proximity of active manufacturing operations, the Menominee River, and a wetland area, the sediment removal and stabilization operations will need to be performed in a manner that captures potential spillage of contaminated materials and bulk pozzolan/reagent materials.

5.3.3.1 Soft Sediment

Mechanically Dredged Soft Sediment

Hopper barges filled with mechanically dredged soft sediment will have excess water decanted and pumped out to a temporary water treatment system installed and operated by others and located at the 6th Street landing. If possible, the dredged material will be pumped out of the hopper barges and delivered to a pugmill unit using twin Toyo DB-75B pumps manifolded together, with a total capacity of 100 yd^3 per hour (yd^3/hr). Debris remaining in the hopper barge after pump out will be removed from the barge using a material rehandler excavator and will be placed in a rolloff container for subsequent resizing and incorporation into the pugmill as described below.

If dredged material is too coarse or dry to pump, it will be removed from the hopper barge using a material rehandler excavator with a clamshell bucket and placed onto a coarse grizzly bar screen for segregation of greater than 6-inch debris fractions, followed by a 2-inch vibratory screen to remove intermediate sized rocks and other debris. The material passing through the screen will be transported via conveyor to the pugmill unit. Debris will be placed in a rolloff container for subsequent resizing and incorporation into the pugmill as described below.

Reagents/pozzolan materials will be blended with screened dredged materials in a pugmill unit, such as the Rapid International Ltd. Rapidmix 400 C. The pugmill will utilize an electronic belt scale material feed conveyor and reagents/pozzolan materials will be electronically metered into the pugmill mixing tank to ensure proper dosage. Pozzolan and reagents will be delivered to the site as needed so that sufficient supply is available for ongoing operations. Based on the anticipated quantity of pozzolan materials needed and the fact that operations are being performed in close proximity to a cantilevered sheet wall, pozzolan materials will likely need to be stored in horizontal "guppy" silos, such as those produced by Diversified Storage Systems. Pozzolan and reagents will be fed into the pugmill unit via variable-frequency drive feeders (silos) and metered chemical feed pumps (reagents).

It is anticipated that the moisture content of stabilized materials exiting the pugmill will be too high to move the material to designated temporary curing storage bins via conveyor belt. A Putzmeister BP 716 GB Jumbo Feeder Trough Module may be utilized to feed two Putzmeister BSA 2110 HP-D units to pump the stabilized materials to the storage bins. If the stabilized material is too dry to be pumped, it will need to be conveyed to the appropriate storage bin using a series of portable radial stacking conveyors or with a front-end loader. Storage bins will be sized to handle approximately 1 day's production capacity of material.

Each day's production of stabilized materials is to be transferred to temporary storage bins for approximately 2 days to permit pozzolan curing, at which time a representative sample will be taken from the stockpile to determine if it passes TCLP testing for arsenic. Results of the TCLP test will be obtained 4 days after the sample is collected. If the material passes TCLP, it will be tested for release of free liquids using the USEPA Paint Filter Test along with a slump cone or other soil strength indicator testing as required by the landfill. If the material passes paint filter and soil strength criteria, it will be loaded into a lined truck, the truck will be weighed on a temporary scale set up onsite, and the material will be hauled offsite to a landfill for disposal as non-hazardous material. Material failing to pass TCLP will be retreated through the pugmill and retested. It is anticipated that failures of TCLP testing, if any, will likely occur in the initial stage of the dredging activities during the process shakedown period. Reagent dosages and processing activities will be the responsibility of the dredging subcontractor to be suitably adjusted to ensure the material reliably passes TCLP, USEPA Paint Filter Test, and landfill strength requirements.

South Channel Soft Sediment

Soft sediment excavated from the South Channel will be transported to the dedicated hopper barge along the east side of the former 8th Street Slip as described previously. Filled hopper barges will be moved to the west side of the former 8th Street Slip for excess water removal and sediment unloading using the twin Toyo pumps and handled in much the same way as mechanically dredged soft sediment described above. The main difference is that the South Channel Soft Sediment is significantly less contaminated and it is anticipated that only a pozzolanic reagent will need to be added in the pugmill due to the low arsenic concentrations in the South Channel soft sediment. Stabilized South Channel soft sediment will undergo the same testing requirements once the material is placed in a temporary storage bins.

5.3.3.2 Semi-Consolidated Materials

Higher Contamination SCM

Hopper barges filled with higher contaminated SCM will be offloaded using an excavator. A screening bucket, such as a REMU WL 160HD screening bucket attachment, may be able to reduce the SCM to a maximum size of 2 inches. The less than 2-inch screened materials would be dropped to a shore-based radial conveyor which will feed the pugmill. Debris retained in the screening bucket will be dropped into a shore-based rolloff container for subsequent resizing, as previously described.

It is anticipated that the higher contamination SCM could be treated in the pugmill with the reagents indicated in Exhibit 5.1, Section 5.3.5 below. However, it is the responsibility of the dredging subcontractor for the selection and dosages of all pozzolan/additives/reagents necessary to meet the TCLP, USEPA Paint Filter Test, and landfill strength requirements. It is anticipated that stabilized SCM dropping out of the pugmill will be too stiff to pump to the storage bins. Stabilized SCM will either be conveyed to the temporary storage bins using a series of portable radial stacking conveyors or transported and dumped into the bins via front-end loader if the material is sufficiently dry. Once in the storage bin, stabilized material will be tested prior to offsite disposal for the same parameters as the soft sediment.

Lower Contamination SCM

Lower contamination SCM will be handled in the same manner as the higher contamination SCM except that it is anticipated that no reagents will be needed. However, it is the responsibility of the dredging subcontractor to ensure the material reliably passes TCLP, USEPA Paint Filter Test, and landfill strength requirements. If sufficient space is available, and the dredging subcontractor deems no reagents need be added, the pugmill can be bypassed entirely by stockpiling sufficiently dry material from the excavator bucket onshore, or dropping it onto a series of portable radial stacking conveyors to convey the material to the temporary storage bins.

Decant water pumped from the dredged material hopper barges, free water from the dredged material stockpiles, decontamination water, and rainwater from contaminated areas will gravity drain to a sump located adjacent to the asphalt pad. Water collecting in the sump will be pumped directly to and treated in the temporary water treatment system. Section 5.6.3 contains water treatment details.

5.3.4 Debris

It is anticipated that all segregated oversized debris will be run through a shredder (SSI Shredding Systems M100H Shredder or equivalent) that will reduce the size to a nominal 2-inch dimension (or other dimension as required by the selected pugmill unit). Wood debris may pass through the shredder at dimensions greater than 2 inches, so there may be a need to reload sized material an additional time before going to the pugmill. The resized debris material would drop to a conveyor for stockpiling and reloaded using a front-end loader. Appropriately sized material will then be put into the pugmill feed hopper using a front-end loader to be co-blended with the screened sediment feed.

If significant debris is encountered while dredging soft sediment that would potentially cause damage to the environmental bucket or would prevent it from closing, a conventional clamshell bucket may be used until the debris is removed.

5.3.5 Stabilization Reagents

Different dredged materials will require different types of reagents. Treatability testing was performed to establish potential types of reagents and dosages to be added and produced the results shown in Exhibit 5-1.

EXHIBIT 5-1
Stabilization Reagents

	Quantity		Fluidized Bed Boiler Ash		$Ca(ClO)_2$		60% $Fe_2(SO_4)_3$	
Material	CY	Ton	% by wt	Tot. Ton	% by wt	Tot. Ton	Gal/ton	Tot. Gal
soft sediment, mechanically dredged	85,000	108,000	18%	19,440	1.0%	1,080	3.0	324,000
soft sediment, wet dredged in S. Chan.	12,000	14,000	22%	3,080	0.0%	0	0.0	0
SCM, higher contamination (>500 mg/kg)	50,000	70,000	0%	0	1.0%	700	3.0	210,000
SCM, lower contamination (<500 mg/kg)	103,000	144,000	0%	0	0.0%	0	0.0	0
Totals	**250,000**	**336,000**		**22,520**		**1,780**		**534,000**

Treatability data are being provided as "information only." The selected dredging subcontractor will be responsible for the selection of the pozzolans/additives/reagents, ratios and blending/mixing technologies sufficient to meet the above stated performance metrics. It is anticipated that the precise pozzolan/additive dosages will be modified by the dredging subcontractor in the field based upon continuous observations of changing material characteristics and testing results.

Pozzolan and reagents will be delivered to the site as needed during the remedial activities so that sufficient supply is available for ongoing operations. Caution will be taken to avoid delivery of excessive material so onsite storage is minimized and reagent degradation does not occur before it can be used.

Results of the treatability testing are included in Appendix C.

5.3.6 Dredging Production Rate and Duration

The expected mechanical dredging rate for the soft sediment is estimated to be 1,300 yd^3 per day up to 12 hours per day/7 days per week. Due to the limited volume and access, dredging at the south channel is estimated to be 350 yd^3 per day. A dredging rate of 1,000 yd^3 per day (also on a 12 hour/7 day/week basis) is estimated for SCM because of its compacted nature and the associated difficulties that might be encountered in dredging this material. The mobilization, setup, and demobilization phases of the project cumulatively may take approximately 5 weeks.

Based on these production rates, the estimated durations are as follows:

- Phase 1 Soft Sediment in Turning Basin 33 days
- Phase II SCM in Turning Basin 77 days
- Phase III Soft Sediment in Transition Area 32 days
- Phase IV SCM in Transition Area 76 days
- Phase V Soft Sediment in South Channel 32 days

Because of the time required to dredge SCM and the need to incorporate calendar restrictions for fish spawning, a temporary winter shutdown period is assumed to avoid issues with freezing temperatures.

5.3.7 Dredging Positioning System

A system that continuously locates and records the horizontal and vertical position of the cutting face will be required. A real-time kinematic positioning system, or an alternative positioning system that can meet the specified tolerance requirements, will be used to provide the horizontal and vertical positioning for the dredge system. The positioning system shall employ software capable of monitoring the X, Y, and Z position of the dredge bucket in real time. The software will be required to provide the following:

- A real-time view of the barge and clamshell bucket position
- A display indicating the surface derived from the pre-dredge hydrographic survey data
- A display that provides real-time feedback showing current depth, final project depth, target depth, and current bucket depth

The following tolerances shall be met:

- Horizontal position accuracy shall be plus or minus 2 feet
- Vertical tolerance shall be plus 0, minus 0.5 foot

5.4 Treatment of Remediation Wastewater

5.4.1 Wastewater Sources

Wastewater will be generated from several sources during the handling, stabilization, and disposal of the dredged material. The following wastewater sources, which include contaminated water generated during remediation activities, will be routed to the onsite temporary water treatment system:

- Free water from the dredged sediment that is gravity drained
- Decontamination water
- Precipitation on the staging pad

The water treatment system itself will generate process wastewater, which will need to be hauled offsite for disposal.

5.4.2 Wastewater Volumes

The rate of water generation and treatment was calculated over a 12 hours per day, 7 days per week period since dredging activities also are assumed to occur over the same period. Volumes given below might not add up precisely because of rounding.

5.4.2.1 Free Water Removed from Sediment

During Phase I and III, the dredging rate is estimated to be 1,300 yd^3 per day. Based on the density of the soft sediment the estimated volume of water draining from material dredged with an environmental bucket is dredging is estimated to produce approximately 40 gallons per cubic yard of in-situ material. Approximately 25 percent of this water, 10 gallons per cubic yard, will be able to be pumped from the material barges to the water treatment system. The total estimated volume of water pumped to the water treatment system is 13,000 gallons per day (gpd), or 18.1 gallons per minute (gpm). During Phases II and IV, the dredging rate is estimated to be 1,000 yd^3 per day. Based on the density of the SCM, the estimated volume of water draining from material dredged with a standard bucket is estimated to produce approximately 38 gallons per cubic yard of in-situ material. Approximately 25 percent of this water, 9.5 gallons per cubic yard, will be able to be pumped from the material barges to the water treatment system. The total estimated volume of water pumped to the water treatment system is 9,500 gpd, or 13.2 gpm. During Phase V, the soft sediment dredging rate is 350 yd^3 per day. The estimated volume of water to the water treatment plant is 3,500 gpd, or 4.9 gpm.

Total free water generated from dredging will be as follows:

- During Phase I: (13,000 gpd)*(33 days) = 0.43 million gallons
- During Phase II: (9,500 gpd)*(77 days) = 0.73 million gallons
- During Phase III: (13,000 gpd)*(32 days) = 0.42 million gallons
- During Phase IV: (9,500 gpd)*(76 days) = 0.72 million gallons
- During Phase V: (3,500 gpd)*(32days) = 0.11 million gallons

5.4.2.2 Decontamination Water (Phases I through V)

A 4-gpm pressure washer is assumed to be used for decontamination activities. Decontamination activities performed during the dredging work will include decontamination of debris, equipment, and trucks. Total volume is estimated to be 1,400 gpd, or 1.0 gpm. Wastewater generated from decontamination activities will be collected in the sump along with the other wastewater sources and sent to the water treatment system.

Total decontamination water generated will be as follows:

- During Phase I: (1,400 gpd)*(33 days) = 0.04 million gallons
- During Phase II: (1,400 gpd)*(77 days) = 0.1 million gallons
- During Phase III: (1,400 gpd)*(32 days) = 0.04 million gallons
- During Phase IV: (1,400 gpd)*(76 days) = 0.1 million gallons
- During Phase V: (1,400 gpd)*(32 days) = 0.04 million gallons

5.4.2.3 Water from Precipitation on Staging Areas

Average monthly rainfall for the Green Bay, Wisconsin, area during the potential construction season is as follows (rssweather.com 2010):

- May: 2.75 inches
- June: 3.43 inches
- July: 3.44 inches
- August: 3.77 inches
- September: 3.11 inches
- October: 2.17 inches

Exhibit 5-2 shows the storm water from precipitation based on the monthly averages listed above.

EXHIBIT 5-2
Estimated Monthly Average Storm Water in the 6th Street and 8th Street Slip Areas

	6th Street Slip Area		8th Street Slip Area	
Month	Gallons/day	Gallons/minute	Gallons/day	Gallons/minute
May	3,700	2.6	21,200	14.8
June	4,800	3.4	27,400	19.0
July	4,700	3.3	26,600	18.5
August	5,200	3.6	29,100	20.2
September	4,400	3.0	24,800	17.2
October	3,000	2.1	16,800	11.6
Average	4,300	3.0	24,317	16.9

The total average storm water by phase is estimated below:

- During Phase I: (27,833 gpd)*(33 days) = 0.92 million gallons
- During Phase II: (27,833 gpd)*(77 days) = 2.14 million gallons
- During Phase III: (27,833 gpd)*(32 days) = 0.89 million gallons
- During Phase IV: (27,833 gpd)*(76 days) = 2.11 million gallons
- During Phase V: (27,833 gpd)*(32 days) = 0.89 million gallons

The maximum flow rate occurs in August and averages 23.8 gpm.

Additionally, there is a need to contain storm water from more intense rainfall events. The 25-year, 24-hour event was evaluated as the critical rainfall event for containment on the site. The storm water for this storm event is approximately 1 million gallons at the former 8th Street Slip area and 0.2 million gallons at the 6th Street Slip area. The water would be retained onsite while it is pumped to the water treatment system. Based on the 150 gpm capacity of the water treatment system, it would take between 5 and 6 days to treat all the water.

5.4.2.4 Summary of Wastewater Generated

- During Phase I, wastewater generated will be 0.43 million gallons (free water in sediment) plus 0.04 million gallons (decontamination water) plus 0.92 million gallons (precipitation), for a total of 1.4 million gallons.

- During Phase II, wastewater generated will be 0.73 million gallons (free water in sediment) plus 0.1 million gallons (decontamination water) plus 2.1 million gallons (precipitation), for a total of 2.93 million gallons.

- During Phase III, wastewater generated will be 0.42 million gallons (free water in sediment) plus 0.04 million gallons (decontamination water) plus 0.89 million gallons (precipitation), for a total of 1.4 million gallons.

- During Phase IV, wastewater generated will be 0.72 million gallons (free water in sediment) plus 0.1 million gallons (decontamination water) plus 2.1 million gallons (precipitation), for a total of 2.92 million gallons.

- During Phase V, wastewater generated will be 0.11 million gallons (free water in sediment) plus 0.04 million gallons (decontamination water) plus 0.89 million gallons (precipitation), for a total of 1.04 million gallons.

Total wastewater generated during the corrective activities is estimated to be 9.7 million gallons. Estimated flow to the water treatment system will vary, but will be at a maximum of 43 gpm during Phases I and III. During a significant rainfall event, a much higher flow rate will be required. Because of the need to clear the site as quickly as possible during a higher intensity rainfall event, the water treatment system will be designed to handle a peak flow of approximately 150 gpm.

Microfiltration (MF) process waste will be approximately 25 percent of the total flow to the treatment system. The remaining 75 percent of the flow will be processed through a two-stage reverse osmosis (RO) unit that will have a 30 percent process waste stream. Therefore, 47.5 percent of the total flow (25 percent from MF and 22.5 percent from RO) will be sent to a Vibratory Shear Enhanced Processing (VSEP) unit, which will further concentrate the waste stream into 20 percent of the incoming volume. Therefore, total volume of reject water from the water treatment system requiring disposal at an offsite hazardous waste facility will be approximately 9.5 percent of the 9.7 million gallons, or 0.92 million gallons.

5.4.3 Water Treatment

The design for the temporary onsite water treatment system is shown on the process flow diagram drawing and is described in detail in Appendix B. This process flow diagram is based on an RO treatment process and represents a proven treatment process for water generated at the site. It is similar to the existing groundwater treatment system and the temporary water treatment system used at the site in 2010. The treated water will be discharged to the Menominee River through a permitted outfall.

The water treatment subcontractor will set up a water treatment system with a capacity of 150 gpm at the 6th Street boat launch parking area (Sheets 6 and 7, Appendix B). Water from the stabilization area sump, 6th Street area sump, hopper barges, and dry excavation area discharge will be pumped to an equalization mix tank, treated with a chemical coagulant and/or polymer, and pumped through geotextile tube filters installed in rolloff boxes to remove suspended solids. Weep water from the geotextile tubes will be collected and pumped into equalization tanks. Equalization tank water then will be pumped through a mobile treatment system containing MF units. If needed, sulfuric acid and/or a scale inhibitor will be added to the MF influent prior to entering the MF units. Reject water from the MF units will be pumped to a waste holding tank equipped with the option to neutralize the MF reject water before being recycled back to the geotextile tube influent or sent to the VSEP unit. The MF permeate will flow into another equalization (draw and fill) tank prior to being pumped to another mobile treatment system containing RO units set up as two-stage units.

Water entering the first stage RO units will be separated into permeate and reject streams. The reject stream of the first stage RO units will be further treated by the second stage RO units, and the RO reject stream from the second stage RO units will be sent to the VSEP unit. The VSEP unit will be used to treat and further concentrate the MF and RO reject streams. The VSEP reject will be sent offsite for disposal. The purpose of the two-stage (rather than single-stage) RO process and using the VSEP unit is to ensure a cost-effective minimum amount of water will be sent offsite for disposal. Finally, the permeate water from the second stage RO units will be stored in holding tanks for use as process water, if needed, or discharged to the Menominee River through a permitted outfall.

The treatment system will include instrumentation to measure and monitor flow rate and volumes, liquid levels, pH (if needed), and pressure. The mobile treatment system trailers will include automation for controlling the equipment within the trailer as well as the capacity to accept control signals from outside sources. Automation will be used to control the operation of pumps and valves outside the mobile treatment trailer footprints.

Influent and effluent samples will be collected from the water treatment system to monitor and record the process performance. A Wisconsin Pollutant Discharge Elimination System (WPDES) permit will be obtained for discharge to the Menominee River. Discharge and sampling will be performed in compliance with the permit.

5.5 Dredged Material Disposal

Testing of stabilized sediment is described in Section 7.3. Once test results indicate a bin of dredged material can be transported offsite, it will be loaded into trucks for disposal at an offsite RCRA Subtitle D landfill. Material will most likely be disposed at the Waste Management landfill located in Menominee, Michigan, which is approximately 8 miles from the site.

Trucks used for offsite transport of contaminated materials will be lined with plastic. Each truck will proceed to the loading area located south of the appropriate storage bin (refer to the drawings in Appendix B), where it will be loaded using an excavator or front-end loader. After being completely loaded, it will proceed to the decontamination area, where the exterior of the truck will be sprayed off with a powerwasher, and the top of the truck bed will be covered with a tarp. Following decontamination, the truck will proceed to the temporary truck scale, where the weight will be checked to verify it is not overloaded or underloaded, before proceeding to the landfill.

5.6 Surface Water Quality

5.6.1 Turbidity Control through Implementation of Best Management Practices

The potential to create turbidity and affect river water quality during mechanical dredging will be minimized by the dredging subcontractor's adherence to mechanical dredging BMPs. These BMPs will be modified slightly to account for using a conventional navigational bucket with teeth for dredging SCM and glacial till. A list of BMPs for dredging soft sediment is provided below:

- Hopper barges shall be watertight and inspected to confirm water tightness before dredging operations and dredged material transport.
- An environmental clamshell bucket shall be used for mechanical dredging of soft sediment.
- "Sweeping" to contour the bottom of the dredge cut shall not be permitted.
- Dredging of slopes shall proceed from the top of slope to the toe of slope.

- The dredging subcontractor shall use positioning devices (such as GPS) to allow the operator to be aware of the location of the dredge bucket in relation to the top of sediment.
- The dredging subcontractor shall use an experienced environmental dredging operator who is capable of implementing appropriate BMPs to limit resuspension of sediment.
- The operator shall minimize overfilling of the dredge bucket.
- The operator shall reduce the rate of bucket descent and retrieval as necessary.
- The operator shall perform single bites with the bucket, and each bucket shall be brought to the surface and emptied between bites.
- The operator shall release excess water slowly at the surface.
- The operator shall not overfill hopper barges with dredged material.
- Oil booms shall be available for emergency use.

Turbidity curtains will be used for the mechanical dredging work. These curtains will be placed around the contiguous dredging areas, as shown on the drawings in Appendix B. The success of the dredging subcontractor's efforts to control the release of turbidity will be evaluated through river water monitoring activities, as described in Section 7.1. If turbidity indicates the TSS requirement is exceeded, the dredging subcontractor will be consulted and the source of the turbidity will be identified. If dredging activities are suspected, the dredging process or equipment will be modified so the TSS requirement is met.

Additional BMPs may be identified and subsequently required as a result of permitting, water quality criteria, and other processes.

5.6.2 Release of Dissolved Phase Arsenic during Dredging Activities

The potential release of particulate arsenic during mechanical dredging operations will be minimized by using BMPs to reduce dredging-induced turbidity. However, turbidity control measures, such as turbidity curtains, are not anticipated to be effective in limiting release of dissolved-phase arsenic during dredging activities. A water quality variance request has been submitted to the WDNR to address expected arsenic concentrations during the project. Arsenic will also be monitored at the turbidity monitoring locations. Arsenic concentration observed could lead to changes in dredging practices, as detailed in Section 7.1 to protect chronic human health protection.

5.7 Working Season and Hours of Operation

Most activities associated with the dredging work will be performed up to 12 hours per day, 7 days per week. Water treatment operations will be performed up to 24 hours per day, 7 days per week. The dredging subcontractor will determine the actual hours of operation.

Mobilization is anticipated to start in summer 2012 (refer to the project schedule in Appendix D). It will be necessary to schedule activities to accommodate the current commercial and industrial uses of the Menominee River. The dredging schedule will be coordinated with USEPA, WDNR, and the U.S. Fish and Wildlife Service (USFWS) to minimize potential disturbance of fish spawning during the spring and fall seasons. The dredging subcontractor will be responsible to coordinate with local industrial facilities to accommodate the arrival and departure of commercial ships delivering raw materials and with the local agencies as necessary.

5.8 Decontamination and Site Restoration

After mechanical dredging activities have been completed, decontamination activities will be performed. Equipment to be removed from the river will be power washed in place or over the river with water, before transport, to remove sediment and invasive species such as mussels.

Land-based equipment will be washed on the asphalt pad with the wash water being captured and treated. Rinse water will be collected in the sump and will be pumped to the water treatment system. Following equipment decontamination, the asphalt pad will be washed to remove visible residual sediment.

Once decontamination has been completed, the temporary infrastructure built for the mechanical dredging work will be removed from the site. The docking platform, drip protection, and access walkway will be disassembled and taken offsite. Soil stabilization and water treatment equipment will be decommissioned and taken offsite. Temporary access roadway materials will be sampled and taken offsite for reuse if not contaminated or disposed at an appropriate landfill if contaminated. Areas of the 6th Street Slip and former 8th Street Slip that were expanded and paved for the staging/stabilization area or water treatment area will have the pavement removed and will be returned to original grades and re-seeded.

Other previously vegetated areas that were impacted by corrective activities will be restored to preconstruction conditions to the extent practical and replanted with grasses.

5.8.1 South Channel Restoration

The South Channel is a narrow channel of the Menominee River located east of the facility, bounded by ThyssenKrupp Waupaca Foundry property on the north, and by the City of Marinette property to the south. The shoreline is comprised predominantly of wetland-type vegetation with water depths within the channel generally less than 2 feet. Portions of the riverbed contain debris such as wood scraps and metal shavings that are remnants of historical milling operations in the area.

Only soft sediment in the South Channel requires removal. Soft sediment in the South Channel is up to approximately 3 feet thick, with arsenic concentrations greater than or equal to 50 mg/kg, extending to a maximum depth of 2 feet below sediment surface. No semi-consolidated or other materials beneath the soft sediment require removal.

The planned remedial action in the South Channel will include the following activities:

- Install turbidity curtains upstream and downstream of the planned dredge areas.
- Place temporary dam upstream of Ogden Street to prevent flow to Menekaunee Harbor during dredging.
- Prepare a temporary access road along the south shore of the under USACE permit.

- Remove debris from the area.
- Dredge impacted soft sediment as required by the AOC.

Soft sediment will be removed as described in Section 5.4. Following removal of impacted material within the south channel area, the area will be restored as follows:

- Remove turbidity curtains from the temporary dam.
- Remove the temporary access road from the south shore and return to pre-construction grades.
- Seed the south shoreline with annual rye grass and cover with a jute erosion protection mat.
- Allow the natural vegetation to repopulate area.

Removal of debris and soft sediment as part of the remedial action will improve natural conditions within the South Channel riverbed. In addition, because of the limited removal depth, significant changes to the hydraulic and structural condition and the habitat within the South Channel are not anticipated as a consequence of removing contaminated soft sediment. In other words, the benthic habitat in this area will not be significantly disturbed by removing soft sediment. The existing benthic ecosystem is expected to be reestablished within 2 years upon completing the removal activities. As such, no additional restoration activities are planned or necessary.

SECTION 6

Compliance with Applicable Requirements

Tyco has developed a permitting strategy that is designed to meet permitting requirements from agency stakeholders on the federal, state, and local levels. The agency stakeholders identified for this project and their associated permits are listed below and are presented in Table 3. Table 3 also indicates anticipated timeframes for review of applications and issuance of permits from each of the stakeholders. The following subsections present a detailed discussion on each the permit anticipated to be necessary for the project.

6.1 U.S. Army Corps of Engineers

6.1.1 Clean Water Act Section 404 and Section 10 Rivers and Harbors Act

The project will result in impacts to the Menominee River and adjacent onshore wetland areas. The federally authorized navigation channel in the Menominee River is under the jurisdiction of the USACE-Detroit District, whereas the onshore wetlands and areas outside the federally designated navigational channel are under the jurisdiction of the USACE-St. Paul District. Consequently, Tyco will coordinate with both District offices during the planning, application, and construction phases of the project. The USACE-Green Bay Office will be the point of contact for the Section 404 Clean Water Act (CWA) and Section 10 Rivers and Harbors Act permits required for the project. Tyco coordinated extensively with the USACE-Green Bay Office during installation of the sheet pile wall in 2010 and the slurry wall in 2009, and as a result, has a good working relationship with the staff. Preliminary conversations with Todd Vesperman of the USACE-Green Bay Office have indicated that the project may qualify for a Nationwide Permit (NWP) 38 due to the proposed hazardous waste removal activities and the involvement of the USEPA as the lead federal agency. Average review times for a NWP prior to issuance typically run 30 to 45 days. However, due to the Joint Permit Application (JPA) process utilized by the WDNR and USACE in Wisconsin, a valid NWP will not be issued by the USACE until the WDNR completes their CWA Section 401 Water Quality Certification and Chapter 30 Waterway Permitting and Shoreland Grading Individual Permit review process. A WDNR Individual Permit will be necessary and based on recent project experiences, it is assumed that issuance of an Individual Permit by the WDNR may take 120 days. To accommodate response time for comments that may be received during the WDNR Individual Permit review process public comment period, Tyco has built in a 120-day allowance in the project schedule for obtaining Section 404 and Section 10 authorization from USACE.

To further facilitate communication with USACE and prevent additional data requests during the application review process, Tyco has committed to a pre-application meeting with USACE to discuss the project goals, area of impact to federally jurisdictional resources, volumes of sediment to be removed, the proposed methods of removal, and any specific concerns from USACE. Following completion of the pre-application meeting, Tyco will prepare an application package for submittal that contains detailed information regarding wetland and waterway impacts and that addresses the specific concerns raised by USACE during the pre-application meeting.

6.1.2 RCRA Regulations and Administrative Order on Consent

As previously mentioned, this sediment removal action is being conducted pursuant to an RCRA 3008(h) AOC, administered by USEPA Region 5. The work described herein complies with the AOC, as well as the applicable RCRA regulations that govern the management and disposal of remediation waste.

The regulatory considerations associated with the sediment removal and disposal work are outlined below.

- In accordance with 40 Code of Federal Regulations (CFR) Section 261.4, because sediment removal is being done under a Section 404 permit, the dredged material exclusion states that the sediments are not considered a hazardous waste. The exclusion states:

  *(g) Dredged material is not a hazardous waste. Dredged material that is subject to the requirements of a permit that has been issued under Section 404 of the Federal Water Pollution Control Act (33 United States Code [USC] 1344)…*For this paragraph (g), the following definitions apply:

  (1) The term "dredged material" has the same meaning as defined in 40 CFR 232.2.

  (2) The term permit means:

  (i) A permit issued by USACE or an approved state under Section 404 of the Federal Water Pollution Control Act (33 USC 1344).

- Since the dredged materials at this point are not considered a hazardous waste, per the exclusion, they can be transported back onsite without being considered a hazardous waste.

Once the sediment dries out and is ready to be moved, the materials become a new waste stream that needs to be characterized and profiled for the offsite disposal. Under RCRA, a generator does not have the responsibility to characterize its material until it is generated, so characterization samples of the dredged material will be taken when they are onsite to determine the next steps. If analytical results indicate the material passes TCLP criteria, the material will be stabilized to the extent necessary to pass a paint filter test and be accepted at an appropriately permitted RCRA Subtitle D facility. If sampling results indicate the materials fail TCLP criteria and would be considered as characteristic of a hazardous waste, the materials will need to be treated before transport to the disposal facility. In order to perform onsite treatment, the site, including the river sediment area and the uplands area, will be defined as an area of contamination.

6.2 U.S. Coast Guard

6.2.1 Restricted Navigation Order and Notice to Mariners

As designed, the project will require work within the limits of the federally authorized navigation channel of the Menominee River. Tyco will communicate with the U.S. Coast Guard (USCG) regarding issuance of a Restricted Navigation Order for the area within the Menominee River adjacent to the sediment removal activities. The Restricted Navigation Order will work in tandem with a WDNR Waterway Marker Permit which will dictate the placement of hazard buoys and lighting within the river to warn traffic of the ongoing sediment removal activities.

In addition, Tyco will coordinate with the USCG office in Marinette to develop a Notice to Mariners, which will be posted during the 14-day period prior to the initiation of project-related activities within the river. The Notice to Mariners will alert local river traffic of the impending sediment removal activities.

6.3 U.S. Fish and Wildlife Service

On August 26, 2011, a letter was sent to the USFWS Green Bay Field Office to request concurrence that no federally listed species would be impacted by the project. Written documentation was received on September 27, 2011, confirming there are no threatened or endangered species, or critical habitat in the project area (USFWS 2011).

6.4 Wisconsin Department of Natural Resources

6.4.1 Clean Water Act Section 401 Water Quality Certification and Chapter 30 Waterway Permitting and Shoreland Grading

The WDNR Peshtigo Office will be the point of contact for CWA Section 401 Water Quality Certification and Chapter 30 Waterway Permitting. Because of the JPA process used in Wisconsin by USACE and WDNR, Tyco is planning to include WDNR in all communications with USACE regarding the project and will anticipate its attendance at the pre-application meeting discussed in Section 6.1.1. WDNR staff from the Bureau of Remediation, Fisheries, and Water Regulation will be included in communications to ensure adequate consideration is given to all state-regulated natural resources. Consequently, Tyco has allowed 120 days in the project schedule for obtaining CWA Section 401 Water Quality Certification and Chapter 30 Waterway permits.

6.4.2 Water Quality Variance Request

Based on water quality modeling evaluations, established water quality criteria will be exceeded during dredging activities because of the nature of the arsenic, even using the most modern dredging methods and equipment to remove soft sediment and SCM. While BMPs will be used to minimize sediment resuspension, release of arsenic during removal is unavoidable (Bridges et al. 2010). Moreover, practices such as deploying silt curtains will do little to reduce the level of dissolved arsenic. Consequently, a water quality variance is needed for this project. WDNR is in agreement that a variance is required.

The water quality variance request included the following:

- A summary of BMPs to be employed for turbidity and water quality control
- An evaluation as to why the turbidity and water quality control BMPs may not achieve general water quality standards as outlined in State of Wisconsin Chapter NR 105, *Surface Water Quality Criteria and Secondary Values for Toxic Substances*
- The anticipated timeframe for potential exceedances, based on current plans for in water activities

- A water quality monitoring plan that includes in-river monitoring locations for turbidity and arsenic at a background location and downstream of dredging where acute and chronic water quality standards are estimated. Water quality monitoring will also occur at the mouth of the river and at the drinking water plants for arsenic for chronic human health protection. Additional information on water quality monitoring is in Section 7.1.
- A contingency plan (that is, what steps will be implemented to minimize the duration and concentration of any potential release). This contingency plan most directly ties into the arsenic water quality monitoring at the mouth of the river and at the drinking water plants for chronic human health protection (see Section 7.1.1).
- Anticipated river flow rate during dredging
- Anticipated rate of release of resuspended dredged material and dissolved arsenic into the water column

The development and evaluation of the information request for the variance considered arsenic concentrations, equipment necessary to remove impacted materials, sediment resuspension, dredging rates, and river flow rates and characteristics. The water quality analysis will consider each of these factors.

Because of the characteristics of the soft sediment and SCM, dredging of the soft sediment will be conducted using an environmental dredge bucket, while SCM will be removed primarily using a clamshell dredge bucket with the required digging capabilities. Release of pore water and resuspension varies with the type of dredge bucket used.

For each material type, resuspension and release rates associated with BMPs to minimize resuspension were used to estimate anticipated releases of dissolved arsenic into the water column. Information available on arsenic concentrations in the various dredged materials was used to determine anticipated arsenic releases and resulting water column concentrations from dredging-induced resuspension. As discussed in Bridges et al. (2010), detailed case studies of chemical releases from environmental dredging projects using all available BMPs reveals an expected release range of approximately 2 to 4 percent of contaminant mass dredged, with most of the release being in the bioavailable dissolved form. As these case studies demonstrate, there are no documented differences in these release rates between projects that use silt curtains or other barrier controls and those that do not. The analysis considered the expected arsenic release using these BMPs.

The preliminary water quality sampling locations are included in the drawings (Appendix B).

6.4.3 Waterway Marker Permit

As discussed previously, the project will require work within the limits of the federally authorized navigation channel of the Menominee River. Tyco intends to communicate with the USCG and WDNR regarding the planned placement of marker buoys and safety lighting.

6.4.4 Wisconsin Pollutant Discharge Elimination System Construction Site Stormwater Runoff

The WDNR WPDES Program requires a Construction Site Stormwater Runoff Permit for any construction project that proposes to disturb 1 or more acres of land. The purpose of the program is to limit the discharge of pollutant-laden stormwater from construction projects into local waterways and wetlands. As currently proposed, the project is anticipated to disturb more than 5 acres, and consequently, Tyco will work with staff from the WDNR WPDES Program to identify the appropriate BMPs and obtain a Construction Site Stormwater Runoff Permit for the project.

6.4.5 Wisconsin Pollutant Discharge Elimination System Point Source Discharge Permit

Tyco currently holds a WPDES Point Source Discharge Permit from WDNR for the discharge of stormwater from storm sewers at the facility. Tyco intends to update the existing permit for the facility to incorporate the discharges of treated water from the onsite water treatment facility proposed as part of the project.

6.4.6 Carriage and Interstitial Water from Dredging Operations General Permit

The WDNR WPDES program requires a permit for sediment dredging operations where there will be a discharge of carriage or interstitial waters to surface waters. The purpose of the general permit is to authorize the discharge of uncontaminated or moderately impacted water from sediments that are unlikely to have environmental concerns. The WDNR has indicated that the project will qualify for a general permit based on the proposed reverse osmosis treatment of carriage and interstitial water. The WDNR will likely include some site-specific conditions in the permit and, consequently, the review process could take up to 90 days. Accordingly, Tyco has allowed for the potential 90-day review process in the proposed schedule.

6.4.7 Natural Heritage Inventory Review

On August 26, 2011, a letter was sent to the WDNR Bureau of Endangered Resources (BER) requesting a review of state-listed species managed under the Natural Heritage Inventory Program that have the potential to be present within the proposed workspaces. An October 11, 2011 response from Lori Steckervetz of the WDNR BER identified five state-listed species and one community (emergent marsh) that are known or have the potential to occur in the Project area (WDNR BER 2011). Due to the lack of suitable habitat, impacts to the five listed species are not anticipated. However, if any of the identified species are observed within the project area Tyco will contact will the BER for further guidance.

6.5 Wisconsin State Historical Society

6.5.1 National Historic Preservation Act Section 106 Review

Section 106 of the National Historic Preservation Act (NHPA; 16 USC 470) and its implementing regulations (36 CFR 800) require federal agencies to take into account the effects of their undertakings on historic properties listed in or eligible for listing in the National Register of Historic Places (NRHP; 36 CFR 60). The act and the regulations also require federal agencies to consult with the appropriate State Historical Preservation Office and federally recognized Native American tribes for undertakings with the potential to affect NRHP-listed or –eligible properties.

To comply with the NHPA, Tyco initiated the necessary consultations and conducted a cultural resources survey for the project. Cultural resource surveys of the project area were conducted by the Commonwealth Cultural Resources Group (CCRG) of Milwaukee, Wisconsin in October 2011. While the survey reports are to be kept confidential, according to the report a single archaeological site was identified within the project area. The site has been determined to be eligible for listing in the NRHP, and Tyco is currently coordinating with the Wisconsin State Historical Society (WSHS) to develop interpretive materials in preparation for requesting a Memorandum of Agreement from the National Advisory Council on Historic Preservation.

6.6 City of Marinette

6.6.1 Erosion Control Permit

An application for an Erosion Control Permit will be submitted to the City of Marinette Engineering Department for earth disturbances related to the project. It is anticipated that a copy of the WDNR WPDES permit application will be sufficient to address City of Marinette erosion control concerns. Tyco will work with the City of Marinette to supply additional information, if any, requested by the City.

6.6.2 Building Permit

Building permits will be required for sheet pile installation and temporary roadways associated with the dredging and dry excavation. Tyco will work with the City of Marinette to obtain the necessary permits.

6.7 Stakeholders

6.7.1 Access Agreements

The City of Marinette and ThyssenKrupp Waupaca Foundry own property adjacent to the South Channel of the Menominee River where dry excavation of soft sediment is planned. Tyco has conducted initial discussions with both property owners to discuss access needs, potential schedule for remedial actions, and the process for completing access agreements. Both parties have expressed a willingness to cooperate with Tyco. Tyco will continue to communicate and coordinate with the City and ThyssenKrupp Waupaca Foundry during the planning and implementation phases of the project.

6.7.2 Turning Basin Users

Marinette Marine Corporation (MMC) and K&K Integrated Logistics (K&K) represent industrial users of the Menominee River Turning Basin. Initial communications have been conducted with MMC and K&K regarding the planned use of the Turning Basin and the pending remedial action. In addition, Tyco has obtained a preliminary schedule for launching and field trials for ships operating out of the MMC facility. Tyco will communicate with MMC and K&K before and during dredging to accommodate usage of the Turning Basin.

SECTION 7

Performance Monitoring Requirements

This section provides a brief summary of the performance monitoring for the corrective actions. Additional details regarding sample collection, sampling methods, and data management will be developed as part of the final design.

7.1 Water Quality Monitoring

7.1.1 River Water Quality Monitoring

The effectiveness of the dredging subcontractor in performing mechanical dredging while using BMPs to minimize the associated water quality impacts will be determined by monitoring turbidity in the river. Arsenic will also be monitored for water quality impacts consistent with the arsenic water quality variance coordinated with WDNR. Other water quality standards relate to meeting discharge limits from treated carriage water as described in Section 7.1.2, Water Treatment System Monitoring.

As described in Section 5.1.1, turbidity will be continuously monitored and a site-specific relationship between turbidity and TSS will be developed. Exceedances will be communicated to the dredging subcontractor so modifications to the process or equipment can be made (as necessary) to meet the proposed control standard. The proposed control standard for work during mechanical dredging activities is no more than 80 mg/L TSS above the background reading. The 80 mg/L TSS above background 1,000 feet downstream of dredging performance threshold has been used previously in Wisconsin for environmental dredging on the Kinnickinnic River.

Surface water monitoring for turbidity will be performed to collect data that will be used to evaluate the potential for sediment resuspension during dredging activities. Before commencing dredging activities, three turbidity monitoring stations will be installed for measuring turbidity during dredging; the turbidity monitoring stations will be located as shown on the drawings in Appendix B. The first station will be located on the southern side of the Menominee River, near the western boundary of the Tyco property. This location will be approximately 800 feet upstream of the Turning Basin and will be used to determine the daily average background turbidity level. Turbidity will be measured real-time and arsenic will be grab-sampled prior to the start of dredging to baseline background arsenic levels.

The second turbidity monitoring station will be located approximately 320 feet east of the eastern side of the Turning Basin and will be positioned near the southern side of the Main Channel. This location is consistent with water quality variance modeling findings that indicated arsenic resuspension from dredging the Turning Basin (the highest average arsenic sediment concentration of all proposed sediment areas) will meet acute standards near this location. Turbidity and arsenic will be sampled at this location. The data collected will be used as confirmation of modeling predictions. Turbidity will be measured real-time and arsenic will be grab-sampled initially three times a day on days when dredging occurs. Arsenic grab sampling will occur during the day with timing varying based upon river flow changes (seiche effects, rainfall, and other changes in flow), and dredging activity.

The third turbidity monitoring station will be located approximately 1,000 feet east of the eastern side of the Turning Basin and will be positioned near the southern side of the Main Channel. This location is consistent with water quality variance modeling findings that indicated arsenic resuspension from dredging the Turning Basin (the highest average arsenic sediment concentration of all proposed sediment areas) will meet chronic standards near this location. This location will also be used to monitor potential suspended sediment entering the river from dredging activities in the Turning Basin and is a consistent downstream distance from dredging for turbidity performance monitoring used for environmental dredging on the Kinnickinnic River. Turbidity and arsenic will be sampled at this location. The arsenic data collected will be used as confirmation of modeling predictions. The turbidity data collected will be used for performance standard comparison to upstream turbidity values. Turbidity will be measured real-time and arsenic will be grab-sampled initially three times a day on days when dredging occurs. Arsenic grab sampling will occur during the day with timing varying based upon river flow changes (seiche effects, rainfall, and other changes in flow), and dredging activity.

A fourth water quality monitoring location will be established at the mouth of the river on the southern side of the Main Channel. No turbidity monitoring will be performed here, but arsenic sampling will be performed. This location is consistent with water quality variance modeling findings to monitor for arsenic for the protection of chronic human health protection standards. The data collected will be used to compare to arsenic standards for drinking water and chronic human health protection standards. Arsenic samples will be obtained through daily composite samples, which will account for variations in flow and dredging activity.

In addition to these four water quality sampling locations in the river, water quality samples will also be obtained at the drinking water plants for the City of Marinette and the City of Menominee. The purpose of collecting these samples is to compare the samples with arsenic drinking water standards for chronic human health protection. These arsenic grab samples will be collected before dredging starts to establish a baseline condition and while dredging is occurring. Levels above 5 parts per billion (ppb) (half the drinking water maximum contaminant level of 10 ppb) will trigger discussion with the agencies regarding slowing the pace of dredging to reduce the rate at which arsenic is being re-suspended or dredging in a lower arsenic sediment concentration area as well as impacts such a slowdown would have upon the project schedule. Grab samples will be taken three times a week during weekdays. If arsenic concentration data collected at the mouth of the river indicates complete mixing may not be occurring and arsenic concentrations at the drinking water plants is at a value over 5 ppb, discussions with the regulatory agencies will occur on alternatives available to reduce arsenic concentration reaching Green Bay. The precise locations will be selected once dredging activities begin based upon observed responses of the upstream and downstream turbidity sensors to background turbidity, as well as the consideration of avoiding damage because of vessel traffic.

A summary of the sampling locations and type of sampling occurring at each is included in Exhibit 7-1.

EXHIBIT 7-1
Sampling Points

	Sampling Point 1: 800 feet Upstream	Sampling Point 2: 320 feet Downstream	Sampling Point 3: 1,000 feet Downstream	Sampling Point 4: Mouth of River	Menominee Drinking Water Plant	Marinette Drinking Water Plant
Pre-Dredging Sampling			**2 weeks of Baseline Sampling**			
TSS	Continuous	Continuous	Continuous	None	None	None
Arsenic	1 time only	3 grab/week	3 grab/week	Daily 24-hour composite sample	3 grab/week	3 grab/week
During Dredging Sampling			**Operated while dredging is occurring**			
TSS	Continuous	Continuous	Continuous	None	None	None
How TSS data will be used:	Establish basis for TSS performance	Relative comparison to upstream.	Dredging performance limited to 80 mg/L increase. Triggers corrective measures if exceeded.	Not applicable	Not applicable	Not applicable
Arsenic	1 at the start of dredging	3 grab/day	3 grab/day	Daily 24-hour composite sample	3 grab/week	3 grab/week
How arsenic data will be used:	Background information	Modeling confirmation comparison to acute standard of 339.8 µg/L	Modeling confirmation comparison to chronic standard of 152.2 µg/L	Comparison to drinking water standard	Comparison to drinking water standard	Comparison to drinking water standard

Note: arsenic sampling frequency at Sampling Points 2 and 3 will be reduced when dredging is not occurring in the highest concentration deposits.
µg/L = micrograms per liter

A sampling point is not included in the South Channel because it will have active dredging in it and consequently, it too will require inclusion within the water quality variance. Consequently, with the South Channel being a dredging location that will require a variance, the sampling locations as outlined in Exhibit 7-1 will be used.

Turbidity sensors will be deployed at mid-depth of the channel. Turbidity readings will be transferred by cellular modem telemetry, compiled, and made available on a password-protected Web site within 5 minutes of each reading. Data from the turbidity sensors also will be stored in an integrated data logger that can be accessed in the event the telemetry system is inoperable. The readings will be recorded once every 10 minutes at both turbidity monitoring stations. A rolling average of six consecutive readings (1 hour) for both locations will be used as the basis of comparison.

If the turbidity levels (and the correlation to TSS control standard) exceed the requirement for above the background location, additional turbidity measurements between the downstream project extent and the downstream monitoring location will be performed to assess the BMPs and determine the cause for increased turbidity. If the turbidity increase is determined to be caused from non-dredging activities, the dredging will continue. If the turbidity is determined to be elevated because of the dredging activities, modifications to the current activities, up to and including temporarily halting dredging, will be implemented until it is demonstrated that turbidity levels at the downstream monitoring location are below the project requirement.

Dredging modifications to reduce turbidity could include:

- Reviewing the dredging BMPs to make sure they are being implemented correctly
- Reviewing silt curtain deployment to make sure it is intake and functioning properly

If none of these BMPs require improvement, then dredging may be slowed or stopped to reduce sediment rate. If corrective measures are implemented twice within 24 hours and the turbidity exceedence continues to occur, then the dredging subcontractor will be required to stop work until the dredging subcontractor demonstrates additional corrective measures have been taken and turbidity levels are below re-suspension performance standards. The dredging subcontractor will then be required to revise their turbidity control plan.

If an obvious outlier appears, it shall be eliminated from the rolling average calculation. An outlier will be defined as a reading that is outside the range of 50 to 200 percent of the average of the three previous readings. In addition, to be considered an outlier, the following reading must return to a range of 75 to 133 percent of the average of the three readings preceding the outlier. In practice, it is common to get occasional one-time spikes that cannot be tied to activities in the water. If this happens regularly (that is, more frequently than twice per day), the sensor will be inspected and cleaned, repaired, or replaced.

7.1.2 Water Treatment System Monitoring

Influent and effluent from the water treatment system will be sampled daily for total arsenic concentrations. The treated water also will be sampled for other parameters as required for discharge in accordance with the WPDES permit to demonstrate compliance with water quality standards. Potential monitoring will likely include an initial expanded list of parameters agreed upon with WDNR during initial start-up and a smaller subset of parameters for extended operation which will include: arsenic, TSS, oil/grease, and other parameters required by WDNR. Additional points in the treatment system might be sampled and other analyses might be run as well to monitor system performance.

Samples for total arsenic analyses will be submitted to a nearby laboratory and immediate results (or 24-hour turnaround) will be requested. Alternatively, an onsite laboratory might be set up during the corrective action. If sample results indicate arsenic concentrations or other chemicals above the WPDES permit criteria, discharge of water will stop immediately, and the system will be inspected and modified so that treated water is once again in compliance with the WPDES permit.

7.2 Post-Dredging Sediment Removal Verification Activities

The removal action includes mechanical dredging of contaminated soft sediment and SCM from the Menominee River in specific targeted dredge prisms determined by the model (described in Section 3.3.4). The Remedial Action Level (arsenic concentrations equal to or exceeding 50 mg/kg) achievement is based on established dredge elevations within the dredge prisms based on the 50 mg/kg interpolated sediment extent.

Activities to confirm that the remedial action objectives have been achieved are described in subsequent subsections.

7.2.1 Hydrographic Surveys

Hydrographic survey methods and means for verifying dredged elevations shall be primarily by electronic means and calibrated to project datum, as described in the Specifications 31 20 25.23, Mechanical Environmental Dredging, Individual hydrographic surveys will be performed after the completion of each Phase to document that the dredging elevations have been achieved: Phases I and III (only in areas where no SCM greater than 50 mg/kg underlies the soft sediment), and in Phases II, IV, and V. Dredging elevations have been achieved if post-dredge surveys confirm that sediment has been removed to specified elevations (material removed to within 0 inch above or 6 inches below target elevations) for a minimum of 90 percent of the total aerial extent of an individual "Phase," and the remaining 10 percent is no more than 6 inches above the target elevation.

7.2.2 Confirmation Sampling

Confirmation sampling will be performed after material removal in each phase (I, II, III, IV, and V) has been verified by hydrographic surveys. Limited confirmation sampling will be performed following Phases I and III; that is, sampling will be performed only where soft sediment with arsenic concentrations above 50 mg/kg overlies soft sediment with arsenic concentrations less than 50 mg/kg and concentrations of arsenic do not exceed 50 mg/kg in the SCM beneath. If during confirmation sampling it is visually verified (in the core samples) that glacial till has been reached in Phases II, IV, and V, no samples will be analyzed for arsenic.

Confirmation sampling locations and other details to guide assessment of the completion of sediment removal activities will be provided in the comprehensive Confirmation Sampling Plan (CSP). This document will guide the project (field and laboratory) personnel in conducting the post-remedial verification activities. It is anticipated that the sample locations for these post-dredge confirmation samples within each area will match the 2010 sediment investigation sample locations.

The CSP will be developed after acceptance of the final design and at least 90 days before construction commences (per Attachment 2, Section IVA, 2nd paragraph of the AOC).

7.2.3 Surface Weighted Average Concentration Calculation Methodology

Development of a SWAC calculation methodology is also part of the post-dredging CSP and will be used to determine the completion of sediment removal activities. A post-remedial action SWAC will be calculated to determine average arsenic concentrations in surficial sediments following dredging. The basis of the SWAC approach is that the exposure domain for ecological receptors is broader than the relatively small areas represented by individual samples; therefore, an area-weighted average concentration should be used to represent their potential exposure. The following methodology is anticipated to be used:

- After confirmation that the target dredge elevations have been reached or exceeded (through dredge overcut), or the area has been found to have reached the glacial till, sampling will be performed of the top 6 inches of sediment. The 6-inch samples will consist primarily of residuals and/or remaining CSM, but will not include glacial till material (exempt in the AOC). This depth represents the typical depth that benthic macroinvertebates inhabit. The total sample depth will be homogenized and sent to an approve laboratory for analysis of arsenic.
- An arsenic residual value will be established (and assigned) to all post-dredge sample locations where viable surficial samples (minimum thickness of 3 inches) are not retrievable due to glacial till or bedrock.
- Locations and total arsenic concentrations for each unique sample will be entered as data points into geographic information system (GIS) where individual polygons have been assigned.
- These known data points (that is, sampling points and total arsenic concentrations) will be used to interpolate arsenic concentrations for all the un-sampled locations within each polygon.
- Inverse Distance Weighting is proposed for the statistical interpolation method because it explicitly implements the assumption that things, in this case arsenic concentrations at locations that are close to one another, will be more similar than arsenic concentrations farther apart. This results in a weighting of the data such that each value has an influence on adjacent points and that influence decreases with increasing distance from the data point; hence, there is an inverse relationship between distance and the weight of data.

Additional details and considerations related to the SWAC methodology will be presented in the CSP. Figure 12 shows polygons associated with proposed sampling locations.

7.3 Monitoring Stabilized Sediment Disposal Parameters

Stabilized materials will be sampled and analyzed for the parameters that are required for disposal at an offsite RCRA Subtitle D landfill. These parameters will be, at a minimum, TCLP arsenic and USEPA paint filter testing. The landfill might also require testing to indicate the sediment has been solidified sufficiently to be placed and worked into the landfill. This testing is expected to be a relatively simple test for which results can be obtained immediately, such as slump cone testing.

Analytical samples for disposal will be obtained after the stabilized materials have been placed in the temporary storage bins. Samples for USEPA TCLP arsenic will be obtained at a rate of approximately one for every 500 yd^3 for disposal, which equals one or two samples per day. Different materials will be stabilized with different percentages of reagents, so the amount of time stabilized material is allowed to cure before TCLP samples are collected will vary. TCLP samples will be collected by the dredging/stabilization subcontractor and be analyzed by the onsite laboratory. Results will be reported by the laboratory approximately 4 days following sample collection.

If TCLP results indicate the material is nonhazardous (that is, less than 5.0 mg/L), the material will be sampled and tested for USEPA paint filter and strength testing. If the material passes these tests, it will be considered ready to be transported and disposed at the offsite landfill.

7.4 Air Monitoring

Because of the possibility that particulates may be released during dredged material and reagent handling, air monitoring for particulate matter will be performed. This air monitoring is proposed to be performed only during Phase III (excavation of soft sediment from the South Channel), because reagents will be directly mixed with sediment in situ, and this activity has potential to release particulates into the air. During the other phases, reagents will be added to wet materials in a pugmill, which will minimize the potential for particulate emissions. Materials that are temporarily stockpiled at the staging area will have minimal potential to release particulates into the air, as they will be either wet (pre-stabilized) or stabilized materials. The exposed surface of materials in the temporary stockpiles will be kept moist to reduce particulate release into the air.

Real-time monitors that measure particulate matter finer than 10 micrometers in diameter and smaller (PM_{10}) will be used for monitoring. Three locations will be used to record continuous data on the Tyco property in the west, south, and east directions between 300 and 400 feet away from the dredged material and reagent handling and operations area.

SECTION 8

Preliminary Construction Schedule

8.1 Estimated Schedule

The schedule developed during the PBOD was updated, as part of the Draft Final Design process, to incorporate the project start dates and the estimated duration for the additional design, procurement, construction, and operation activities. Based on the current estimated project start date, the conservative dredging production rates discussed in Section 5.3.7 will be adequate to meet the AOC project completion date of November 1, 2013.

It should be noted that the current schedule is conceptual only, and based on conservative production rates with standard equipment, but actual durations may change based on subcontractor input during the procurement process.

SECTION 9

Biddability, Constructability, and Operability Review

The 2009 AOC contains specific goals for the remedial action within the Menominee River and sets forth a remedial strategy to achieve these goals. The activities proposed in this Draft Final Design Report will achieve the stated goals, and they have been reviewed with an emphasis on biddability, constructability, and operability.

9.1 Approach

9.1.1 Design Approach

The SRWP components and implementation strategy were presented to USEPA in the PBOD dated October 2011. The initial construction phase involved completing minor improvements to the existing asphalt surface in the former Salt Vault area for use as a staging pad; demarcating roads on the existing asphalt surface on which trucks could travel; constructing a temporary mooring structure along the shoreline of the facility; installing a temporary water treatment system, sediment processing system, and other temporary infrastructure on the Tyco property; installing turbidity monitoring equipment in the river; and mobilizing equipment and personnel.

Following construction of the sediment processing facility, dredging, stabilization, and disposal corrective actions would be implemented in seven phases. During the corrective action activities, some phases would be performed simultaneously with others. The original proposed construction phases in the PBOD included the following seven phases:

- Phase I—Mechanical Dredging of Contaminated Soft Sediment in the Turning Basin
- Phase II—Mechanical Dredging of Contaminated SCM in the Turning Basin
- Phase III—Dry Excavation of Contaminated Soft Sediment
- Phase IV—Dry Excavation of SCM
- Phase V—Mechanical Dredging of SCM Near Temporary Sheet Piling
- Phase VI—Placement of Chemical Isolation Layer in the 8th Street Slip Area
- Phase VII—Monitoring Natural Recovery

Water generated during dredging would be treated through a temporary water treatment facility. This temporary water treatment facility would include pre-treatment using coagulation/filtration in geotextile tube filters and separation process, and MF prior to treatment in a two-stage RO system. The treated water would be discharged back into the Menominee River under a WPDES permit.

Post-dredging activities include decontamination, teardown, removing, and offsite disposal of temporary infrastructure built on the Tyco property; restoring the Tyco property to pre-corrective action conditions, to the extent practical; restoring the South Channel; and demobilizing equipment and personnel.

9.1.2 Modifying Factors

Since the submittal of the PBOD in October 2011, various remedial action (RA) activities have been modified, modeled, and extensively reviewed to determine biddability, constructability, and operability. Although the new activities will not affect the remedy implementation or effectiveness, they may impact the overall schedule and/or estimated costs and have been considered in the development of this Draft Final Design. The modifying factors and potential impacts are discussed below.

9.1.2.1 Expanded Dry Excavation versus Dredging

The remedy presented in the conditionally approved SRWP (and subsequent PBOD) was based on Tyco's initial proposal of dry excavation in the South Channel only and the USEPA's response to expand the dry excavation area to include portions of Transition Areas 1, 2, and 3. Subsequent groundwater modeling during the Draft Final Design process has rendered the planned dry excavation impracticable due to the significant water treatment that would be required and concerns about capture of groundwater with unknown contaminants from the ThyssenKrupp Waupaca Foundry property on the north side of the South Channel.

Excavation was originally planned in part of the river bed in the South Channel of the Menominee River near the Tyco facility. Part of this planning required estimation of the quantity of groundwater that will have to be pumped to dewater the excavation area. The extent of the area to be dewatered is shown in Figure 13. Also shown are the locations of two temporary sheet pile walls that are to be installed across the South Channel at the eastern and western ends of the segment to be excavated. The channel bed in this segment is to be excavated to an elevation of 574 ft msl and the excavation area will be dewatered to an elevation of 572 ft msl. The normal water level of the Menominee River is 579 ft msl.

A 3D numerical groundwater flow model of the Tyco facility and the surrounding area was developed between 2006 and 2008 in conjunction with the design of the subsurface hydraulic barrier that was installed around the facility. This model was documented by CH2M HILL in a technical memorandum dated September 10, 2009. The model was calibrated using water-level and aquifer test data from the immediate vicinity of the Tyco facility, which was the area of interest for model development. However, the model grid extends several thousand feet away from the facility to the east, south, and west, and includes the South Channel area that is to be excavated as part of this project. Therefore, it was possible to use the model to simulate the proposed channel dewatering even though the model was not designed or calibrated for that purpose. Because the model was not designed for this application, the simulated flow rates and patterns of water-table depression generated by the model in the dewatering area can only be considered as rough estimates of aquifer behavior.

9.1.2.2 Model Implementation of South Channel Dewatering

The Menominee River, including the South Channel, is represented in the groundwater model using constant-heads cells in the top model layer, with an assigned elevation of 579 ft msl. Excavation dewatering of the South Channel excavation was simulated by reducing the assigned constant-head values to 572 ft msl in the excavation area. The affected model cells are shown in Figure 13. In addition, the model was modified by adding horizontal flow barrier (HFB) cells across the South Channel to represent the temporary sheet piles on either end of the excavation. These HFB cells are the same type of interior boundary condition that was used in the original calibrated model to represent the permanent subsurface barrier wall surrounding the Tyco facility. Like the permanent barrier walls, the temporary sheet piles are assumed to be installed to the top of bedrock (bedrock being the bottom layer of the model). However, the HFB hydraulic conductance value assigned to the temporary sheet pile cells was double the value used for the permanent barrier walls at the facility.

Figure 14 shows a map of the simulated water table elevation in the area surrounding the South Channel excavation under normal flow conditions. Figure 15 shows the simulated water table in the same area after the first day of dewatering. The total simulated rate of groundwater flow into the dewatered area at this time was approximately 2,500 gpm. The groundwater flow rate at the start of dewatering is relatively high because drawdown has not propagated very far from the edges of the excavation area, so the inward and upward hydraulic gradients are high. As time progresses, with the heads in the excavation area maintained at the dewatering elevation of 572 ft msl, the area of drawdown influence expands, the gradients decrease, and the rate of flow into the area of excavation also decreases. Figure 16 shows the simulated water table after 90 days of dewatering. The simulated flow rate into the dewatered area at 90 days was 433 gpm. In Figure 17, the simulation was carried to steady state, and the total simulated inflow to the constant-head cells representing the dewatering area was reduced to a minimum of 415 gpm.

Figure 18 shows a plot of simulated groundwater flow to the dewatering area versus time. The curvature of the plot illustrates the highly transient nature of the expected dewatering flow. During the early stages of dewatering, much of the groundwater inflow is derived from groundwater that is released from storage as the water table elevation decreases around the excavation. The simulated rate of release from storage is determined mainly by the specific capacity value used in the model, which was a dimensionless value of 0.2 in this simulation. This is the same specific storage value that was used in calibration of the model, and it produced reasonable simulated agreement with the results of an aquifer pumping test that was performed at the Tyco facility. However, this storage property of the aquifer can be expected to vary from place to place, and could be either higher or lower in the area of the South Channel excavation. That would result in higher or lower rates of flow into the dewatered area, which could be significantly different than the predicted rates shown in Figure 18.

9.1.2.3 Simulated Dewatering of the Western Half of the South Channel Excavation Area

Given the relatively high initial pumping rates indicated by the dewatering simulation of the full South Channel excavation area, an alternative was considered in which the excavation area would be dewatered and excavated in multiple phases. To estimate the potential reduction in dewatering flow for a phased approach, a simulation was done whereby only the western half of the South Channel excavation area was dewatered, as illustrated in Figure 19. The modeling procedure for his reduced dewatering area was the same as for the full area. Temporary sheet piles were simulated at each end, and the water level within the excavation area was maintained at 572 ft msl using constant-head cells. Figures 20 and 21 show the simulated water table after 1 day and after 90 days of dewatering, respectively. The simulated transient rate of groundwater flow into the western half of the South Channel excavation area is graphed in Figure 18 along with the simulated flow rate for the full excavation area.

Comparison of the simulated flow rates for the full South Channel excavation area and for the western half only shows that the western half initially produces only about 42 percent as much water as the full area (1,046 gpm vs. 2,468 gpm). This is because the inward hydraulic gradients are initially concentrated near the periphery of the excavation. Due to the shape of the channel, the periphery of the simulated western half excavation is less than half as long as the periphery of the full excavation. After 90 days, however, the flow to the western half is approximately 72 percent of the flow to the full excavation (310 gpm vs. 433 gpm). This is greater than the initial ratio of flow rates because the area of water-table depression has expanded away from the edge of the excavation. The inward flow pattern after 90 days is more nearly radial and is affected by the proximity of constant head values in main channel of the Menominee River.

9.1.2.4 Impacts to Proposed Expanded Dry Excavation Area

Groundwater influx has been modeled to stabilize at approximately 510 gpm within the proposed expanded dry excavation; however, in order to reach a potential equilibrium state, initial de-watering will need to be performed at approximately 3,600 gpm for the first few days (6 to 10 days) and recovery rates will drop off as the de-watering continues. This does not take into account the initial water volume of approximately 16 to 17 million gallons that will be decanted directly to the river, without treatment, prior to the 3,600 gpm water treatment system. It is important to note that this evaluation used the same simplified model to calculate groundwater influx and many of the input variables associated with this model are assumed based on general site knowledge and default modeling inputs. Therefore, there is a potential for significant variability in the actual groundwater influx volume that may be observed during the actual work. Tyco will provide additional details related to the modeling results under separate cover.

It was determined that isolating and excavating the entire South Channel and/or the proposed expanded dry excavation area, by dewatering with available technologies to treat arsenic, is not technically feasible due to the following:

- The initial drawdown of the aquifer (3,600 gpm to reach equilibrium) would require significant temporary water treatment equipment that is not readily available, and the required land-based staging area would be substantially larger than the available space at both the former 8th Street Slip and the 6th Street Slip.
- Water generated during the dry excavation preparation and sediment removal would be approximately 150 million gallons, increasing the total estimated project cost by approximately $66 million.
- Significant schedule impacts that delay the completion of dredging into 2014.

This Draft Final Design has been modified to include performing the entire project in the wet, by utilizing barge-mounted mechanical dredge equipment to perform the dredging components of the updated Phases in both the South Channel and the Transition Areas.

9.1.2.5 Locations of the Sediment Processing and Water Treatment Systems

The remedy presented in the PBOD included the construction of the sediment processing and water treatment systems entirely on the Tyco Plant Site. The PBOD showed both the sediment processing and water treatment systems fitting on the former 8th Street Slip staging area; however, based on final design of the temporary water treatment facility, this equipment will be placed in the 6th Street Slip area owned by the City of Marinette.

9.2 Constructability and Biddability

Following the aforementioned design modifications, equipment and process systems (and their corresponding production rates) were evaluated for constructability and biddability. This evaluation included the following assessment criteria:

- Site conditions (for example, water depth, water currents)
- Distance between various processes (for example, mechanical dredging, sediment processing, and water treatment)
- Site access limitations
- Material characteristics and associated volumes
- Site-specific removal requirements (for example, production rates and sediment thickness)
- Availability of equipment
- Seasonal or regional restrictions on schedules

Based on the above assessment criteria (also discussed in Section 5), the Draft Final Design is fully implementable from both a constructability and biddability standpoint. Standard equipment is readily available for the dredging and sediment processing. Temporary water treatment equipment is also readily available, but some individual components will require a 60-day lead time.

9.3 Operability

Based on this Draft Final Design there are no long-term operational or maintenance requirements.

SECTION 10

References

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Tables

TABLE 1
Summary Statistics – Nature and Extent of Arsenic (mg/kg)
Tyco Fire Products LP Facility - Marinette, WI

Area/Matrix	Minimum	Maximum	Average (Arithmetic Mean)
Turning Basin			
Soft sediment	2.3	20,000	2,900
SCM	1.5	2,900	270
Glacial till	1.6	310	66
Weathered bedrock	3.3	3.3	3.3
Main Channel			
Soft sediment	1.8	850	62
SCM	1.4	97	6.3
Glacial till	1.6	140	11
Weathered bedrock	6.8	6.8	6.8
Transition Areas			
Soft sediment	0.71	5000	170
SCM	1.1	1300	54
Glacial till	1.6	3.3	2.6
South Channel			
Soft sediment	1.7	110	36
6th Street Slip			
Soft sediment	3.5	230	75

SCM – semi-consolidated material

TABLE 2
Sampled Locations with Clean Materials Overlying Impacted
Tyco Fire Products LP Facility - Marinette, WI

Sample Location Name	Area Assignment	Top of Sediment Surface Elevation (ft amsl)	Depth to Top of Sampled Interval (ft)	Depth to Bottom of Sampled Interval (ft)	Arsenic Concentration (mg/kg)	Midpoint elevation of Sampled Interval (ft amsl)	Layer Assignment
SD515	Turning Basin	569.9	0.0	-1.0	6.9	569.4	soft sediment
		569.9	-1.0	-2.0	4.6	568.4	soft sediment
		569.9	-2.0	-2.4	4.8	567.7	soft sediment
		569.9	-4.0	-5.0	3	565.4	semiconsolidated
		569.9	-6.0	-7.0	2.5	563.4	semiconsolidated
		569.9	-8.0	-9.0	2.5	561.4	semiconsolidated
		569.9	-9.0	-10.0	3.2	560.4	semiconsolidated
		569.9	-10.0	-11.0	3.8	559.4	semiconsolidated
		569.9	-12.0	-13.0	48.8	557.4	semiconsolidated
		569.9	-13.0	-14.0	**152**	556.4	semiconsolidated
		569.9	-14.0	-15.0	**262**	555.4	semiconsolidated
		569.9	-15.0	-16.0	**522**	554.4	semiconsolidated
		569.9	-16.0	-17.0	**631**	553.4	semiconsolidated
		569.9	-17.0	-18.0	**692**	552.4	semiconsolidated
		569.9	-18.0	-19.0	**332**	551.4	semiconsolidated
		569.9	-19.0	-20.0	**94.6**	550.4	till
		569.9	-20.0	-21.0	**246**	549.4	till
		569.9	-21.0	-22.0	22.1	548.4	till
		569.9	-22.0	-23.0	4.3	547.4	till
		569.9	-23.0	-24.0	3.3	546.4	till
		569.9	-24.0	-25.0	2.7	545.4	till
		569.9	-25.0	-26.0	3.3	544.4	weathered bedrock

TABLE 2
Sampled Locations with Clean Materials Overlying Impacted
Tyco Fire Products LP Facility - Marinette, WI

Sample Location Name	Area Assignment	Top of Sediment Surface Elevation (ft amsl)	Depth to Top of Sampled Interval (ft)	Depth to Bottom of Sampled Interval (ft)	Arsenic Concentration (mg/kg)	Midpoint elevation of Sampled Interval (ft amsl)	Layer Assignment
		576.6	0.0	-0.5	8.7	576.4	soft sediment
		576.6	-0.5	-1.0	8.5	575.9	soft sediment
		576.6	-1.0	-1.5	3.1	575.4	soft sediment
		576.6	-1.5	-2.0	2.5	574.9	soft sediment
		576.6	-2.0	-2.5	2.3	574.4	soft sediment
		576.6	-2.5	-3.0	2.6	573.9	soft sediment
		576.6	-5.0	-6.0	4.3	571.1	semiconsolidated
		576.6	-7.0	-8.0	4.8	569.1	semiconsolidated
		576.6	-9.0	-10.0	**61.7**	567.1	semiconsolidated
		576.6	-10.0	-11.0	**133**	566.1	semiconsolidated
		576.6	-11.0	-12.0	44	565.1	semiconsolidated
SD519	Turning_Basin	576.6	-12.0	-13.0	6.9	564.1	semiconsolidated
		576.6	-13.0	-14.0	30.9	563.1	semiconsolidated
		576.6	-14.0	-15.0	42.5	562.1	semiconsolidated
		576.6	-15.0	-16.0	2.3	561.1	semiconsolidated
		576.6	-16.0	-17.0	1.7	560.1	semiconsolidated
		576.6	-17.0	-18.0	2.3	559.1	semiconsolidated
		576.6	-18.0	-19.0	1.5	558.1	semiconsolidated
		576.6	-19.0	-20.0	2.3	557.1	semiconsolidated
		576.6	-20.0	-21.0	1.6	556.1	semiconsolidated
		576.6	-21.0	-22.0	6	555.1	semiconsolidated
		576.6	-22.0	-23.0	1.9	554.1	semiconsolidated
		576.6	-23.0	-24.0	6.3	553.1	semiconsolidated

TABLE 2
Sampled Locations with Clean Materials Overlying Impacted
Tyco Fire Products LP Facility - Marinette, WI

Sample Location Name	Area Assignment	Top of Sediment Surface Elevation (ft amsl)	Depth to Top of Sampled Interval (ft)	Depth to Bottom of Sampled Interval (ft)	Arsenic Concentration (mg/kg)	Midpoint elevation of Sampled Interval (ft amsl)	Layer Assignment
		576.6	-24.0	-25.0	1.8	552.1	semiconsolidated
		576.6	-25.0	-26.0	2.5	551.1	semiconsolidated
		576.6	-26.0	-27.0	2.4	550.1	semiconsolidated
		576.6	-27.0	-28.0	2.6	549.1	semiconsolidated
		576.6	-28.0	-29.0	3	548.1	semiconsolidated
		576.6	-29.0	-30.0	1.8	547.1	till
		576.6	-30.0	-31.0	1.6	546.1	till
		576.6	-31.0	-32.0	2	545.1	till
		576.6	-32.0	-33.0	2.4	544.1	till
		576.6	-33.0	-33.8	3.6	543.2	till
SD562	Transition Area 3	575.1	0.0	-0.5	**101**	574.9	soft sediment
		575.1	-0.5	-1.0	**97.8**	574.4	soft sediment
		575.1	-1.0	-1.5	**111**	573.9	soft sediment
		575.1	-1.5	-2.0	**71.9**	573.4	soft sediment
		575.1	-2.0	-2.5	9.7	572.9	soft sediment
		575.1	-2.5	-3.0	5.9	572.4	soft sediment
		575.1	-3.0	-3.5	29.8	571.9	soft sediment
		575.1	-5.0	-6.0	37	569.6	semiconsolidated
		575.1	-7.0	-8.0	23.3	567.6	semiconsolidated
		575.1	-8.0	-9.0	24.1	566.6	semiconsolidated
		575.1	-9.0	-10.0	28.8	565.6	semiconsolidated
		575.1	-11.0	-12.0	**65.6**	563.6	semiconsolidated
		575.1	-12.0	-13.0	34.6	562.6	semiconsolidated

TABLE 2
Sampled Locations with Clean Materials Overlying Impacted
Tyco Fire Products LP Facility - Marinette, WI

Sample Location Name	Area Assignment	Top of Sediment Surface Elevation (ft amsl)	Depth to Top of Sampled Interval (ft)	Depth to Bottom of Sampled Interval (ft)	Arsenic Concentration (mg/kg)	Midpoint elevation of Sampled Interval (ft amsl)	Layer Assignment
		575.1	-13.0	-14.0	19.5	561.6	semiconsolidated
		575.1	-14.0	-15.0	24.7	560.6	semiconsolidated
		575.1	-15.0	-16.0	12.5	559.6	semiconsolidated
		575.1	-16.0	-17.0	5.3	558.6	semiconsolidated
		575.1	-17.0	-18.0	4.1	557.6	semiconsolidated
		575.1	-18.0	-19.0	2.2	556.6	semiconsolidated
		575.1	-19.0	-20.0	5.8	555.6	semiconsolidated
		575.1	-20.0	-21.0	2.5	554.6	semiconsolidated
		575.1	-21.0	-22.0	3.4	553.6	semiconsolidated
		575.1	-22.0	-23.0	2.3	552.6	semiconsolidated
		575.1	-25.0	-26.0	2	549.6	semiconsolidated
		575.1	-26.0	-27.0	1.7	548.6	semiconsolidated
		575.1	-27.0	-28.0	1.9	547.6	semiconsolidated
		575.1	-28.0	-29.0	2.1	546.6	semiconsolidated
		575.1	-29.0	-30.0	2.4	545.6	semiconsolidated
		575.1	-30.0	-31.0	1.9	544.6	semiconsolidated
		575.1	-31.0	-32.0	1.6	543.6	till
		576.7	-5.0	-6.0	13.2	571.2	semiconsolidated
		576.7	-7.0	-8.0	**62.4**	569.2	semiconsolidated
		576.7	-9.0	-10.0	**61.3**	567.2	semiconsolidated
SD574	Transition Area 2	576.7	-10.0	-11.0	**108**	566.2	semiconsolidated
		576.7	-11.0	-12.0	**55.7**	565.2	semiconsolidated
		576.7	-12.0	-13.0	**145**	564.2	semiconsolidated

TABLE 2
Sampled Locations with Clean Materials Overlying Impacted
Tyco Fire Products LP Facility - Marinette, WI

Sample Location Name	Area Assignment	Top of Sediment Surface Elevation (ft amsl)	Depth to Top of Sampled Interval (ft)	Depth to Bottom of Sampled Interval (ft)	Arsenic Concentration (mg/kg)	Midpoint elevation of Sampled Interval (ft amsl)	Layer Assignment
		576.7	-13.0	-14.0	**79.1**	563.2	semiconsolidated
		576.7	-14.0	-15.0	**78.4**	562.2	semiconsolidated
		576.7	-15.0	-16.0	31.3	561.2	semiconsolidated
		576.7	-16.0	-17.0	5.5	560.2	semiconsolidated
		576.7	-17.0	-18.0	10.5	559.2	semiconsolidated
		576.7	-18.0	-19.0	5.1	558.2	semiconsolidated
		576.7	-19.0	-20.0	**66.3**	557.2	semiconsolidated
		576.7	-20.0	-21.0	**87.2**	556.2	semiconsolidated
		576.7	-21.0	-22.0	**53.8**	555.2	semiconsolidated
		576.7	-22.0	-23.0	**53.2**	554.2	semiconsolidated
		576.7	-23.0	-24.0	4.5	553.2	semiconsolidated
		576.7	-24.0	-25.0	2.8	552.2	semiconsolidated
		576.7	-25.0	-26.0	2.4	551.2	semiconsolidated
		576.7	-26.0	-27.0	2.1	550.2	semiconsolidated
		576.7	-27.0	-28.0	2	549.2	semiconsolidated
		576.7	-28.0	-29.0	2.3	548.2	semiconsolidated
		576.7	-29.0	-30.0	3.1	547.2	semiconsolidated
		576.7	-30.0	-31.0	3.1	546.2	till
		576.7	-31.0	-32.0	2	545.2	till
		576.7	-32.0	-33.0	2.1	544.2	till

Notes:

Arsenic Concentration above 20 mg/kg

Arsenic Concentration above 50 mg/kg

TABLE 3
Permitting / Clearance Status Table
Tyco Fire Products LP Facility - Marinette, WI

Permit	Agency	Contact	Budgeted Review Time	Notes
Federal				
Clean Water Act- Section 404	U.S. Army Corps of Engineers- Green Bay	Todd Losee Green Bay, WI 920-448-2824	180 days	Joint Permit Application package with Section 401
Section 10- Navigable Waterway	U.S. Army Corps of Engineers- Green Bay	Todd Losee Green Bay, WI 920-448-2824	180 days	Joint Permit Application package with Section 401
Coast Guard Bulletin	U.S. Coast Guard	LT Kevin M. Dugan Commanding Officer U.S. Coast Guard Marinette, WI 715-735-4100	30 days	Notify Coast Guard 2 to 4 weeks prior to commencing work within Menominee River. Coast Guard will prepare a bulletin notifying boat traffic. Also need to contact: Meredith Foster Security Officer Marinette, WI 715-735-4100
U.S. Fish and Wildlife Service	Section 7 Endangered Species Consultation	Ms. Jill Utrup Green Bay Field Office U.S. Fish and Wildlife Service 2661 Scott Tower Drive New Franken, WI 54229 920-866-1717	30 days	
State				
Section 401- Water Quality Certification	Wisconsin Dept. of Natural Resources	Robert Rosenberger	180 days	Joint Permit Application package with Section 404
Chapter 30 Shoreland Grading Permit	Wisconsin Dept. of Natural Resources	Robert Rosenberger	180 days	Will be issued in conjunction with the Section 401 WQC

TABLE 3
Permitting / Clearance Status Table
Tyco Fire Products LP Facility - Marinette, WI

Permit	Agency	Contact	Budgeted Review Time	Notes
Waterway Marker Permit	Wisconsin Dept. of Natural Resources	Jeremy Cords Northeast Region Recreational Safety Warden - North 2984 Shawano Ave Green Bay, WI 54313 920-662-5129 jeremy.cords@wisconsin.gov	180 days	May require establishment of local ordinance for placement of buoys within Menominee River
Wisconsin Pollutant Discharge Elimination System- Construction Site Stormwater Runoff	Wisconsin Dept. of Natural Resources	David Bougie Northeast Regional Headquarters 2984 Shawano Avenue Green Bay, WI 54313-6727 920-662-5124	45 days	
Wisconsin Pollutant Discharge Elimination System- Point Source Discharge Permit	Wisconsin Dept. of Natural Resources	Jeff Brauer Wisconsin Department of Natural Resources Madison, WI 608-267-7643		
Natural Heritage Inventory Review	Wisconsin Dept. of Natural Resources	Bureau of Endangered Resources 608-266-7012	45 days	
Natural Historic Preservation Act-Section 106 Review	Wisconsin State Historical Society	Mr. Sherman Banker Wisconsin SHPO Historical Society 816 State Street, Room 306 Madison, WI 53706 608-264-6507	30 days	

TABLE 3
Permitting / Clearance Status Table
Tyco Fire Products LP Facility - Marinette, WI

Permit	Agency	Contact	Budgeted Review Time	Notes
Local				
Wastewater Coordination	City of Marinette	Tim Peterson	30 days	
Erosion Control Permit	City of Marinette	Brian Miller City Engineer 715-732-5134 bmiller@marinette.wi.us	30 days	
Building Permit	City of Marinette	Brian Miller City Engineer 715-732-5134 bmiller@marinette.wi.us	30 days	

Figures

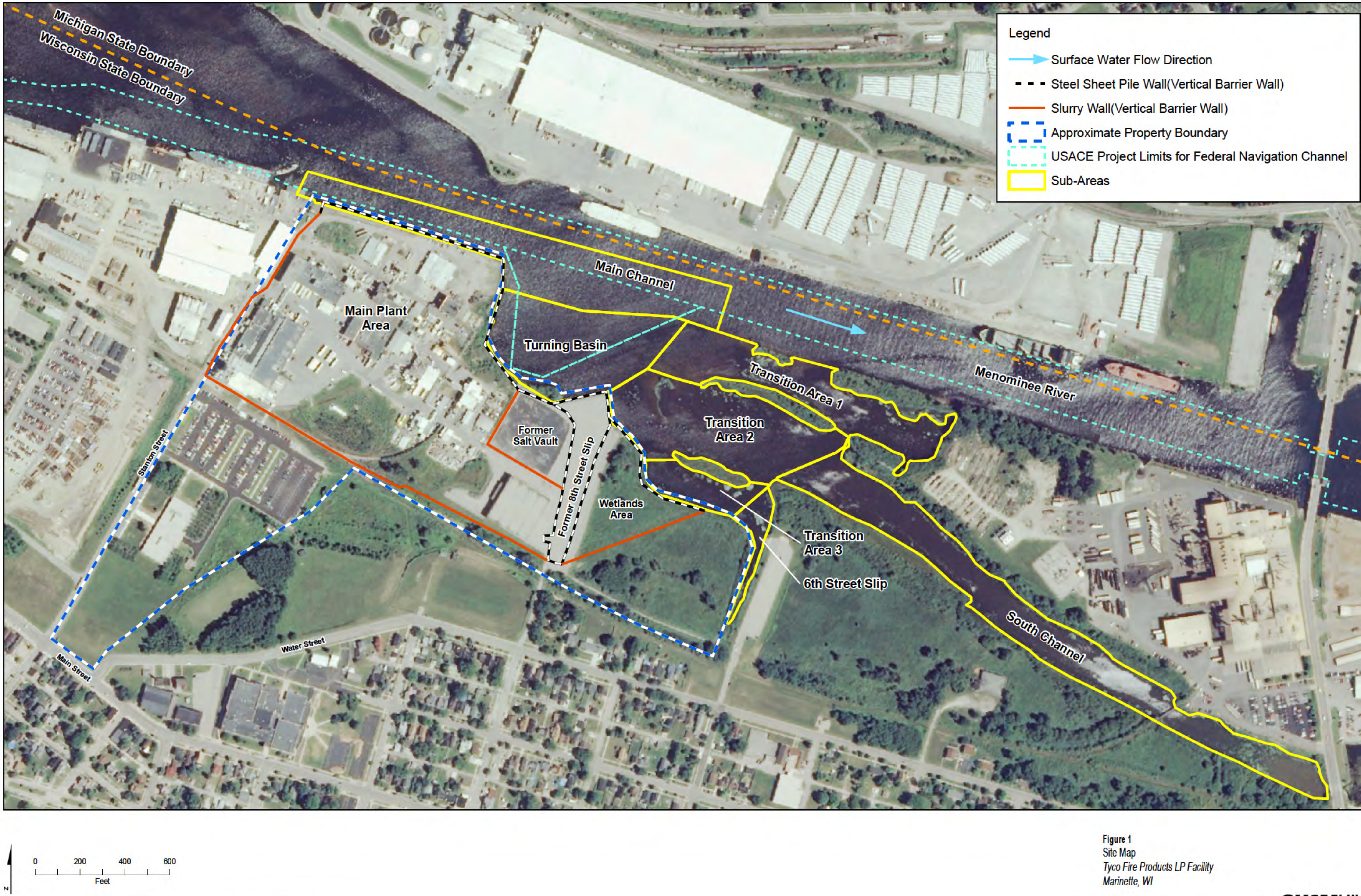


Figure 1
Site Map
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL

E:\TYCO\MAPF LES\DELIVERABLE_012312\FIGURE 01 - SITE MAP MXD JHANSEN1 1/20/2012 3 52:06 PM

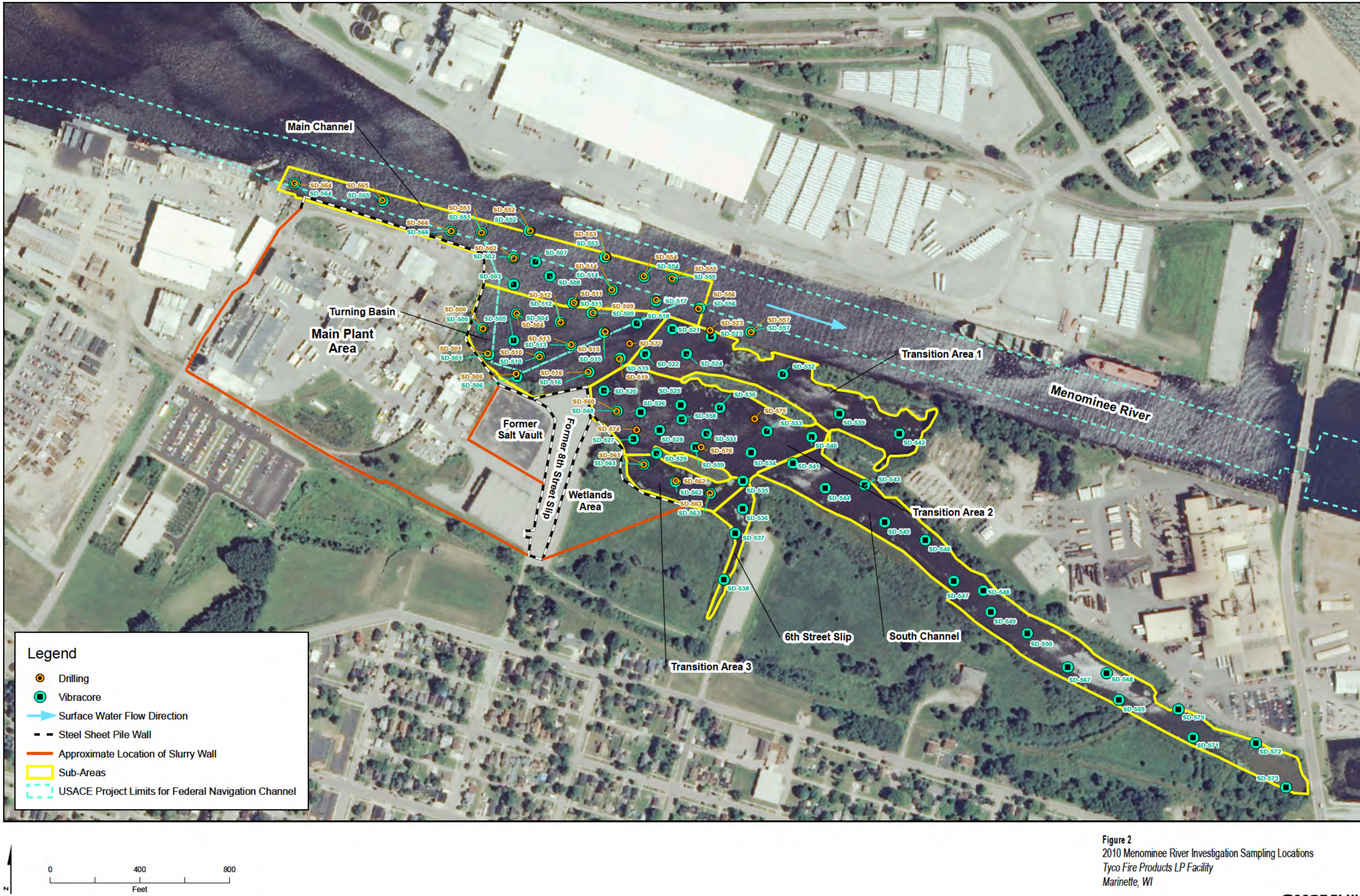
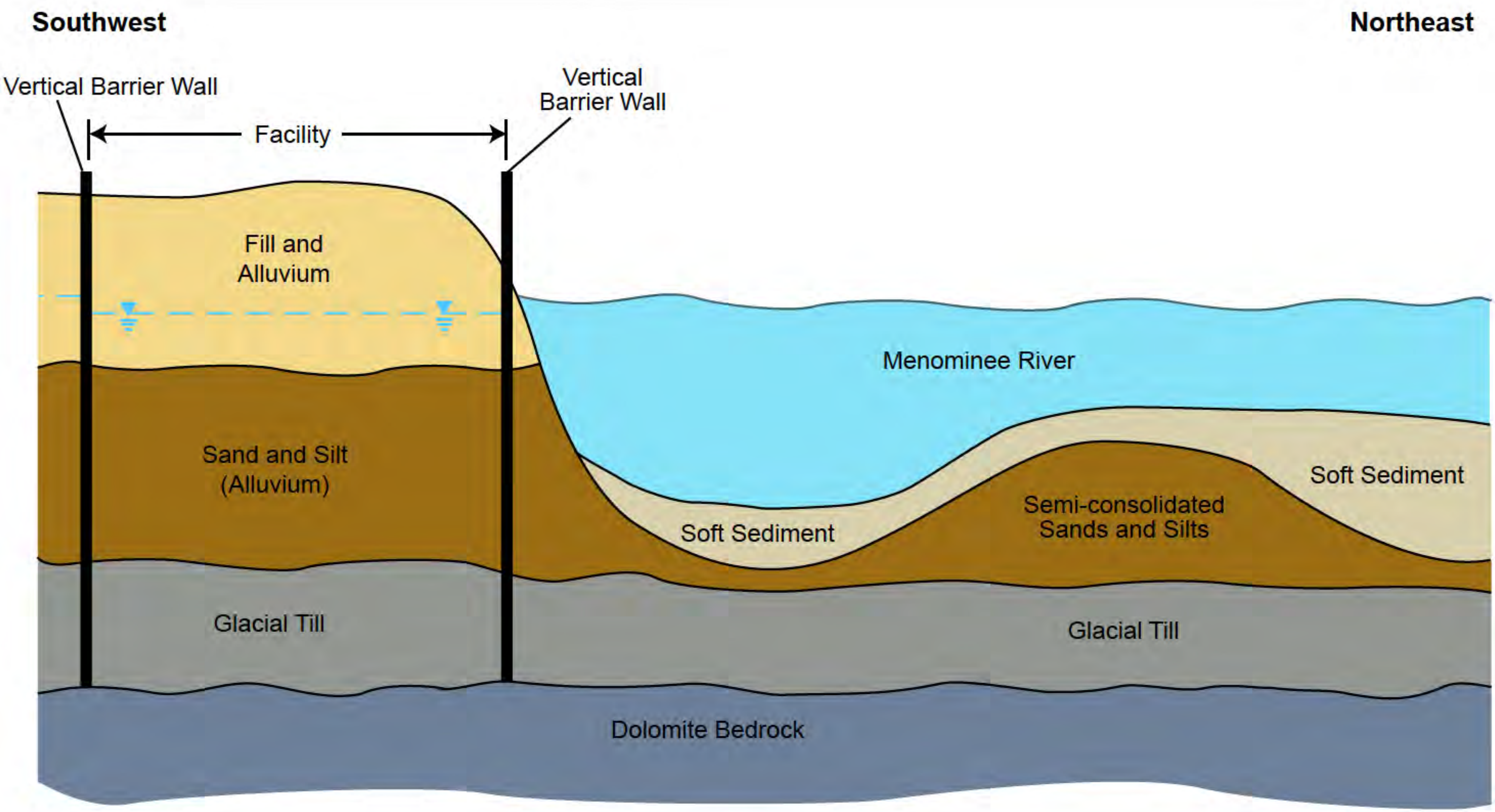


Figure 2
2010 Menominee River Investigation Sampling Locations
Tyco Fire Products LP Facility
Marinette, WI

E:\TYCO\MAPFILES\DELIVERABLE_012312\FIGURE 02 - 2010 MENOMINEE RIVER INVESTIGATION SAMPLING LOCATIONS.MXD JHANSEN1 1/20/2012 3:51:26 PM

CH2MHILL



Not to scale.

FIGURE 3
Conceptual Site Model – Existing Conditions
Tyco Fire Products LP Facility and Menominee River Sediment

CH2MHILL.

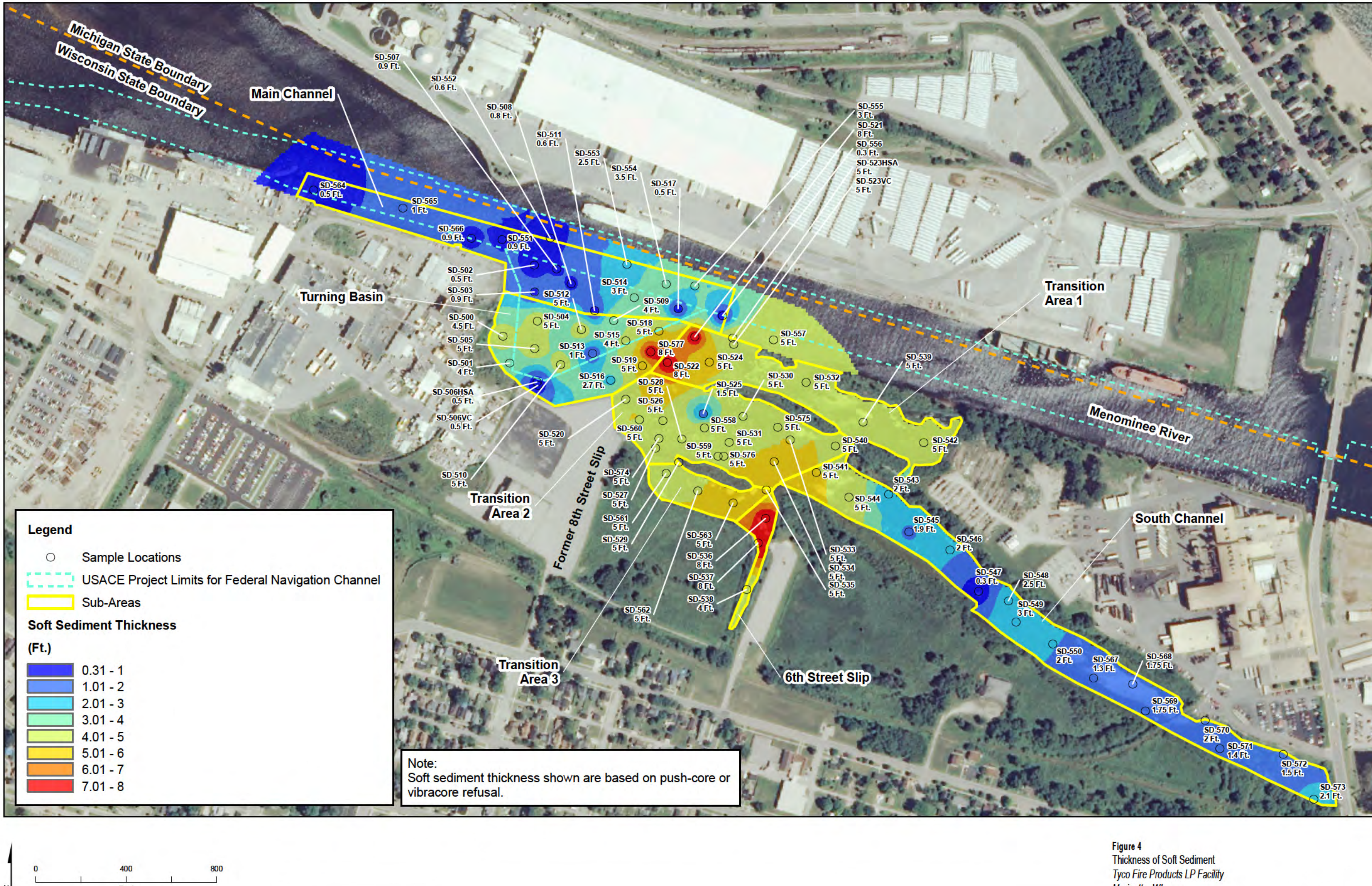


Figure 4
Thickness of Soft Sediment
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL

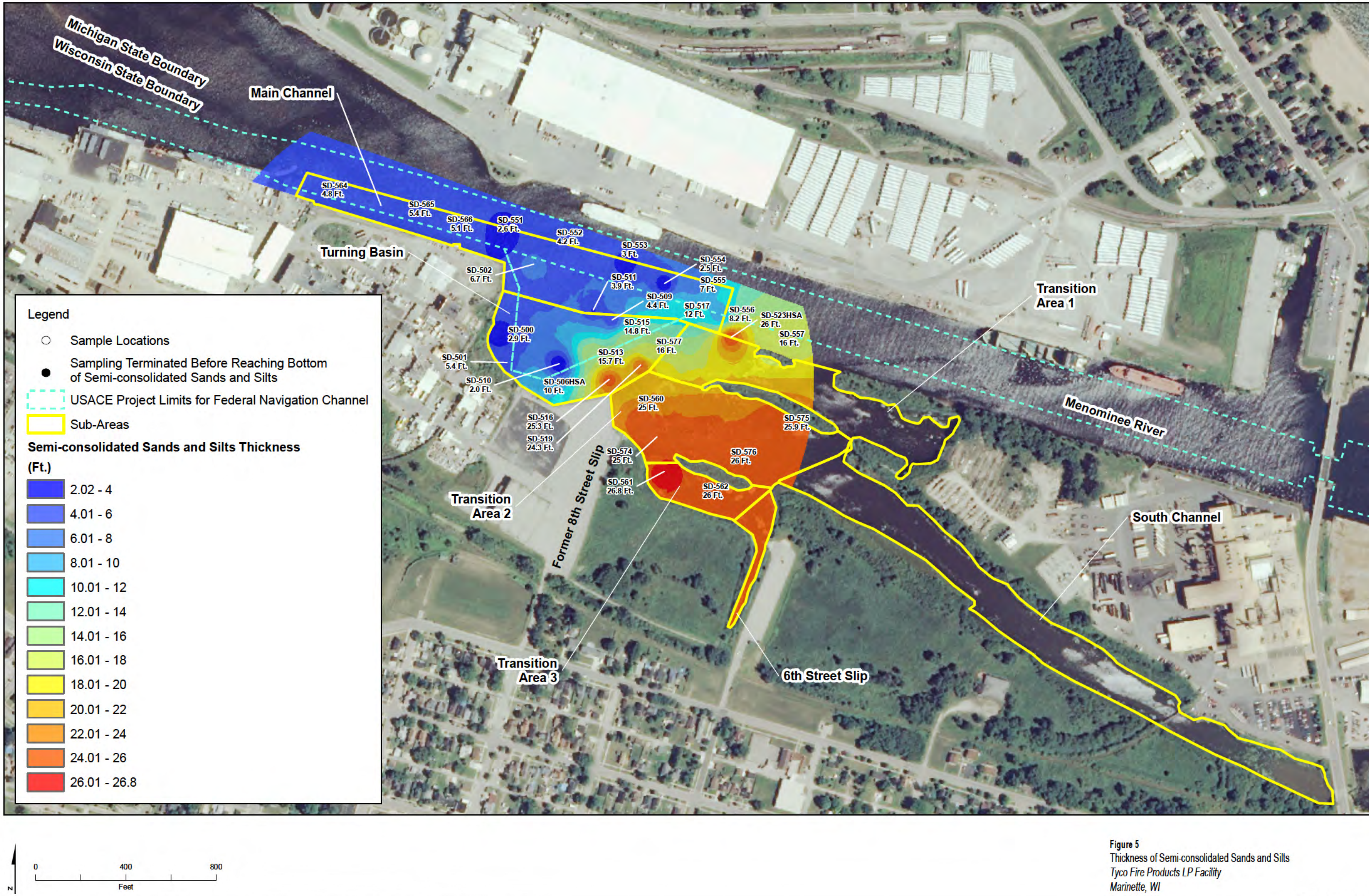
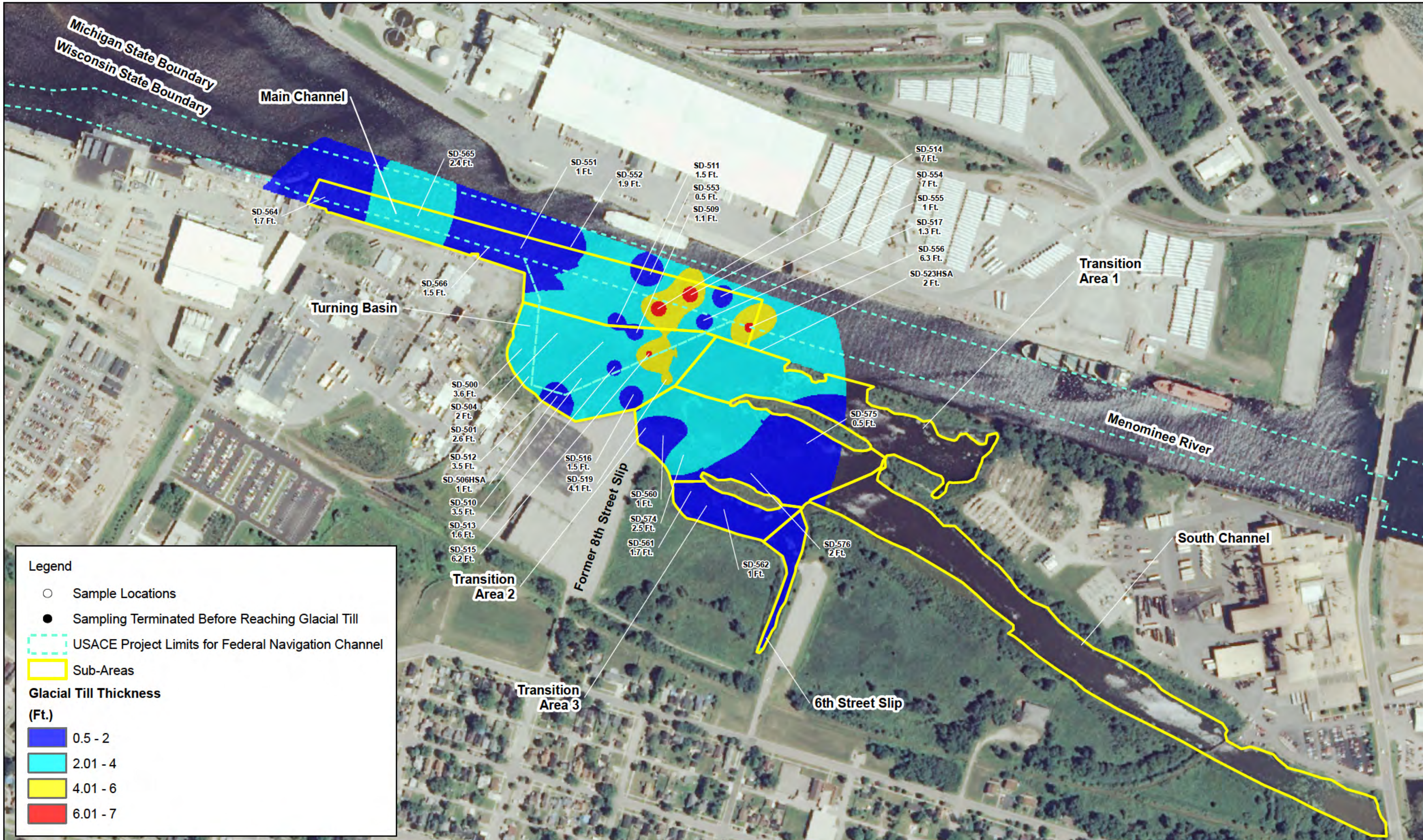


Figure 5
Thickness of Semi-consolidated Sands and Silts
Tyco Fire Products LP Facility
Marinette, WI

E:\TYCO\MAPFILES\DELIVERABLE_012312\FIGURE 05_TYCO_SITE_SEMICONSOLIDATEDSANDSANDSILTS_2010.MXD JHANSEN1 1/20/2012 3:56:14 PM

CH2MHILL



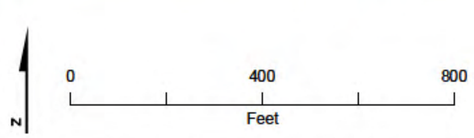


Figure 6
Thickness of Glacial Till
Tyco Fire Products LP Facility
Marinette, WI

E:\TYCO\MAPFILES\DELIVERABLE_012312\FIGURE 06_TYCO_SITE_GLACIALTILLTHICKNESS_2010.MXD JHANSEN1 1/20/2012 3:55:12 PM

CH2MHILL

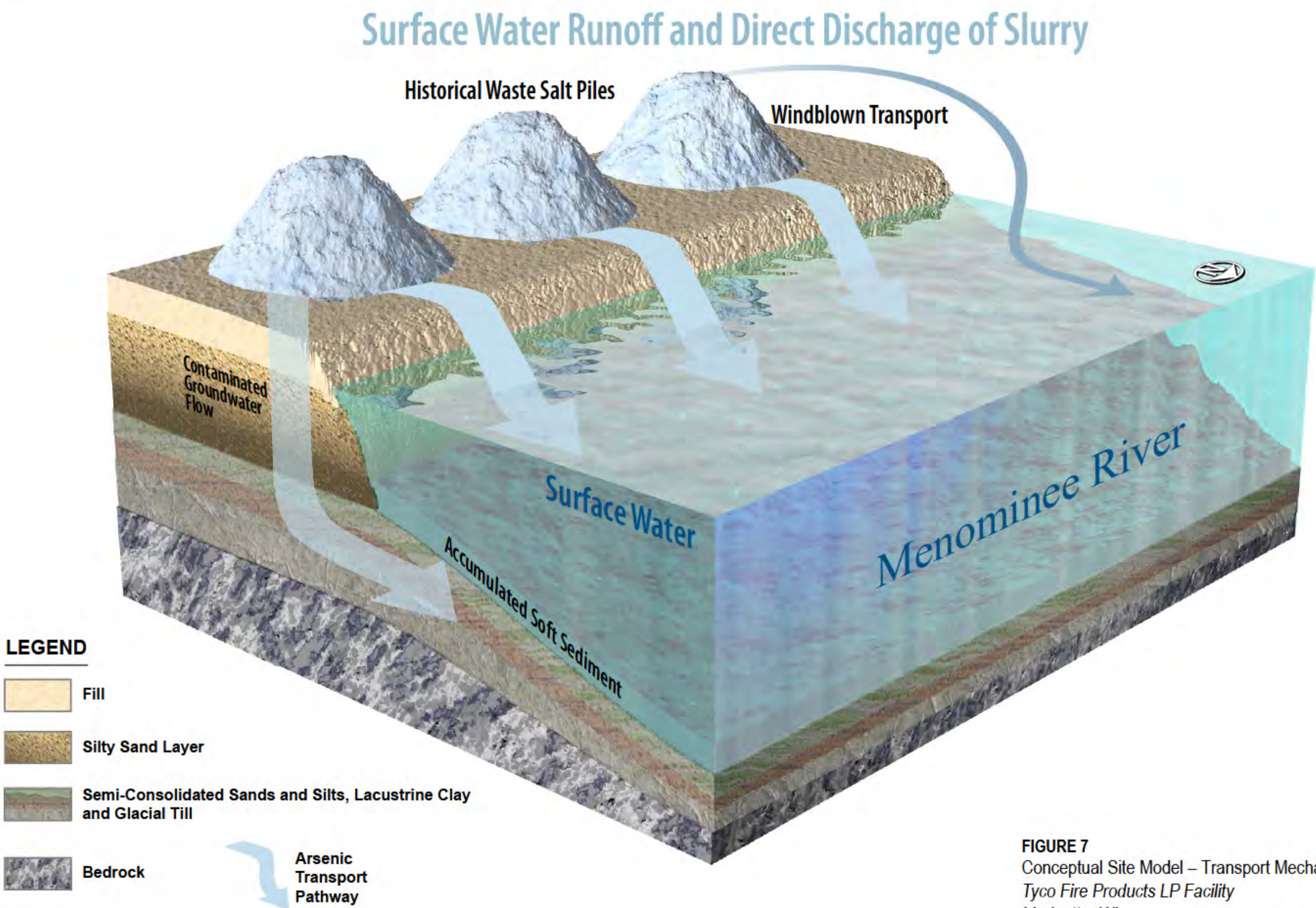


FIGURE 7
Conceptual Site Model – Transport Mechanisms
Tyco Fire Products LP Facility
Marinette, WI

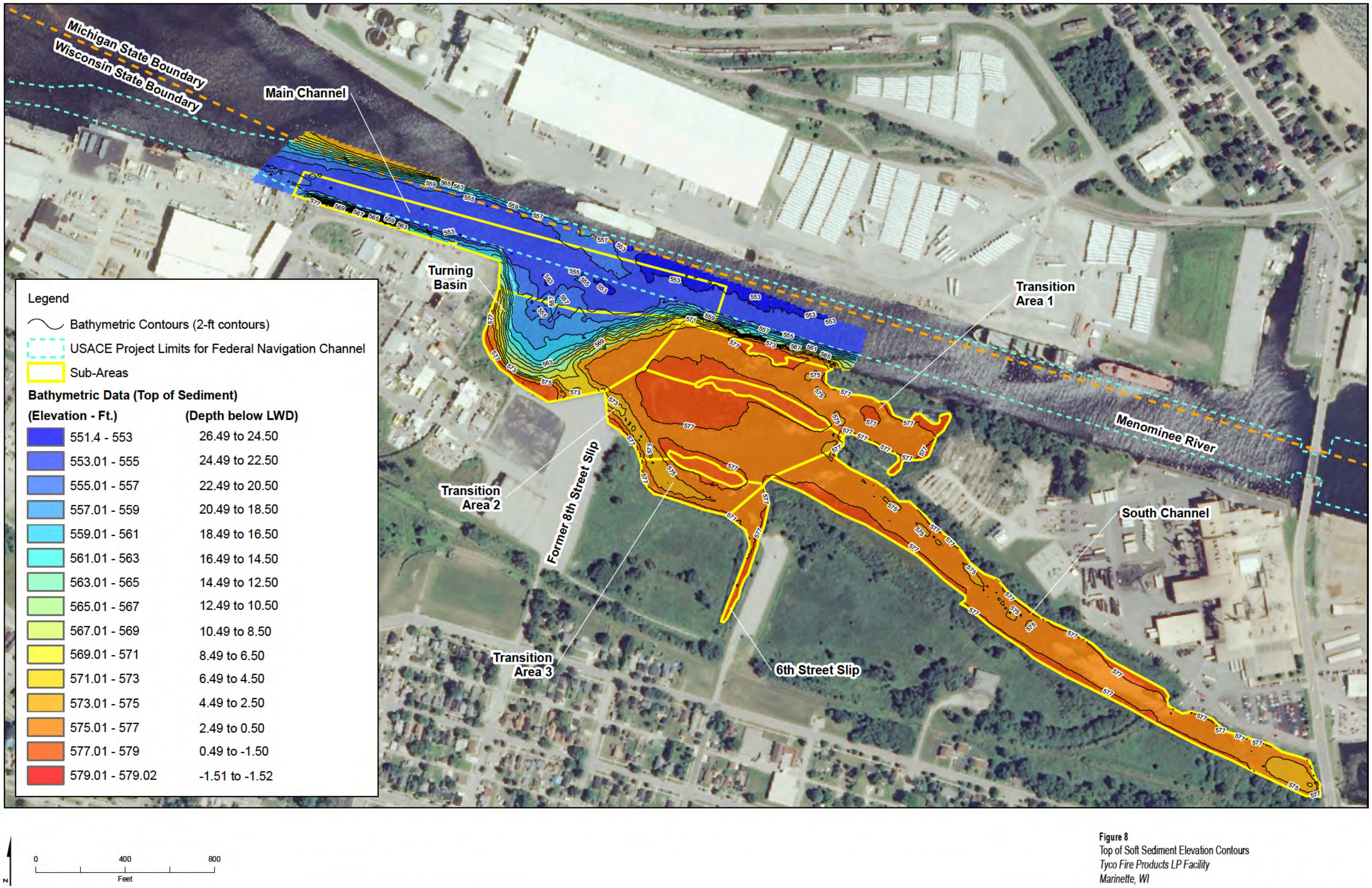
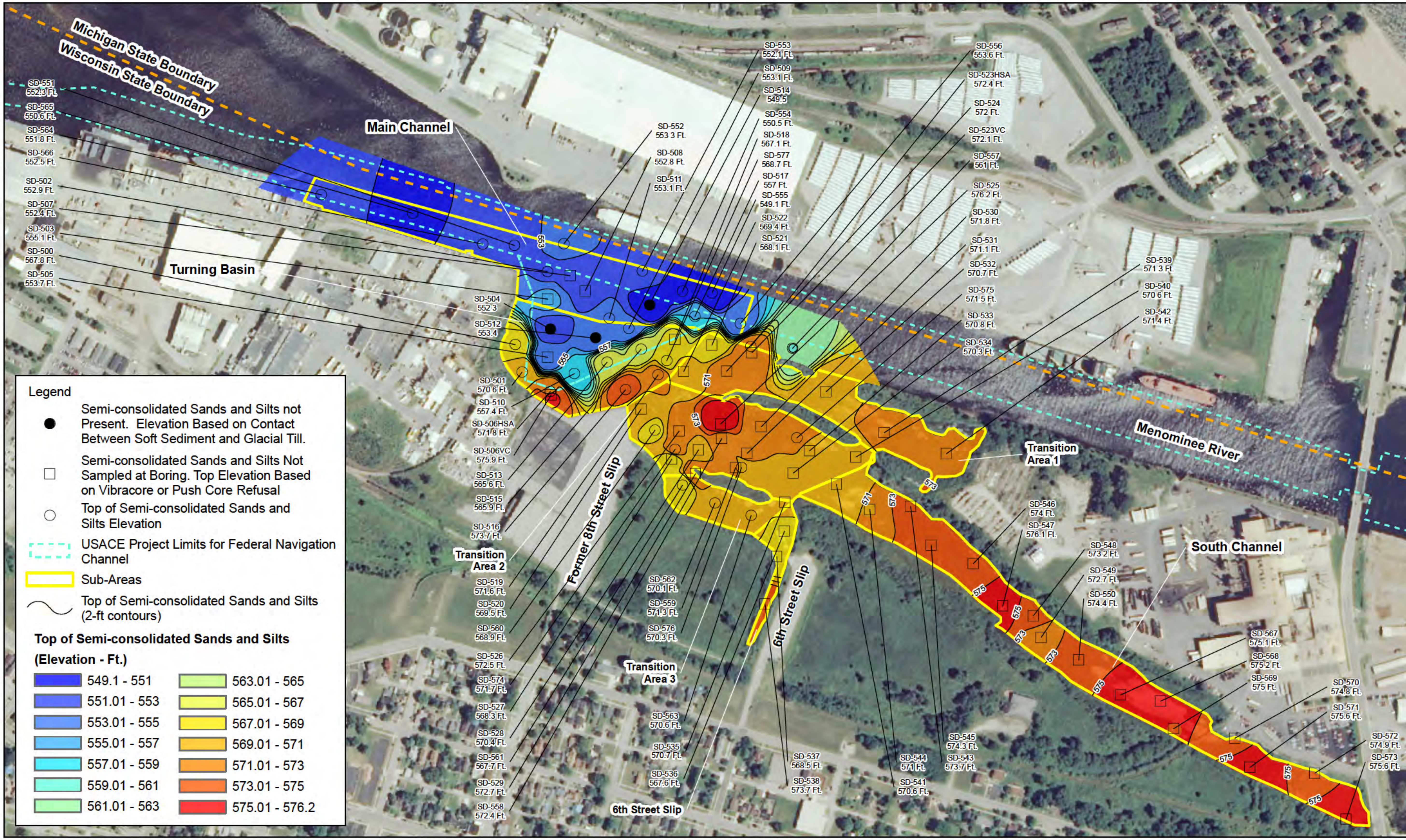


Figure 8
Top of Soft Sediment Elevation Contours
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL

E:\TYCO\MAPFILES\DELIVERABLE_012312\FIGURE 08 - TOP OF SOFT SED MENT ELEVATION CONTOURS.MXD JHANSEN1 1/20/2012 3:45:37 PM



N

0 400 800
Feet

Figure 9
Top of Semi-consolidated Sands and Silts Elevation Contours
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL

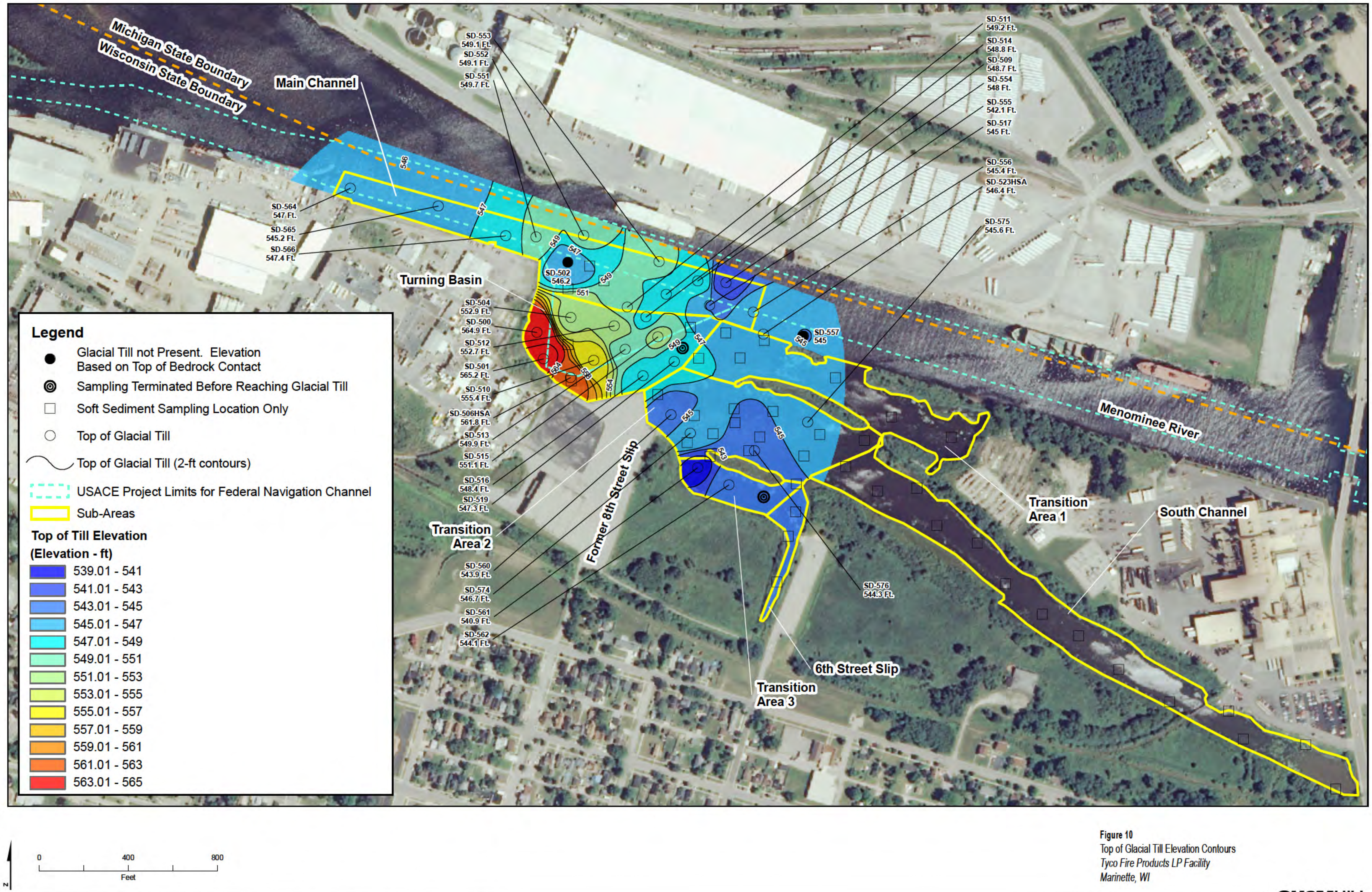


Figure 10
Top of Glacial Till Elevation Contours
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL

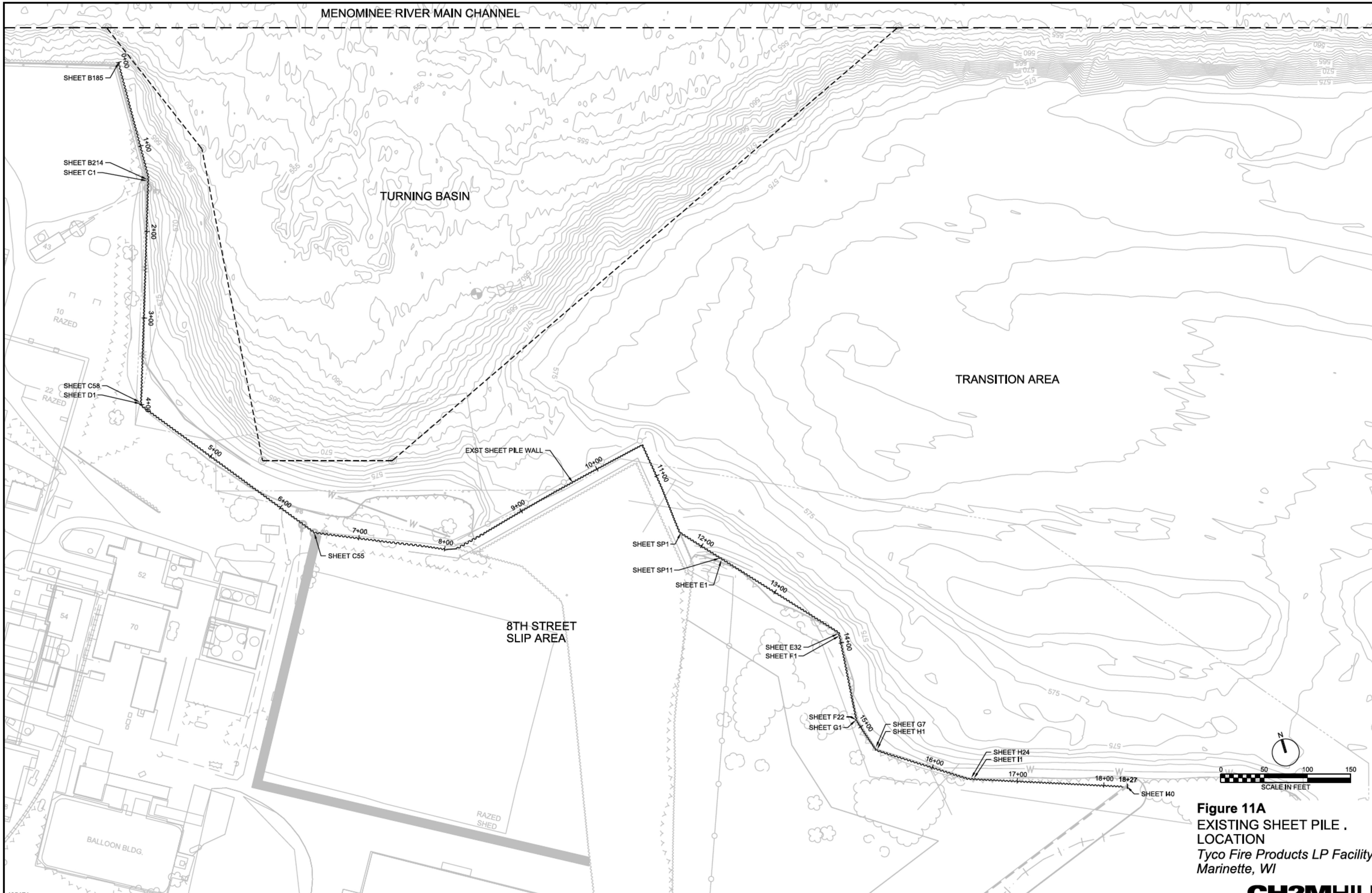


Figure 11A
EXISTING SHEET PILE .
LOCATION
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL.

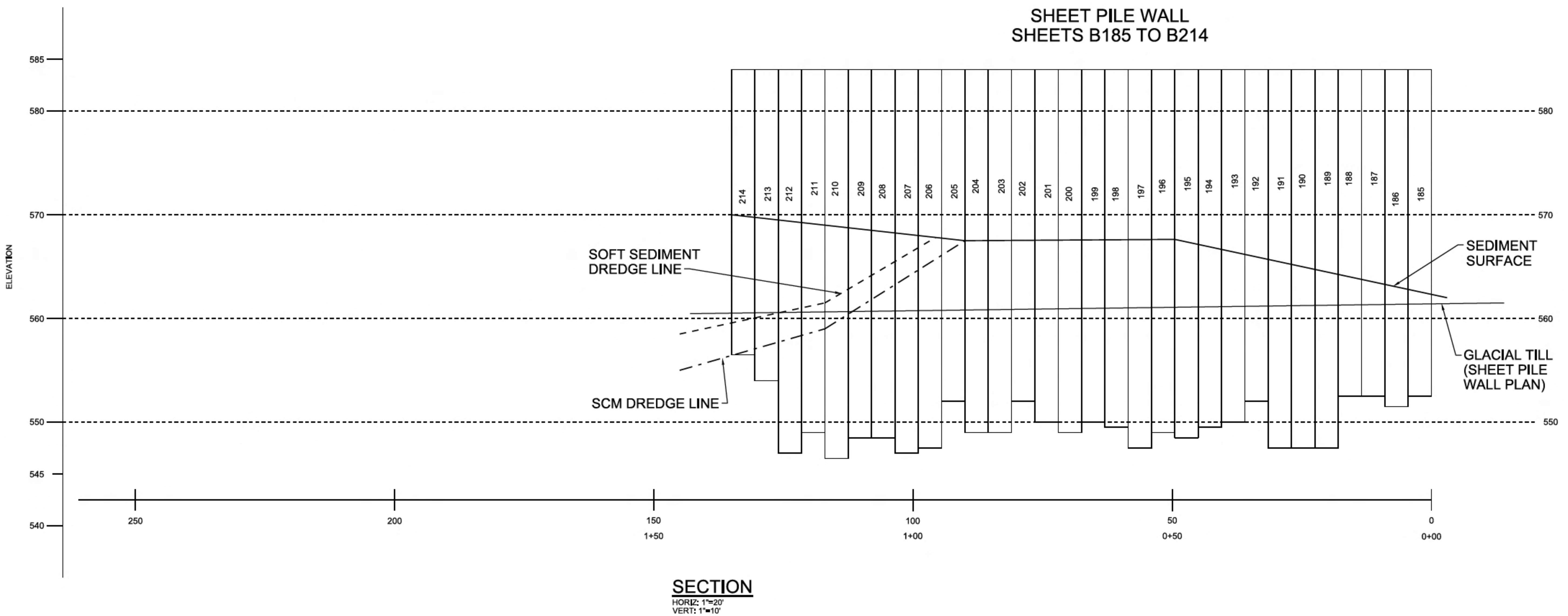


Figure 11B
SHEET PILE WALL
SHEETS B185 TO B214
Tyco Fire Products LP Facility
Marinette, WI

425171

CH2MHILL.

FILENAME: 001-NF-0002_425171.dgn PLOT DATE: 16-JAN-2012

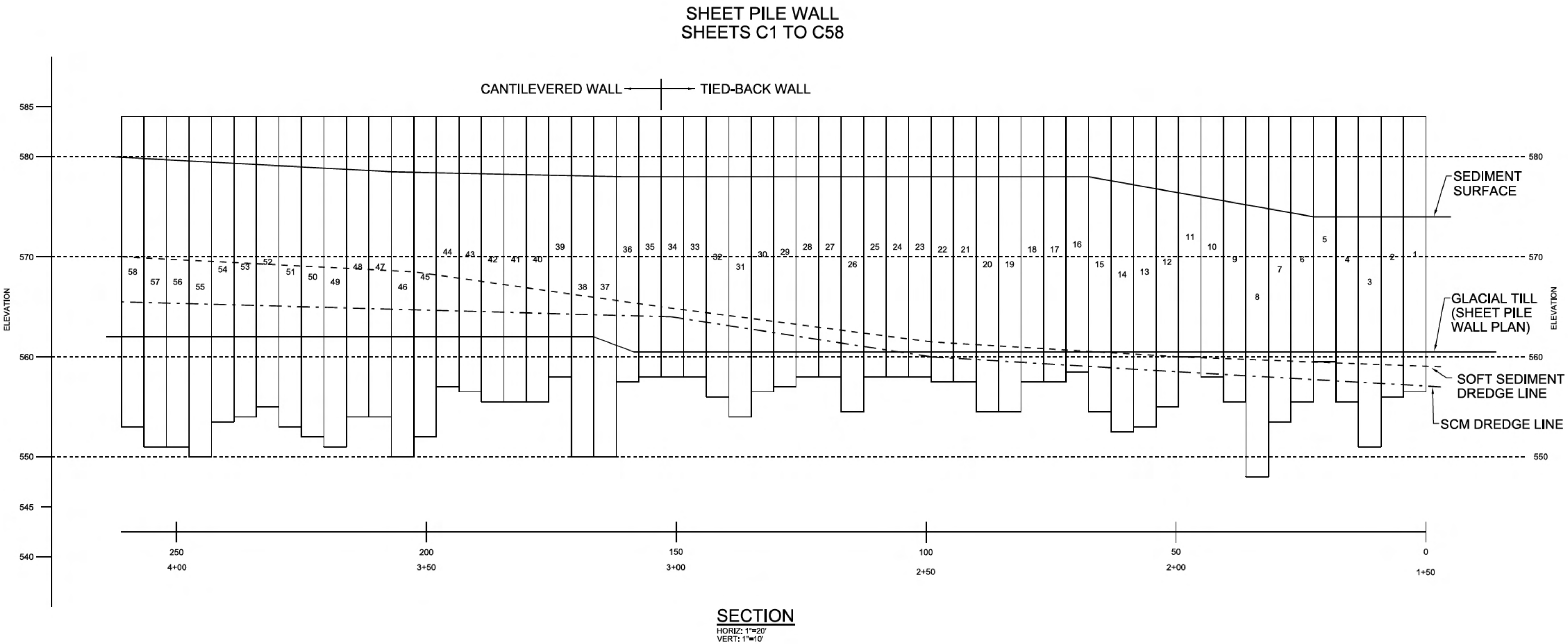


Figure 11C
SHEET PILE WALL
SHEETS C1 TO C58
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL.

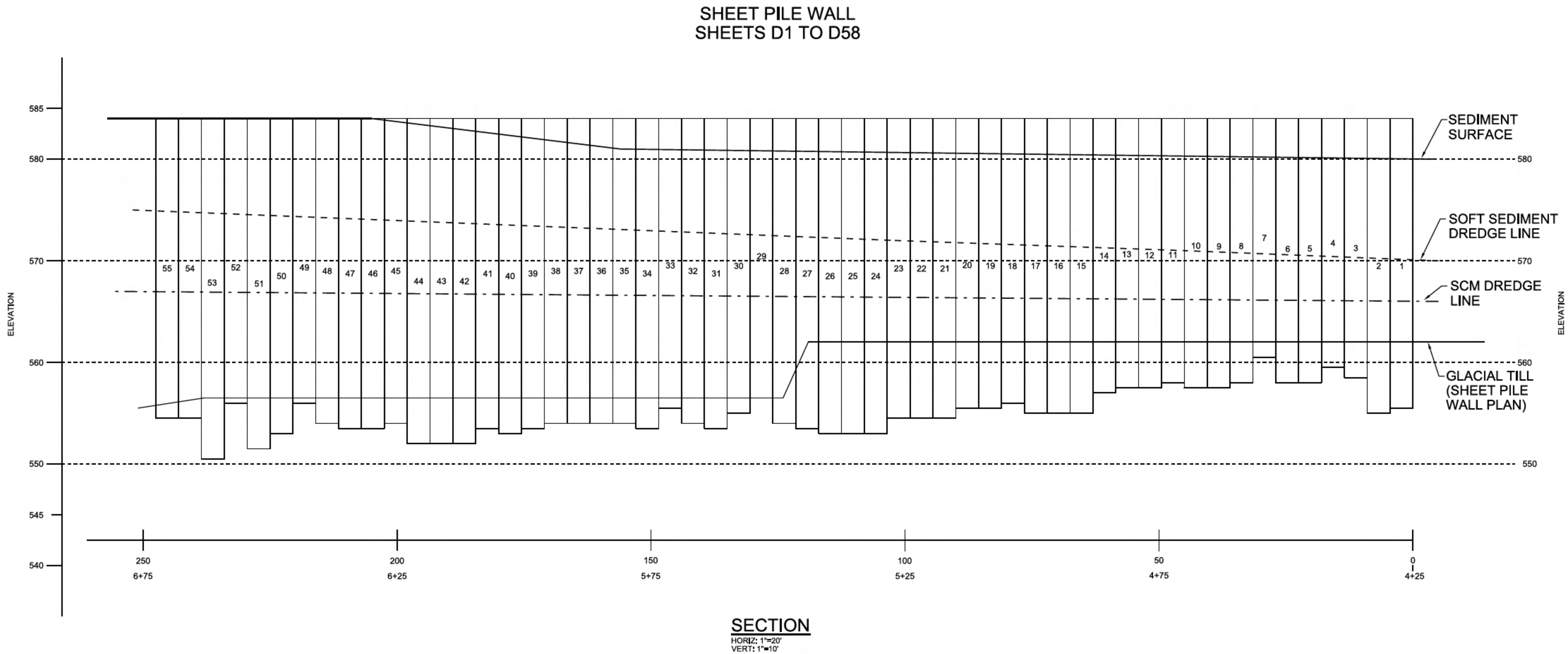


Figure 11D
SHEET PILE WALL
SHEETS D1 TO D58
Tyco Fire Products LP Facility
Marinette, WI

425171

CH2MHILL.

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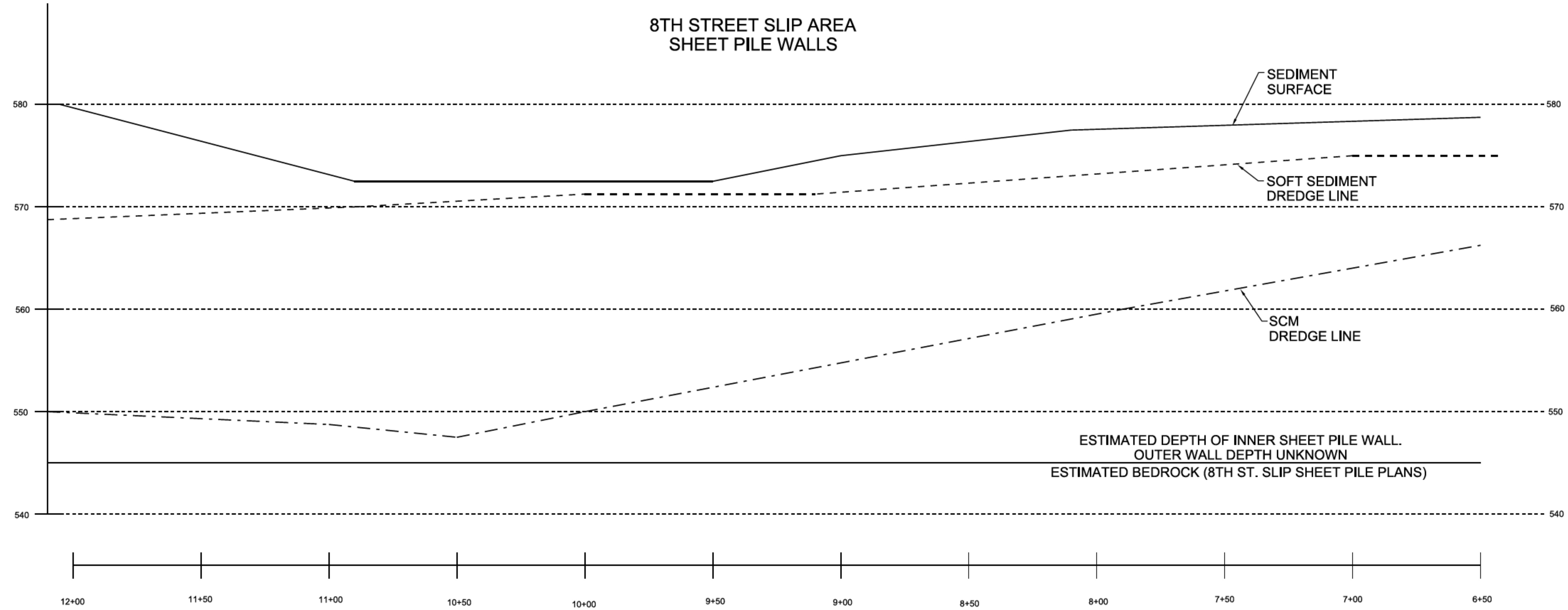
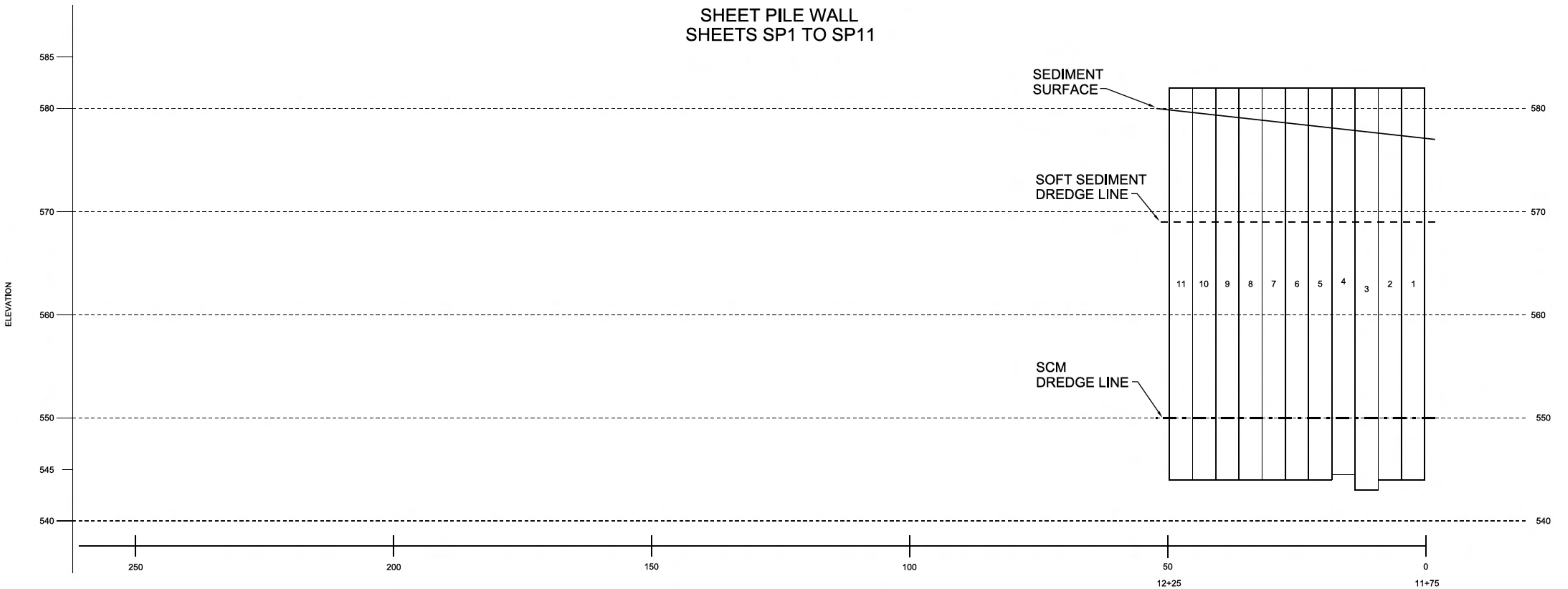


SECTION
HORIZ: 1"=40'
VERT: 1"=10'

Figure 11E
8TH STREET SLIP AREA
SHEET PILE WALLS
Tyco Fire Products LP Facility
Marinette, WI

425171

FILENAME: 001-NF-0011_425171.dgn PLOT DATE: 16-JAN-2012



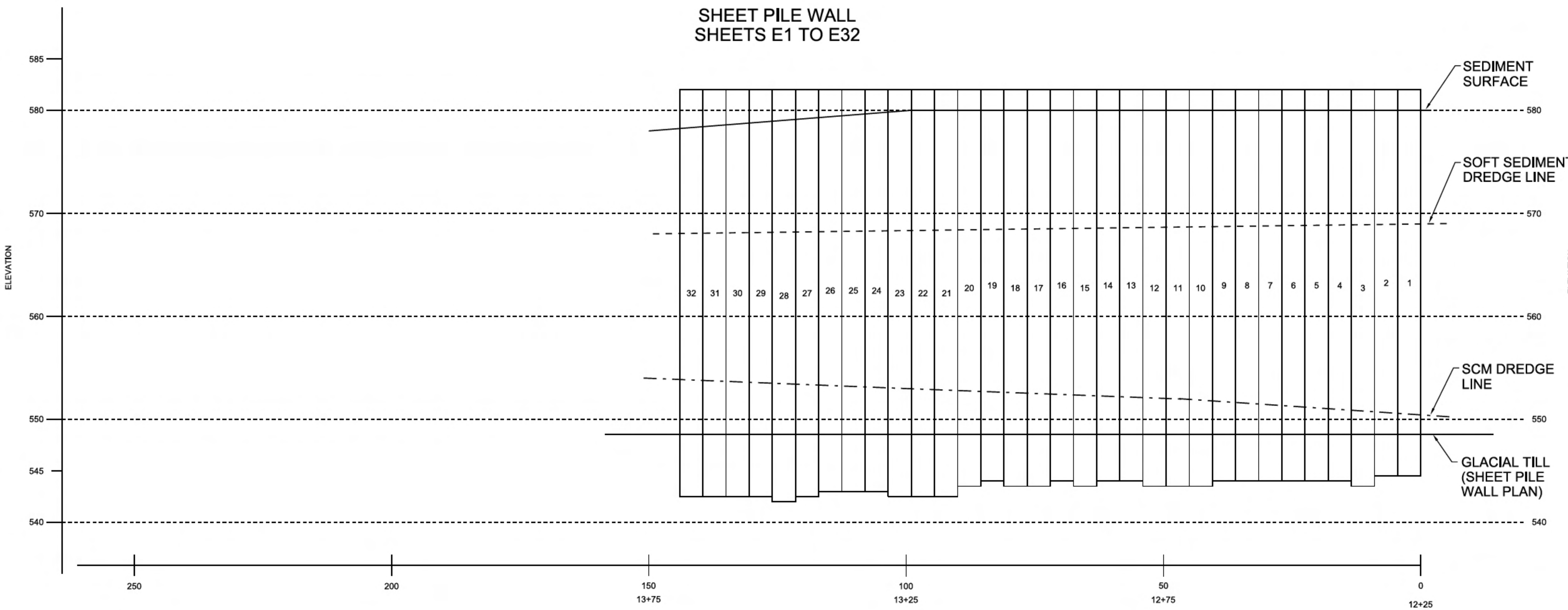
SECTION
HORIZ: 1"=20'
VERT: 1"=10'

Figure 11F
SHEET PILE WALL
SHEETS SP1 TO SP11
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL.

425171

FILENAME: 001-NF-0010_425171.dgn PLOT DATE: 16-JAN-2012



SECTION

HORIZ: 1"=20'
VERT: 1"=10'

Figure 11G
SHEET PILE WALL
SHEETS E1 TO E32
Tyco Fire Products LP Facility
Marinette, WI

425171

FILENAME: 001-NF-0005_425171.dgn PLOT DATE: 16-JAN-2012

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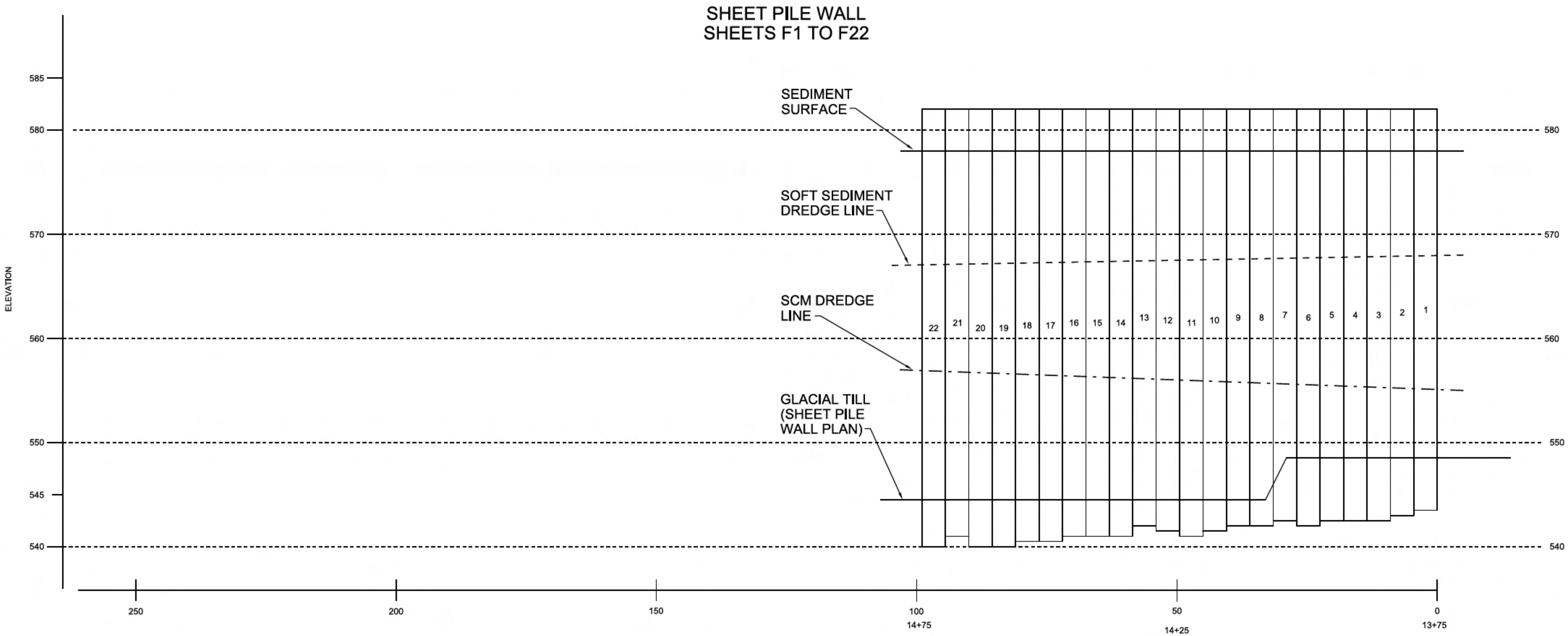

SECTION
HORIZ: 1"=20'
VERT: 1"=10'

Figure 11H
SHEET PILE WALL
SHEETS F1 TO F22
Tyco Fire Products LP Facility
Marinette, WI

425171

FILENAME: 001-NF-0006_425171.dgn PLOT DATE: 16-JAN-2012

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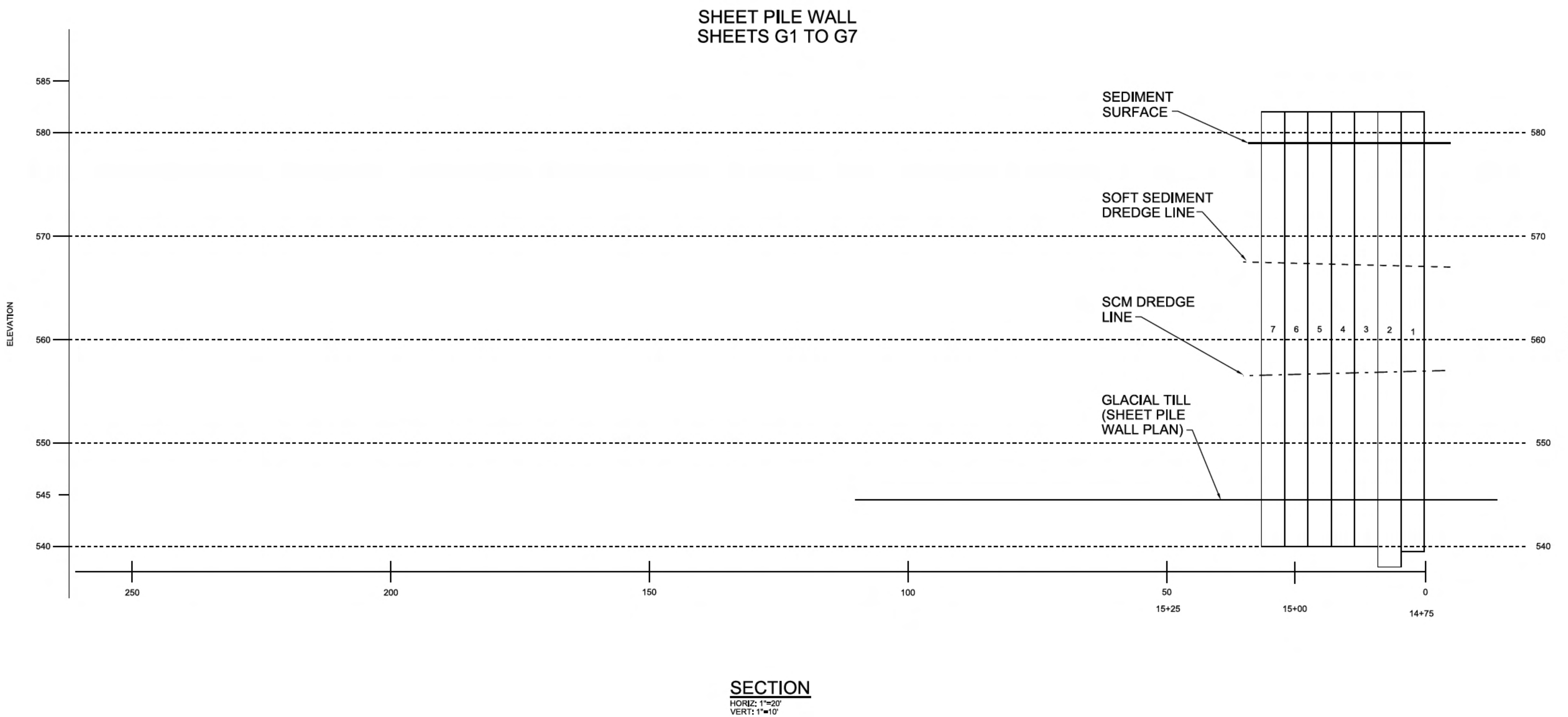
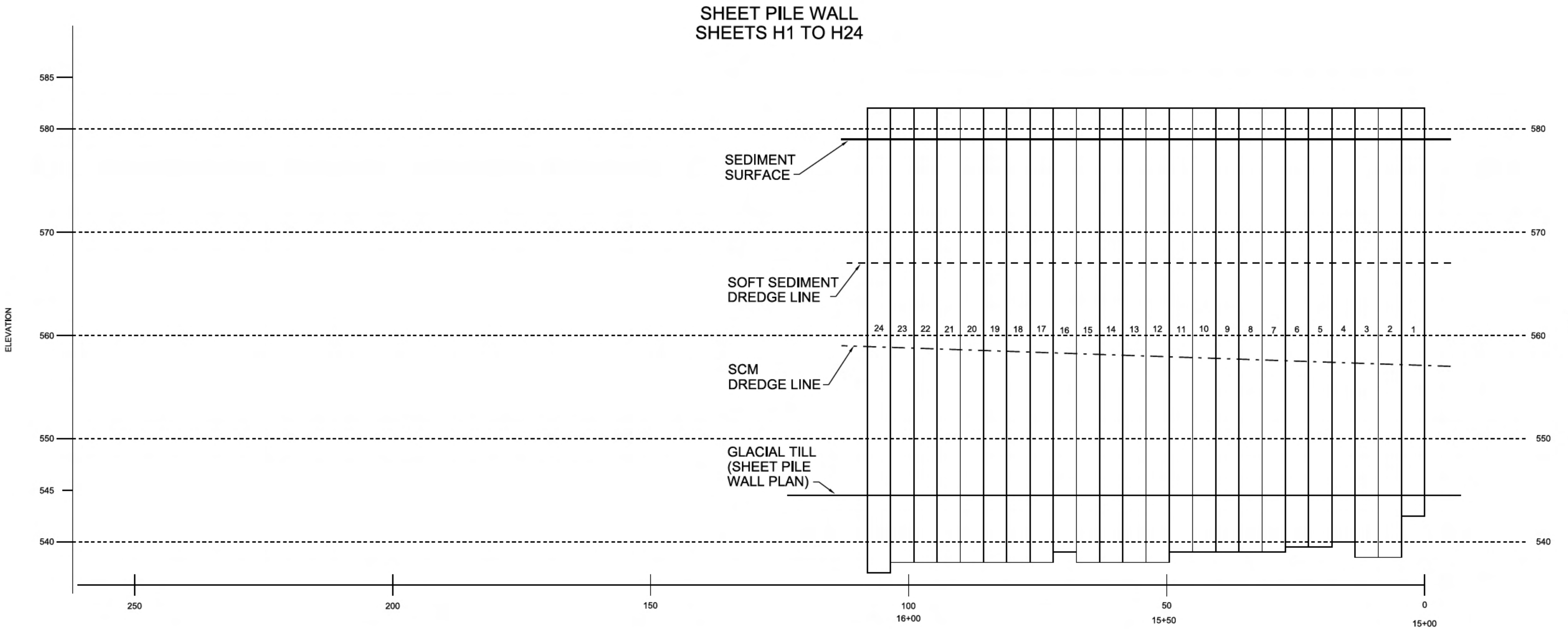


Figure 11I
SHEET PILE WALL
SHEETS G1 TO G7
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL

425171

FILENAME: 001-NF-0007_425171.dgn PLOT DATE: 16-JAN-2012

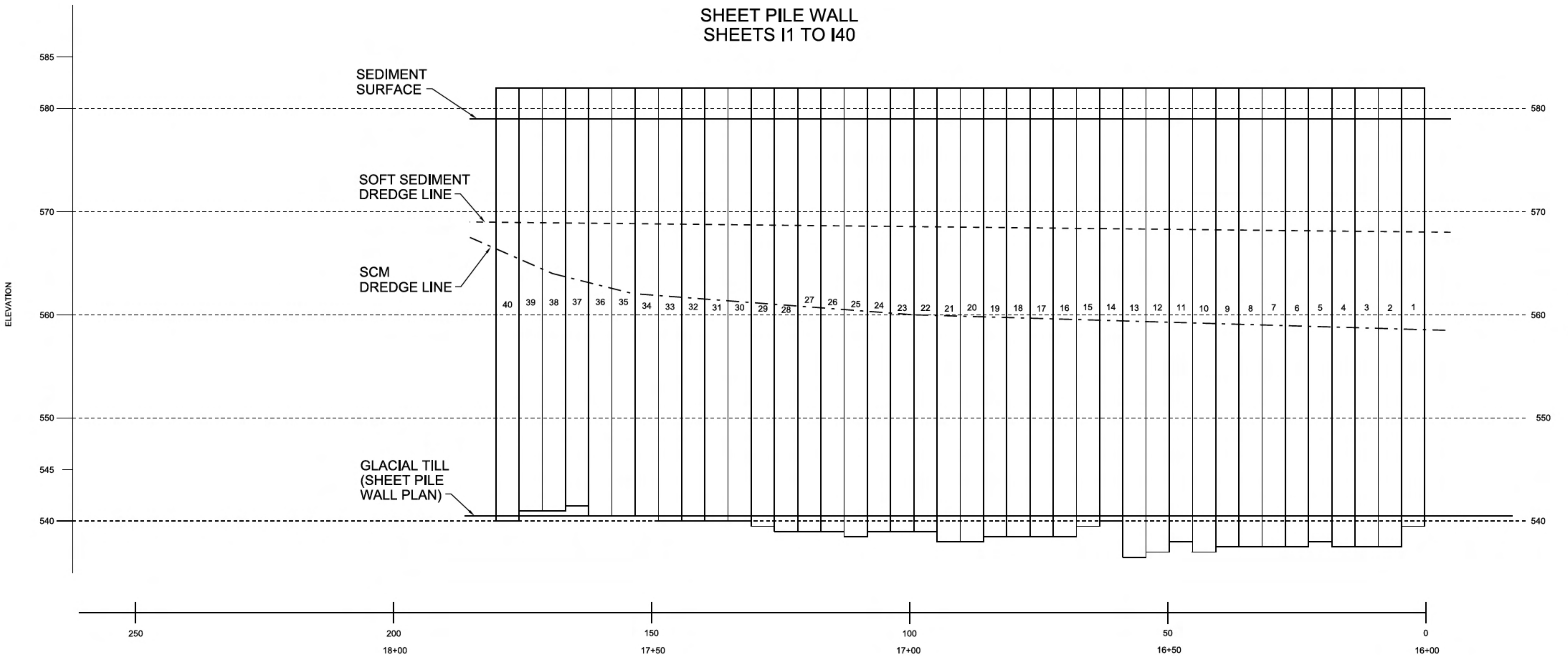


SECTION
HORIZ: 1"=20'
VERT: 1"=10'

Figure 11J
SHEET PILE WALL
SHEETS H1 TO H24
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL

425171
FILENAME: 001-NF-0008_425171.dgn PLOT DATE: 16-JAN-2012



SECTION
HORIZ: 1"=20'
VERT: 1"=10'

Figure 11K
SHEET PILE WALL
SHEETS I1 TO I40
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL.

425171

FILENAME: 001-NF-0009_425171.dgn PLOT DATE: 16-JAN-2012

N

0 200 400 600

Feet

Figure 12

Post Removal Area SWAC - Thiessen Polygons

Tyco Fire Products LP Facility

Marinette, WI

CH2MHILL

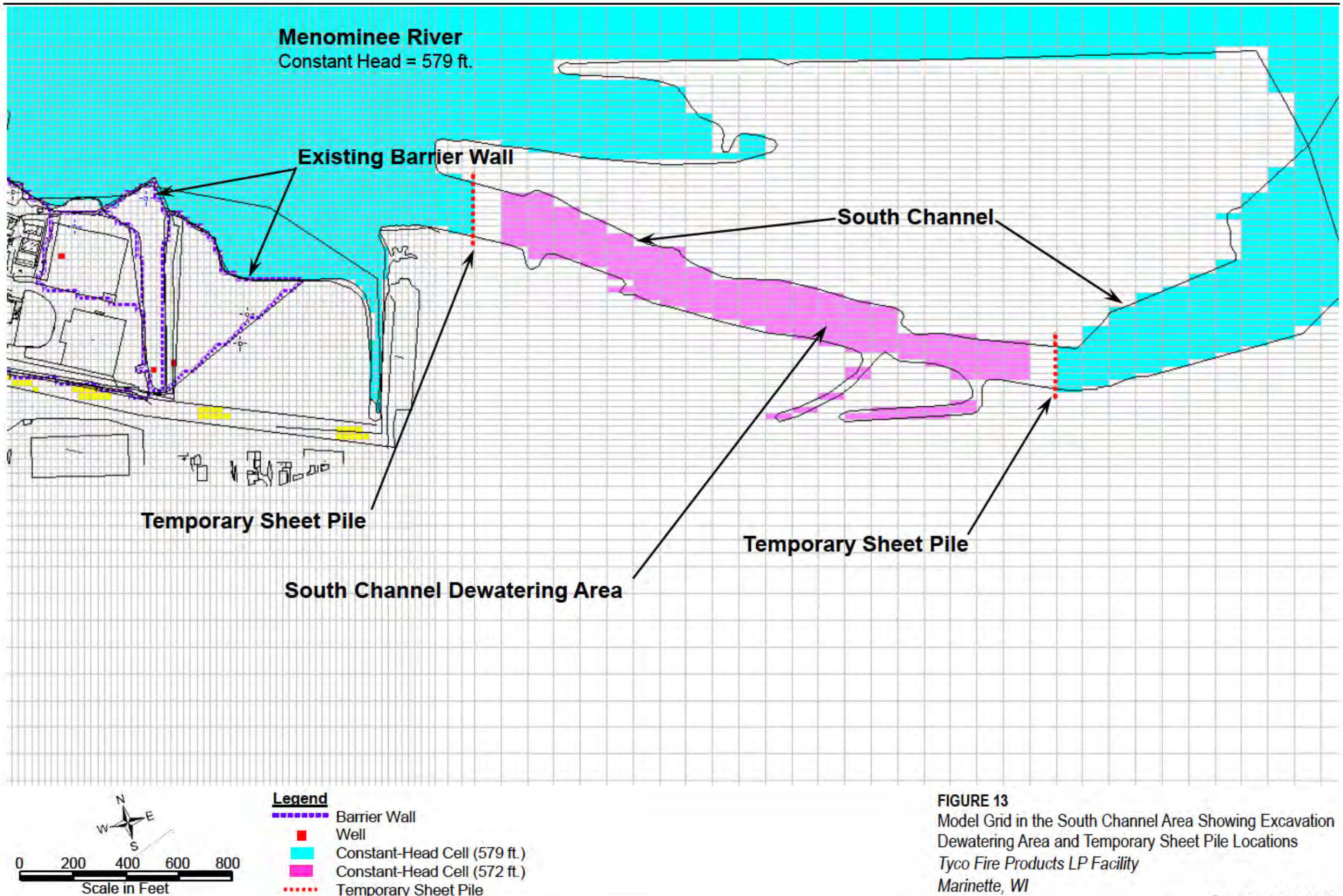
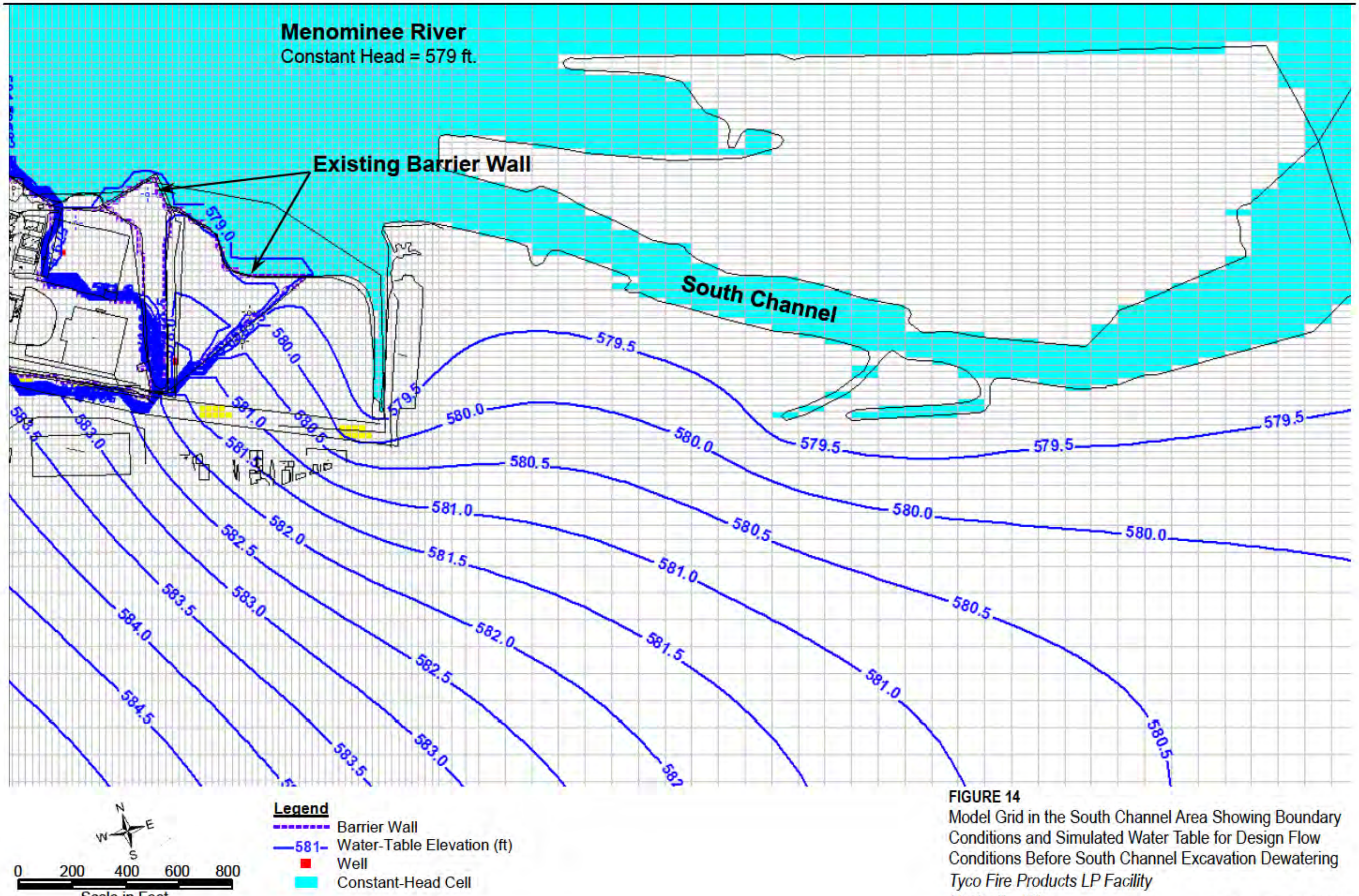


FIGURE 13
Model Grid in the South Channel Area Showing Excavation Dewatering Area and Temporary Sheet Pile Locations
Tyco Fire Products LP Facility
Marinette, WI

ES011612042739MKE Tyco_Figure13_v2.ai 1.16.12 jls

CH2MHILL.



Legend

- Barrier Wall
- 581 Water-Table Elevation (ft)
- Well
- Constant-Head Cell

FIGURE 14

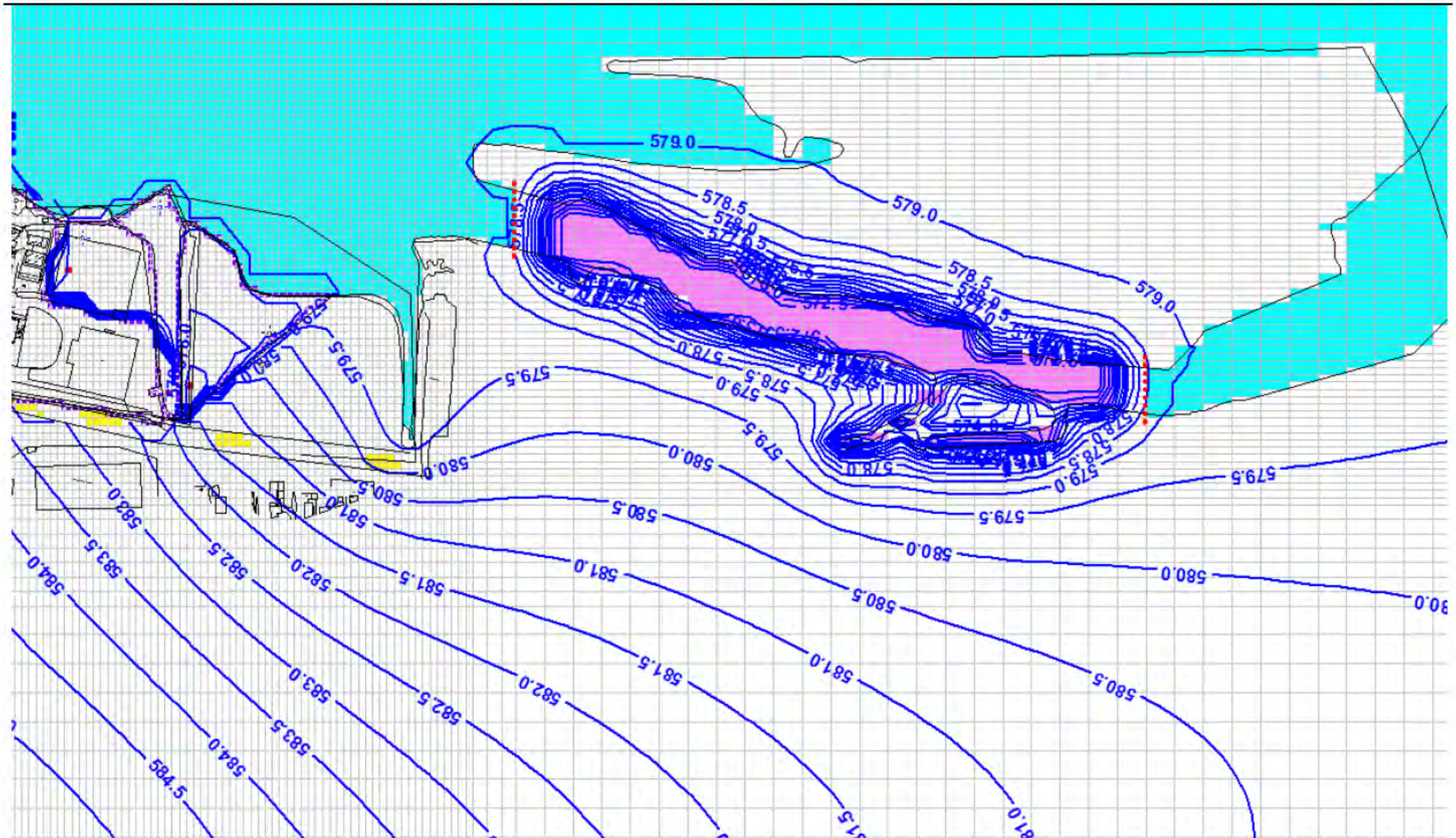
Model Grid in the South Channel Area Showing Boundary Conditions and Simulated Water Table for Design Flow Conditions Before South Channel Excavation Dewatering

Tyco Fire Products LP Facility

Marinette, WI

CH2MHILL.

ES011612042739MKE Tyco_Figure14_v2.ai 1.16.12 jls



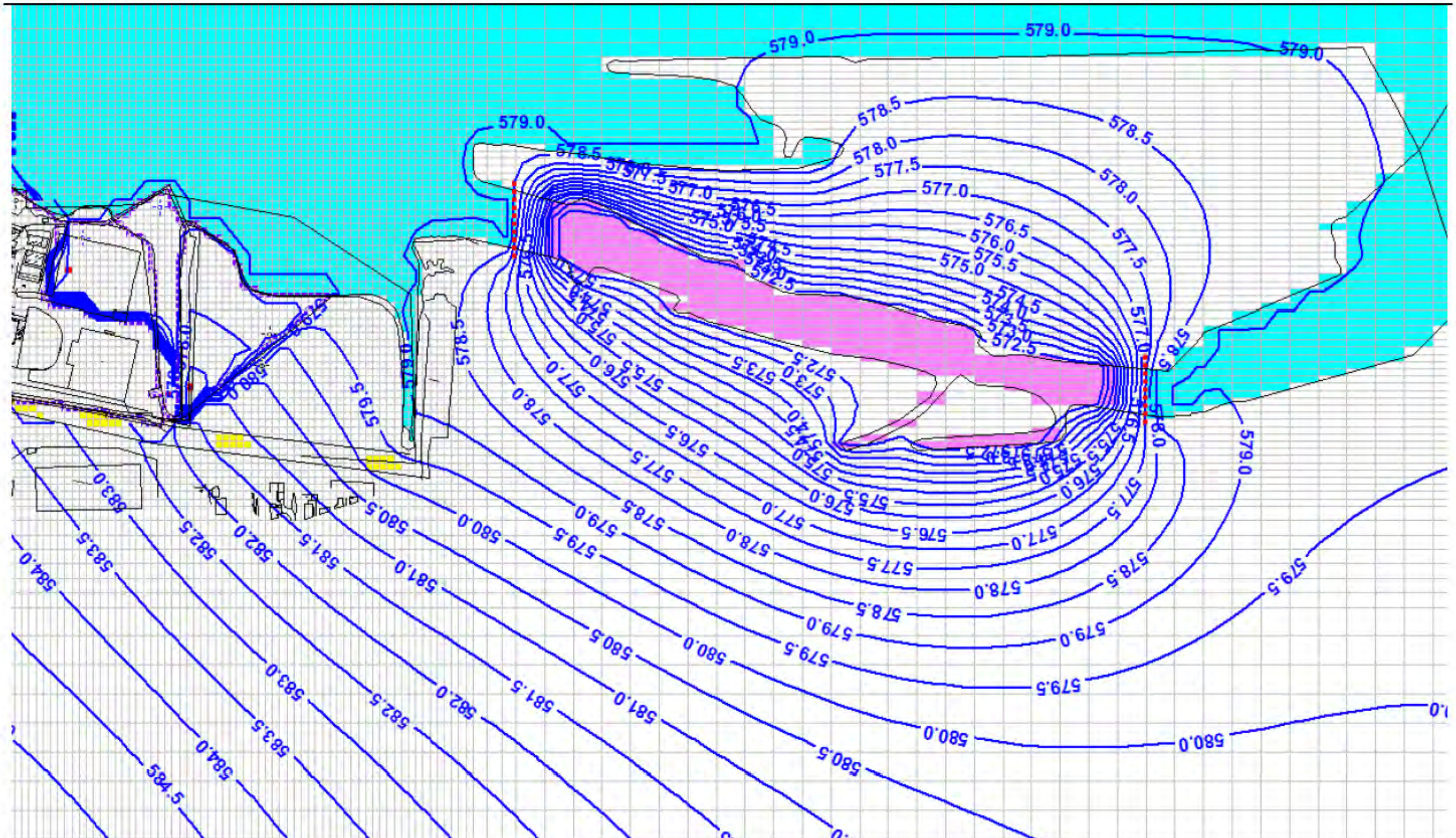
Legend

Barrier Wall
581 Water-Table Elevation (ft)
Well
Constant-Head Cell (579 ft.)
Constant-Head Cell (572 ft.)
Temporary Sheet Pile

FIGURE 15
Simulated Water-Table Elevation After First Day of South Channel Dewatering
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL.

ES011612042739MKE Tyco_Figure15_v1.ai 1.16.12 jls



Legend

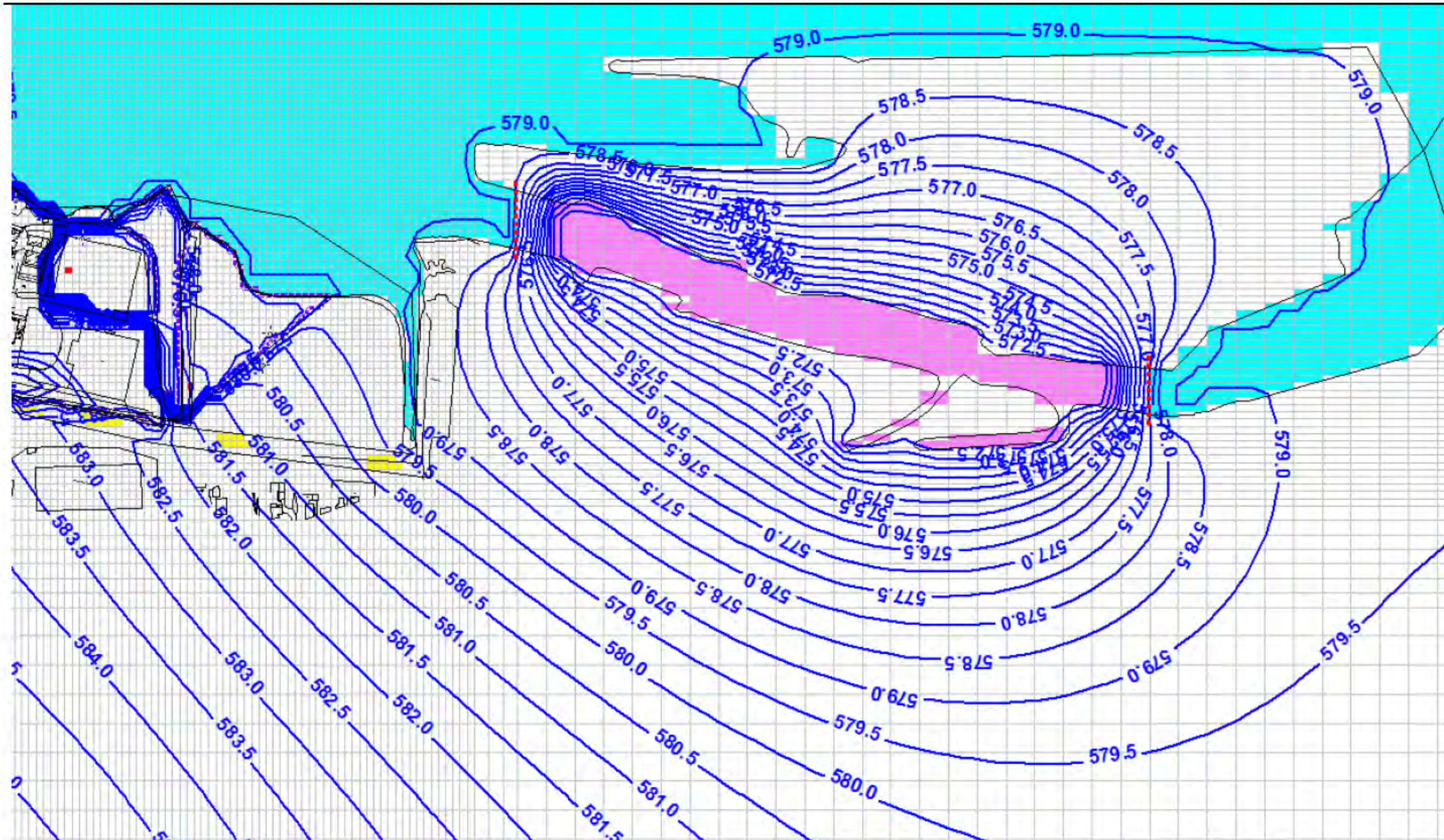
- Barrier Wall
- 581 Water-Table Elevation (ft)
- Well
- Constant-Head Cell (579 ft.)
- Constant-Head Cell (572 ft.)
- Temporary Sheet Pile

N E S W

0 200 400 600 800
Scale in Feet

FIGURE 16
Simulated Water-Table Elevation After 90 Days of South Channel Dewatering
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL.



N
W
E
S

0 200 400 600 800
Scale in Feet

Legend

- Barrier Wall
- 581 Water-Table Elevation (ft)
- Well
- Constant-Head Cell (579 ft.)
- Constant-Head Cell (572 ft.)
- Temporary Sheet Pile

FIGURE 17
Simulated Steady-State Water-Table Elevation for South Channel Dewatering
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL.

ES011612042739MKE Tyco_Figure17_v1.ai 1.16.12 jls

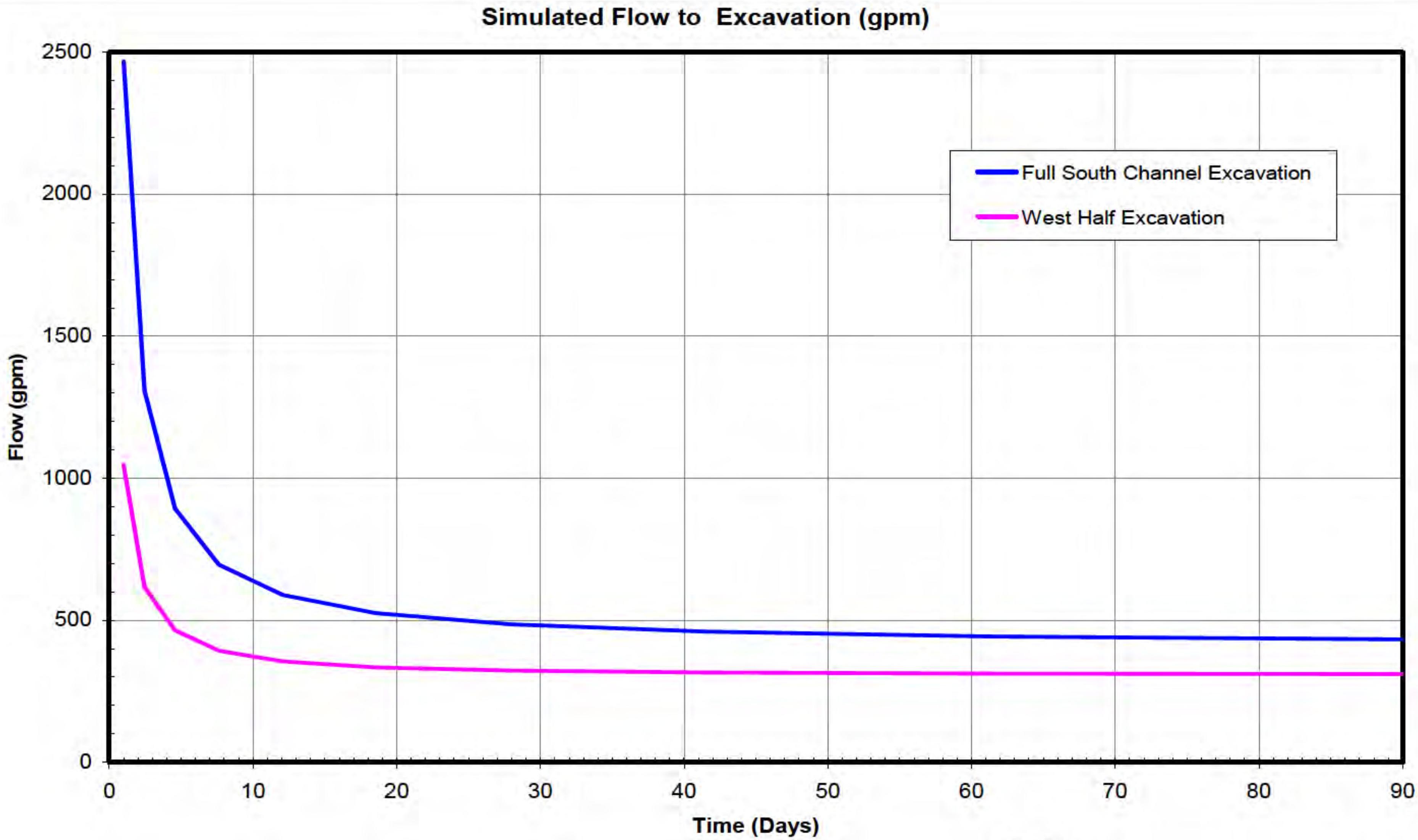


FIGURE 18
Simulated Rates of Groundwater Discharge Over a 90-Day Period for Dewatering of the Full South Channel Area and for the Western Half Only
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL.

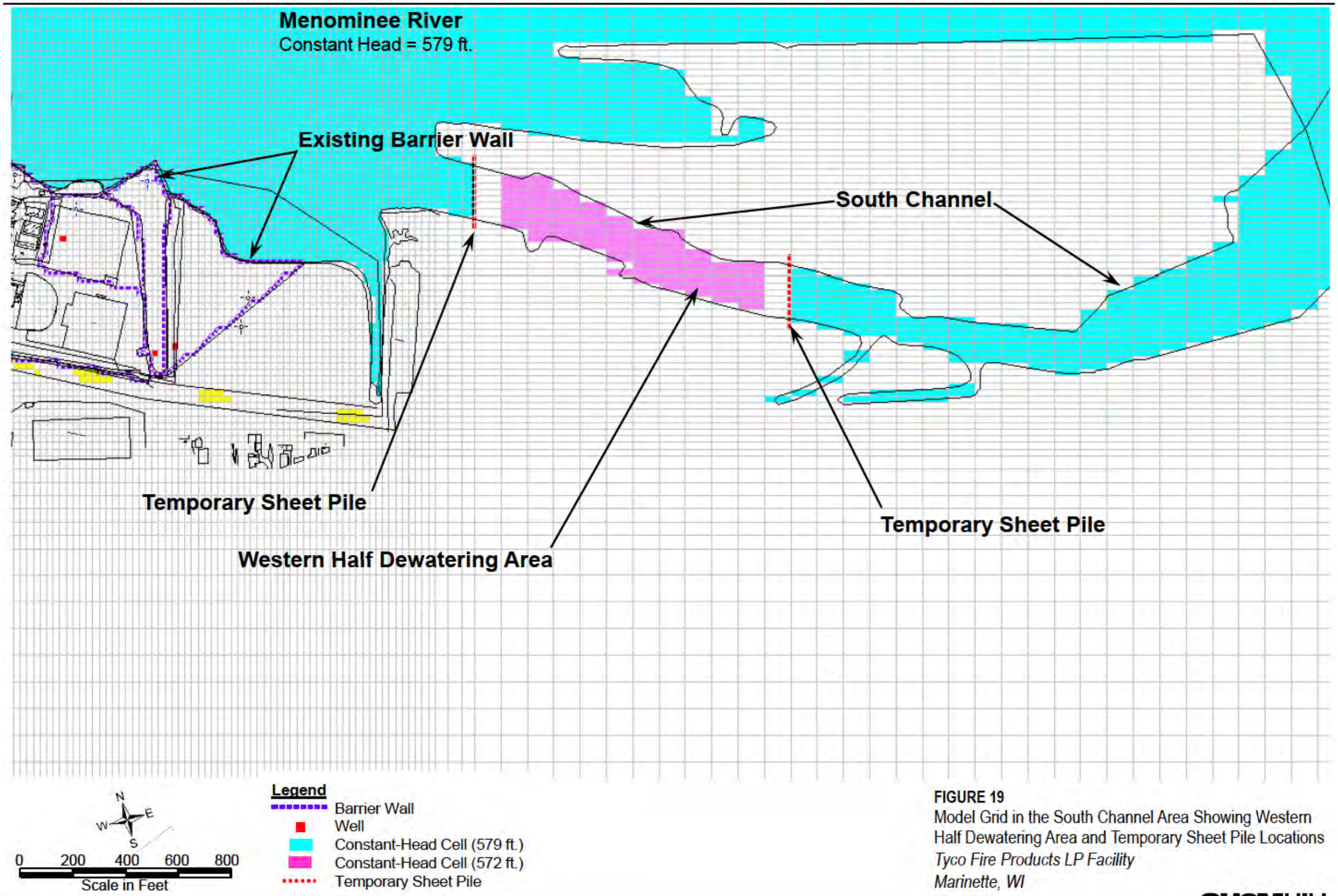


FIGURE 19
Model Grid in the South Channel Area Showing Western Half Dewatering Area and Temporary Sheet Pile Locations
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL.

ES011612042739MKE Tyco_Figure19_v1.ai 1.16.12 jls

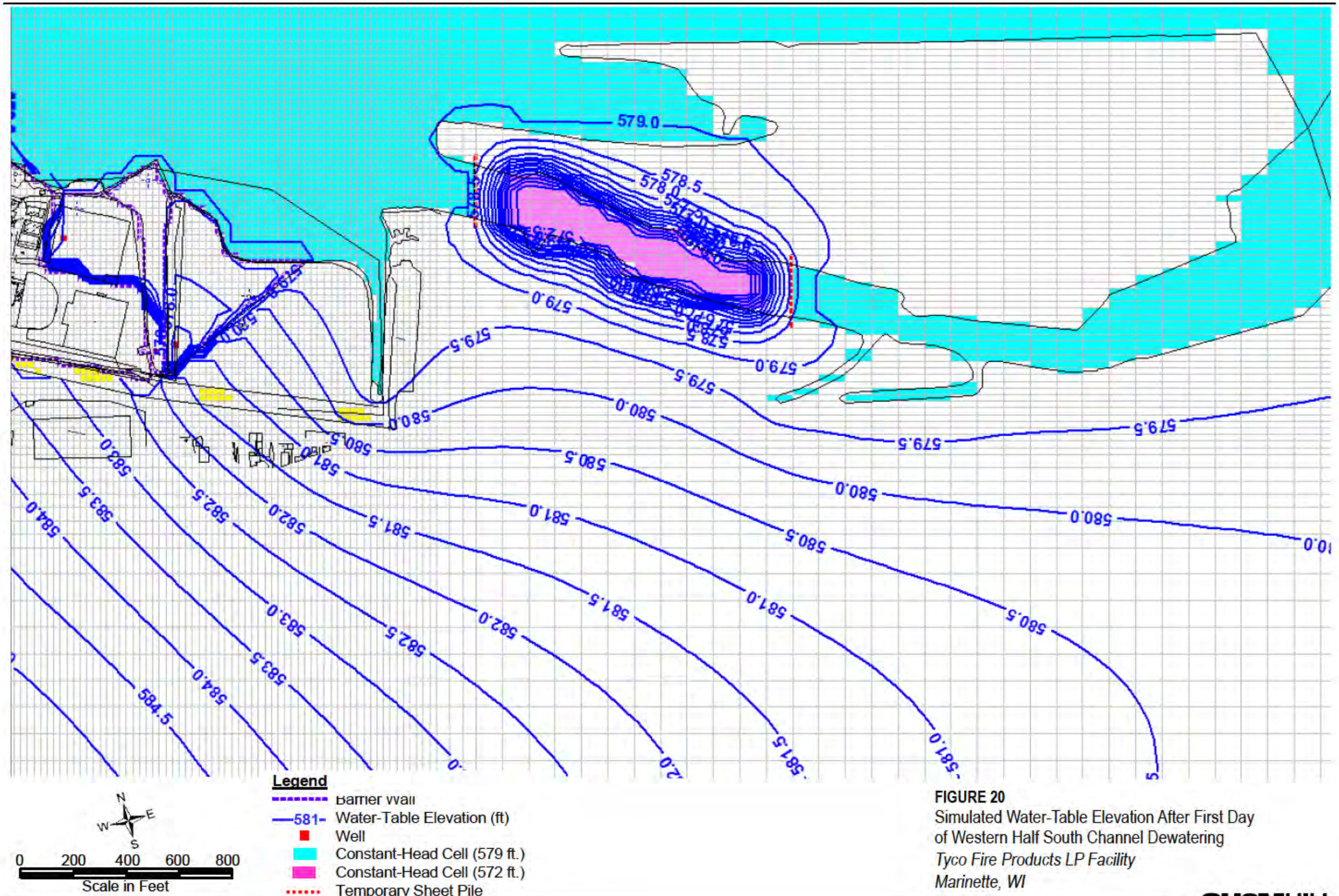
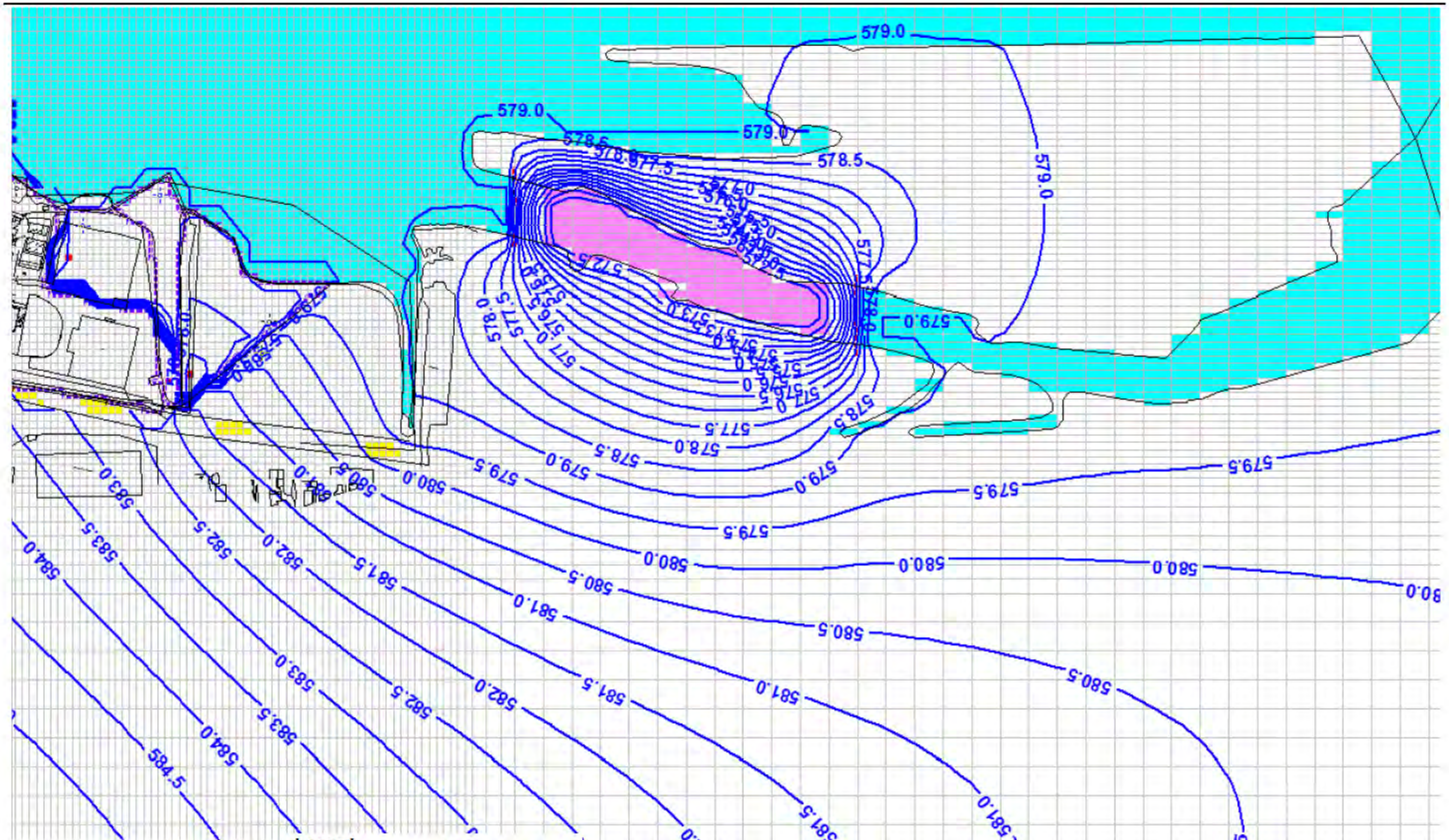


FIGURE 20
Simulated Water-Table Elevation After First Day of Western Half South Channel Dewatering
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL.



Legend

Barrier Wall
581 Water-Table Elevation (ft)
Well
Constant-Head Cell (579 ft.)
Constant-Head Cell (572 ft.)
Temporary Sheet Pile

0 200 400 600 800
Scale in Feet

FIGURE 21
Simulated Water-Table Elevation After 90 Days of Western Half South Channel Dewatering
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL.

ES011612042739MKE Tyco_Figure21_v1.ai 1.16.12 jls