Prepared by

HDR

Renew Harbor Island

Work today, protect tomorrow.

Assessment of Corrective Measures

Compliance with 40 CFR §257.96 and Michigan Administrative Code R 299.4443

Former J.B. Sims Generating Station

August 5, 2024

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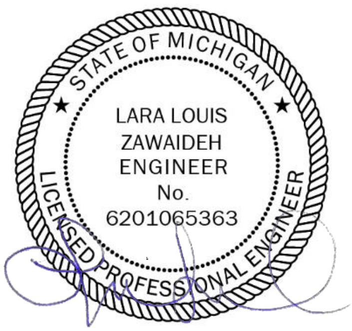
Former J.B. Sims Generating Station Assessment of Corrective Measures Report

I hereby certify to the best of my knowledge that this assessment of corrective measures for the Former J.B. Sims Generating Station impoundments is an accurate demonstration of the potential corrective measures under consideration for the impoundments and is in general compliance with 40 CFR Part §257.96 and Michigan Administrative Code R 299.4443.

I am a duly licensed Professional Engineer under the laws of the State of Michigan.



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1.0 Introduction

This Assessment of Corrective Measures (ACM) was performed for groundwater conditions at the former J.B. Sims Generating Station (Facility or Site). The Facility is located at 1231 North 3rd Street, on Harbor Island, in Grand Haven, Michigan (**Figure 1**). The area denoted as the "Soccer Fields" on **Figure 1** are outside of the study area and are considered a separate facility under Part 201 regulation, therefore it will not be addressed herein.

The former J.B. Sims Generating Station was a coal-fired, steam generating power facility operated by the Grand Haven Board of Light and Power (GHBLP) which ceased operations in February 2020. The former Facility had a net capacity of approximately 70.5 megawatts. The coal combustion residuals (CCR) generated at the former Facility were disposed in two CCR units that are subject to the United States Environmental Protection Agency (EPA) CCR Rule (40 CFR Part 257) and Part 115 of the Michigan Natural Resources and Environmental Protection Act, Act 451 of 1994 (Part 115) and the Part 115 rules, Michigan Administrative Code R 299.4101 et seq. The two regulated CCR surface impoundments are the inactive Units 1/2 Impoundment and the former Unit 3A/B Impoundments (**Figure 2**).

Historical records indicate portions of the Island were utilized for fishing, shipbuilding, and lumber storage prior to and into the 1900s. The use of the Island remained industrial through the 1960s with uses such as power generation, coal docks, and petroleum storage. An undefined portion of the Island operated as a municipal dump site from the 1950s until 1970 when disposal operations ceased (WSP, 2023). When the J.B. Sims Generating Station began operation in the early 1960s, CCR from boiler units 1 and 2 was sluiced into the internal marshland which was later delineated as the Units 1/2 Impoundment. This unit ceased receiving CCR material in 2012. The Unit 3A/B Impoundments were clay-lined, above-ground impoundments that ceased receiving CCR material in July 2020. Excavation of CCR material from Unit 3A/B Impoundments for physical closure was completed in December 2020.

This ACM was prepared in response to the determination that one or more constituents listed in Appendix IV to 40 CFR Part §257 and Michigan Administrative Code R 299.4440 has been detected at statistically significant levels (SSL) exceeding groundwater protection standards (GPS).

On February 2, 2019, GHBLP published the *Notice of Initiating Assessment of Corrective Measures 40 CFR §257.95(g)(3)(i) and 40 CFR §257.95(g)(5)*, announcing that both Units 1/2 Impoundment and Unit 3A/B Impoundments were in assessment of corrective measures (Golder, 2019). A change to the groundwater monitoring network, including new background wells, resulted in a reevaluation of background water quality and GPS values for each unit, as documented in the Hydrogeologic Monitoring Plan (HDR, 2024c). Due to the well network revisions, the program status of the updated (current) well network restarted with background monitoring in November 2022. Background values for the current monitoring well network were recalculated in December 2023, and in February 2024, the *Determination of Statistically Significant Levels over Groundwater Protection Standards per §257.95(g) and Michigan* Administrative Code *R 299.4441* was published describing that downgradient wells at both CCR units had constituents that were observed at Statistically Significant Levels (SSLs) over GPS (HDR, 2024c). In May 2024, the *Notification of Initiation of Assessment of Corrective Measures 40 CFR §257.96 and Michigan Administrative Code R 299.4441(7)(g)* was placed in the operating record and posted to the website indicating the initiation of ACM (HDR, 2024 and HDR, 2024b).

Three critical factors impacting the corrective measures for groundwater at this Site are:

- Historical records indicate the Island operated as a municipal dump site from the 1950s through 1970 (WSP, 2023). Boring logs indicate the presence of various waste materials such as household waste, industrial waste, and ash. These materials have the potential to impact groundwater flow and water quality.
- Some of these municipal waste materials may contain per-and polyfluoroalkyl substances (collectively referred to as “PFAS”). PFAS constituents have been detected in groundwater, although the source of the detected PFAS is unknown. PFAS compounds in groundwater were first observed in May 2021 by GHBLP. A study was performed by Golder that collected soil and groundwater samples across the Site and certain PFAS constituents were observed at concentrations above EGLE Part 201 Residential & Non-Residential Drinking Water Criteria, as well as Groundwater Surface Water Interface Criteria, in numerous locations around the Site (WSP, 2023).
- The groundwater is hydraulically connected to the Grand River that surrounds the Island, the surface water ponds internal to the Island, the wetland internal to the Island and on the north side of the Island. These surface waters have an impact on the groundwater flow and represent a contaminant pathway via groundwater surface water interface boundaries. The surface waters also limit the number of viable corrective measure alternatives because in many locations there is minimal space between the Island and the surface water that could serve as the location for any corrective measure implementation. The corrective measures must be accomplished in the footprint of the Island and be protective of surface waters.

Figure 1 | Site Vicinity Map

Figure 2 | Former J.B. Sims CCR Units and Monitoring Wells

1.1 Purpose and Approach

The purpose of the ACM is to identify and evaluate potential groundwater corrective measures for the inactive Units 1/2 Impoundment and the former Unit 3A/B Impoundments, and to discuss the benefits and limitations associated with each alternative. In accordance with 40 CFR §257.96(c) and Michigan Administrative Code R 299.4443, this assessment of corrective measures includes a preliminary analysis of the feasibility of potential corrective measures to meet the requirements and objectives of the remedy.

A timeline of state and federal compliance steps leading to the ACM is outlined below:

- January 24, 2024 - The memorandum *Determination of Statistically Significant Increases over Background per §257.93(h)(2) and Michigan Administrative Code R 299.4440(8) of the Michigan Part 115 Rules*, was placed into the operating record and initiated the assessment monitoring program.
- February 5, 2024 - The memorandum *Determination of Statistically Significant Levels over Groundwater Protection Standards Per §257.95(g) and Michigan Administrative Code R 299.4441,* was placed into the operating record.
- March 8, 2024 – In compliance with Michigan Administrative Code R 299.4442, the *Response Action Plan* (RAP) was published. The RAP documented sources of contamination, interim response activities taken to identify possible sources of contamination and steps taken to prevent additional contamination, and termination of waste schedule.
- May 1, 2024, the *Notification of Initiation of Assessment of Corrective Measures 40 CFR §257.96 and Michigan Administrative Code R 299.4441(7)(g)* was placed in the operating record formally initiating the assessment of corrective measures.

This ACM details the proposed strategies to address future mitigation, and includes components required in Michigan Administrative Code R 299.4443.

Potential corrective measure alternatives are being evaluated for the CCR impoundments to identify a remedy (or remedies) that may be implemented as part of the long-term corrective action plan. As outlined in 40 CFR §257.96 and Michigan Administrative Code R299.4443, corrective measure alternatives are evaluated using the following criteria to assess the effectiveness of potential corrective measures:

- Performance.
- Reliability.
- Ease of implementation.
- Potential impacts of the alternative.
- Time required to begin and complete the alternative.
- Institutional requirements.

These evaluation criteria are discussed in more detail in **Section 5.1**. While this ACM is developed to comply with State and Federal regulations applicable to CCR, the corrective measures alternatives for the Former J.B. Sims Generating Station must also address the non-CCR groundwater contamination that is regulated under Michigan Part 201. Due to the comingling of the CCR and non-CCR impacts at the Site, the goal is to identify a holistic approach that meets all applicable regulatory closure requirements.

Remedy selection progress reports will be submitted on a semiannual basis as required in §257.97(a) of the CCR Rule. The reports will describe progress toward selecting and designing a remedy for the Site. The remedy will be formally selected once the alternatives are vetted for site-specific feasibility, reviewed, and approved by EPA and EGLE. Additionally, a public meeting will be conducted at least 30-days prior to the remedy selection as required under §257.96(e) and Michigan Administrative Code R 299.4443(4) to seek public input. At the time of remedy selection, a Remedial Action Plan will be prepared and submitted to EGLE that meets the requirements of Part 201, as required by Michigan Administrative Code R 299.4319(7). A Remedy Selection Report in compliance with §257.97 of the CCR Rule also will be prepared.

2.0 Site Description

2.1 Units 1/2 Impoundment

The inactive CCR Units 1/2 Impoundment was a depression in the ground where sluiced ash was disposed. A 2016 ash investigation by ERM confirmed that no liner was present beneath the Units 1/2 Impoundment and waste was placed into the topographic low area (ERM, 2016). Limited information is available on the early operation of the unit. It is estimated that ash disposal began in the early 1960's when the plant was constructed, and ceased in 2012, which coincides with the estimated 50-year active life of the impoundment. Due to the abstract size and lack of any formally defined boundaries, the boundary of the Units 1/2 Impoundment was delineated by GHBLP and agreed to EPA, and EGLE. The boundary of this unit includes an area of sluiced ash disposal to the east of the MW-19 and MW-30 as depicted on **Figure 2** (HDR, 2024c). The parties also agreed that the former northern outlet channel from the Units 1/2 Impoundment, where ash was known to have been released and deposited into the wetland to the north (referred to as the "North Channel"), would be included in the unit boundary. Based on additional data collected, EGLE and EPA determined that the former north outlet channel would not be considered part of the Units 1/2 Impoundment, nor would the presence of any CCR in the North Channel be considered a release from the Units 1/2 Impoundment (see EPA and EGLE excerpts below). Therefore, the North Channel will be investigated under the expanded coverage of the §257 rule (see **Section 2.3**).

> *Anika Mandelia (EPA) - "… We have reviewed the results of the sampling and the information regarding the CCR generation activities you have provided to answer your question regarding continued sampling to establish the northern boundary of Units 1/2 at JB Sims.*

As you know, according to 40 CFR 257.53, a CCR surface impoundment means "a natural topographic depression, man-made excavation, or diked area, which is designed to hold an accumulation of CCR and liquids, and the unit treats, stores, or disposes of CCR." Defining the Units 1/2 boundary has been a point of discussion in the past. In 2020, EPA, EGLE, and the facility agreed to a unit boundary relying on the visual presence of coal ash using aerial photos, with the understanding that further sampling would be done to find its northernmost extent.

The data confirm that there are CCR present in all the sampling conducted to-date. Given the hydraulic nature of this area and the fact that it is a flood plain (which is sometimes under-water), we suspect the presence of CCR may extend beyond the sampled area further into the flood plain (and further, into Grand River). However, the hydraulic nature of this area, combined with the sampling results and the knowledge of historical CCR disposal activities, also makes it difficult either to determine how much farther out sampling should be extended to support potentially extending the Units 1/2 boundary, or to cease sampling at this point and include what has been sampled to-date as part of the unit.

We do not believe it is necessary to conduct further sampling to delineate the Units 1/2 boundary. The weir that separates the pond from the North Channel provides a distinct physical boundary for Units 1/2 in this area, therefore the Unit boundary remains unchanged. The facility will need to ensure this unit and any releases or newly identified units and connecting structures in the vicinity are appropriately managed under the regulations. …"

Kent Walters (EGLE) - "… EGLE points out that while EPA has determined the unit boundary for 1 and 2 does not need to extend out further than previously determined, the ash identified in the northern channel borings seems to fall under the definition of a CCRMU under the new legacy rule and would need to be managed accordingly. …"

2.2 Unit 3A/B Impoundments

The former CCR Unit 3A/B Impoundments were constructed as two above-ground surface impoundments that included a clay liner; however, the engineered clay liner did not meet Part 115 or §257.71(a)(1) surface impoundment liner criteria. The unit was constructed in late 1983 and ceased receiving waste approximately 36 years later in July 2020. Golder (2020) stated that the former Unit 3A/B Impoundments were built over a "field of ash" that was generated from Boiler Units 1 & 2; however, existing soil borings do not support that a "field of ash" is present under the former impoundments. As stated in Golder's 2020 report - *Permanent Cessation of a Coal Fired Boiler by Date Certain Notification per 40 CFR §257.103* placed into the operating record February 14, 2020, the operation of J.B. Sims Generating station ceased on February 13, 2020. Although the plant ceased operations in February 2020, the Site continued to use the Unit 3A/B Impoundments to store cleanout materials from the hoppers, vessels, etc. prior to demolition of the buildings.

The impoundments ceased receiving waste on July 30, 2020 following the decommissioning of the plant buildings (HDR, 2024c). Removal of CCR from the impoundments was completed on November 6, 2020, and the liner remains in place. Following the CCR removal, Golder conducted ash removal verification and submitted a report to EGLE that was ultimately denied (EGLE, 2021). In 2020, it was determined that any additional removal of liner or subsurface material for decontamination potentially could expose solid waste and PFAS impacted groundwater. Therefore, the closure by removal process was suspended to investigate the non-CCR contamination at the Site. The closure by removal initiated in 2020 will be continued if additional site investigation work identifies any areas of remaining ash and if the "field of ash" purported to be beneath the unit is confirmed and delineated.

2.3 Recent Regulatory Changes

In May 2024, EPA finalized revisions to the CCR Rule that expand coverage of the CCR Rule to include what are referred to as legacy CCR surface impoundments and CCR management units (CCRMU). The new Rule requires that active facilities, including the Former J.B. Sims Generating Station, perform a Facility Evaluation to determine if there are any CCRMU[1] at the facility and conduct field investigations to establish the boundaries of any identified CCRMU. As required by the new Rule, a Facility Evaluation will be conducted at the Site that includes a records review and field investigation with borings. Based on existing information regarding ash in the north outlet channel, the potential "field of ash" beneath the Unit 3A/B impoundments, ash used in the roads, and ash storage in the vicinity of the former tank farm (southeast side of Harbor Island), the presence of a CCRMU is likely. Owners or operators of any CCRMU that contains more than 1,000 tons of CCR are required to comply with the requirements in §257 for fugitive dust, groundwater monitoring, corrective action, closure, post-closure care, recordkeeping, notification, and internet posting.

Due to the additional requirements applicable to CCRMU, it is anticipated that closure and groundwater remediation requirements for CCR may increase beyond what is identified herein once the Facility Evaluation, associated field work, and groundwater monitoring are completed. The results of the Facility Evaluation may alter the corrective measure alternatives and certainly will alter any cost estimates. Michigan Administrative Code R 299.4443(3) requires that the ACM include cost estimates. Since it is likely the costs will increase after the CCRMU work is incorporated, cost estimates are not included in this ACM but will be provided after the Facility Evaluation has been conducted.

[1] §257.53 Definition: Any area of land on which any noncontainerized accumulation of CCR is received, is placed, or is otherwise managed, that is not a regulated CCR unit. This includes inactive CCR landfills and CCR units that closed prior to October 19, 2015, but does not include roadbed and associated embankments in which CCR is used unless the facility or a permitting authority determines that the roadbed is causing or contributing to a statistically significant level above the groundwater protection standard established under § 257.95(h)

3.0 Conceptual Site Model

3.1 Hydrogeology

The uppermost aquifer across the Site is located between the surface and 39 feet below surface and consists of fine sand with gravel and silt lenses, clay, peat, ash, and municipal solid waste. From 2022 through 1st quarter 2024, groundwater was encountered between 0.58 and 16.22 feet below ground surface within the unconsolidated fill material. The bottom of the aquifer is believed to consist of continuous clay and dense silt observed between 20.5 – 48.0 feet below surface (HDR, 2024c).

The regional general direction of groundwater flow across Harbor Island is west to southwest towards Lake Michigan (Western Michigan University, 1981). The Grand River is located on the northern and western sides of the Site, and the South Channel is located on the south side of Harbor Island. Internal to the Island there are several influences on groundwater flow, including the following features:

- Various fill materials observed in boring logs and cross-sections as shown in **Appendix A**.
- Surface water features, such as the inactive Units 1/2 Impoundment and internal wetland shown in **Figure 2**.
- The former coal yard area, shown in **Figure 2**, which may have lower infiltration rates due to compaction from heavy equipment and stockpiling.

Groundwater contour maps from April 2023 through April 2024, provided in **Appendix B**, show groundwater flow beneath Unit 3A/B Impoundments is consistently west toward the Grand River. Groundwater flow beneath Units 1/2 Impoundment is seasonably and spatially variable. However, more generally, flow appears to be fairly consistent in the following areas where flow is generally:

- North from SG-02 toward the northern wetland (MW-31), however flow in this area appears to be south between August and November.
- East from wells MW-05, MW-18, MW-19, and MW-30 toward the internal wetland.
- Potentially south from MW-05 towards PZ-17 and MW-36.
- The presence of the internal wetland east of the Units 1/2 Impoundment appears to provide a hydraulic sink between the CCR impoundments and the wells situated to the east (PZ-23 through PZ-26, MW-27, MW-33, and MW-34) (**Figure 2**).

The uppermost aquifer, which extends from the surface to approximately 39 feet below surface, consists of fine sand with gravel and silt lenses, clay, peat, ash, and municipal solid waste. Silty clay is observed at 20.8 feet below ground surface at PZ-26 to 45 feet below ground surface at PDR-3 (**Appendix A**). The clay is assumed to be the bottom of the aquifer and was logged in borings CPT-5, MW-12, MW-17, PZ-16, PZ-26, PZ-24, PZ-25, MW-30, PDR-1, and PDR-3 as shown in the developed cross-sections for the Site. The "CPT" borings used in cross sections are from the *Report of Evaluation for Grand Haven Power Plant Ash Impoundment* (Soils and Structures, 2014). The "PDR" borings shown in cross sections are from the *Geotechnical*

Exploration and Engineering Evaluation for Harbor Island Reciprocating Engine Generation Site (GEI, 2019). The cross-sections are provided in **Appendix A**.

Slug tests were performed at monitoring wells MW-01R, MW-02, MW-04, MW-05, MW-07, MW-08, PZ-17, PZ-20, PZ-26, and MW-31 by Golder in 2021. The results of the slug testing were consistent in 25 of the 29 tests performed. The average hydraulic conductivity value, based on tests completed by Golder in 2021, is provided in **Table 1**. Generally, hydraulic conductivity values across the Site range from 0.19 feet per day (feet/day) at MW-02 to 18.76 feet/day at MW-05. Higher hydraulic conductivity values were calculated at PZ-17 and PZ-20 (172.51 and 242.25 feet/day, respectively). Due to the unusually high values measured at PZ-17 and PZ-20, these wells will be re-tested. Additional slug tests at MW-10, MW-12, PZ-17 MW-20 were completed in the 2nd quarter 2024 and analysis of the results will be completed in the 3rd quarter of 2024.

Table 1. Hydraulic Conductivity Values (Golder 2021)		
Well ID	Screen Interval Lithology	Average Hydraulic Conductivity (feet/day)
MW-01R	Silty fine sand with trace refuse and silt	5.41
MW-02	Silty clay and poorly graded fine sand	0.19
MW-04	Well graded fine to medium sand and sandy silt	1.70
MW-05	Fine grained ash with refuse	18.76
MW-07	Sandy peat with shell fragments and silty sand	7.99
MW-08	Refuse and clayey sand	7.90
PZ-17	Sand with some gravel and gravelly silt with trace organics	172.51*
PZ-20	Peaty sand and peaty silt	242.25*
PZ-26	Very fine to medium sand with organics	8.34
MW-31	Mucky sand with refuse and sandy peat with refuse	0.36

*This analysis is in question and these wells will be reanalyzed in 3rd quarter 2024 after the testing in 2nd quarter 2024.

Hydraulic conductivity values are on the lower end when compared to reference values of fine sand according to the Freeze and Cherry (1979) (10^4 to 10^{-1} feet/day); however, the calculated values are consistent with hydraulic conductivity ranges for silt (10 to 10^{-3} feet/day) and glacial till (10^2 to 10^{-6} feet/day) (Freeze and Cherry, 1979). Historical land use activities, such as dumping of dredge material and refuse, disposal of ash, and coal storage affect localized hydraulic conductivity.

Groundwater velocity calculations were performed using data from January and May 2023, as well as February and April 2024, using Darcy's Law. Groundwater velocity calculations are in **Table 2**. Groundwater flow directions across the Site are presented in potentiometric contour maps in **Appendix C**. To address the heterogenous nature of the lithology, separate groundwater velocity calculations were performed for the eastern and western sides of Harbor Island. Slug test data provided by Golder was used to calculate average hydraulic conductivity values for the eastern and western regions (Golder, 2022). Data provided from PZ-26 was used for calculations on the eastern side of the Island. Hydraulic conductivity values from MW-01R, MW-02, MW-04, and MW-05 were averaged for the western side of the Island.

Table 2. Groundwater Velocity Calculations

Well Pair	Area of Harbor Island	Hydraulic Gradient				Porosity[1]	Hydraulic Conductivity (feet/day)	Groundwater Velocity (feet/day)			
		Jan. 2023	May 2023	Feb. 2024	Apr. 2024			Jan. 2023	May 2023	Feb. 2024	Apr. 2024
PZ-25 to PZ-26	East	0.0021	0.0005	0.0022	0.0007	0.30	8.34[2]	0.058	0.014	0.061	0.020
PZ-25 to PZ-23		0.0008	0.0006	0.0004	0.0006	0.30	8.34[2]	0.021	0.016	0.012	0.017
MW-01R to MW-03	West	0.0078	0.0035	0.0094	0.0025	0.30	6.23[3]	0.162	0.073	0.195	0.052
MW-01R to MW-04		0.0065	0.0029	0.0077	0.0020	0.30	6.23[3]	0.134	0.061	0.159	0.042
MW-01R to MW-05		0.0037	0.0022	0.0054	0.0039	0.30	6.23[3]	0.077	0.046	0.112	0.082
MW-01R to MW-10		0.0055	0.0034	0.0085	0.0026	0.30	6.23[3]	0.115	0.070	0.178	0.054

1. Porosity value estimated using reference values for poorly sorted fine to medium sand (Freeze-Cherry, 1979).
2. Average hydraulic conductivity value from Golder (2022) on PZ-26.
3. Calculated by averaging hydraulic conductivity values from wells MW-01R, MW-02, MW-04, and MW-05 (Golder, 2022).

A porosity value of 0.30 was used based on varying amounts of sand, gravel, and silt observed in borings (Freeze and Cherry, 1979). Horizontal hydraulic gradients and groundwater velocities were higher in January than May of 2023. Groundwater velocities on the eastern side of the Island ranged from 0.012 to 0.061 (feet/day). Groundwater velocities on the western side of the Island ranged from 0.042 to 0.195 (feet/day).

3.2 Water Quality

As required in the CCR Rule and Part 115, eight rounds of background groundwater sampling and detection monitoring were completed between November 2022 and August 2023. On October 15, 2018, GHBLP published the *Updated Notice of Groundwater Protection Standard Exceedance 40 CFR §257.95(g)*, identifying that cobalt, fluoride, and lithium were detected at statistically significant levels (SSL) for Units 1/2 Impoundment and Unit 3A/B Impoundments (Golder, 2018). On February 2, 2019, GHBLP published the *Notice of Initiating Assessment of Corrective Measures 40 CFR §257.95(g)(3)(i) and 40 CFR §257.95(g)(5)*, announcing that both Units 1/2 Impoundment and Unit 3A/B Impoundments were in assessment monitoring (Golder, 2019). In August 2019, monitoring wells MW-09 and MW-10 were installed as additional downgradient monitoring wells and included in the multi-unit network. In 2020, the monitoring well network was converted from a multi-unit system into two separate units, one for Units 1/2 Impoundment and one for Unit 3A/B Impoundments (Golder, 2021). On July 22, 2021, GHBLP published the *Updated Notice of Groundwater Protection Standard Exceedance 40 CFR §257.95(g),* in which the additional constituents such as arsenic and chromium were added to the list of cobalt, fluoride, and lithium as being observed at SSLs (Golder, 2021b).

On January 14, 2021, GHBLP, EPA, and EGLE met to discuss documentation regarding the boundary delineation for Units 1/2 Impoundment and ultimately expanded the boundary to the current location shown on **Figure 2** (Golder, 2021). Following revisions to the Units 1/2 Impoundment boundary, however, the monitoring well network was deemed insufficient.

In August 2021, 22 piezometers and three stilling wells were installed to better understand groundwater flow and the groundwater/surface water interaction of Harbor Island to determine appropriate background well locations and the monitoring network for the CCR units (Golder, 2022b). Based on groundwater flow direction data collected in 2021 and 2022, as well as boring logs from the *Field Summary Report of Results from Approved Work Plan*, it was determined that the previous background monitoring wells (MW-07 and MW-08) were impacted by the CCR units and did not represent background water quality (Golder, 2022b). The monitoring well network was revised in the *Hydrogeologic Monitoring Plan* (HDR, 2024c).

Background water quality sampling of the updated groundwater monitoring well network was conducted over eight events from November 2022 through August 2023. Following the completion of background sampling, the *Background Water Quality Statistical Certification* was submitted (HDR, 2023), as specified in §257.94 and Michigan Administrative Code R 299.4440(8). The water quality data collected from the monitoring wells located upgradient of the CCR units were pooled and statistically analyzed to develop the background threshold values (BTVs) for the impoundments. The background report provides the selection of the statistical method for each constituent of interest (COI) for each CCR unit.

The first detection/assessment monitoring event of the updated monitoring network was conducted in October 2023, following completion of the background sampling events using the updated monitoring network. Monitoring data was compared to BTVs and the memorandum *Former J.B. Sims Generating Station Determination of Statistically Significant Increases over Background per §257.93(h)(2) and Michigan Administrative Code R 299.4440(8) of the Michigan Part 115 Rules* was submitted to EGLE. The SSIs identified for Units 1/2 Impoundment included boron, calcium, fluoride, sulfate, and total dissolved solids (TDS). The SSIs identified for Unit 3A/B Impoundments include boron, calcium, chloride, fluoride, sulfate, and TDS. The SSIs identified from the October 2023 sample event are considered revised SSIs from the 2019 SSIs because the updated monitoring network includes different background wells that are not impacted by the CCR units. The identification of these SSIs for both CCR units means both Units 1/2 Impoundment and Unit 3A/B Impoundments are in assessment monitoring. der the assessment monitoring program, as required in §257.25 and Michigan Administrative Code R 299.4441(9), the CCR owner must establish groundwater protection standards (GPS) for each constituent detected in the groundwater. The federal and state GPS values are included as Table 3 and 4, respectively. The October 2023 sampling event served as the initial assessment monitoring event. Sampling data from waste boundary wells was compared to the GPS values and several COIs were found to exceed GPS at both CCR units. To determine if an exceedance of a GPS value is statistically significant, the 95% lower confidence limit (LCL) was calculated for each of the downgradient wells. A comparison of state and federal GPS values to the LCLs SSLs was conducted. At the Units 1/2 Impoundment, one or more COIs exceeded state and federal GPS values at SSLs at the following waste boundary wells: MW-06, MW-08, MW-18, MW-19, MW-30, and MW-31. At the Unit 3A/B Impoundments, one or more COIs exceeded state and federal GPS values at SSLs at the following waste boundary wells: MW-02, MW-03, and MW-04. Following the identification of SSLs at waste boundary wells, the monitoring well network was expanded to include nature and extent monitoring wells to further delineate the extent of the contamination. The nature and extent wells for each unit are listed below:

- Units 1/2 Impoundment – MW-07, MW-10, and MW-32
- Unit 3A/B Impoundments – MW-01R, MW-09, and MW-10

In February 2024, the monitoring well network was expanded a second time in response to identification of SSLs at the nature and extent wells listed above. The revised nature and extent monitoring wells for each CCR unit are listed below:

- Units 1/2 Impoundment – MW-07, MW-10, MW-16, MW-17, MW-28, MW-32, MW-36, and MW-37
- Unit 3A/B Impoundments – MW-01R, MW-09, MW-10, and MW-38

The most recent assessment monitoring event for which analytical results are available was conducted in April 2024. Sampling data from waste boundary wells was compared to the GPS values and several COIs were found to exceed GPS at both CCR units. To determine if an exceedance of a GPS value is statistically significant, the 95% lower confidence limit (LCL) was calculated for each of the downgradient wells. The LCLs that exceed GPS for Units 1/2 Impoundment are shown in **Table 5** and include arsenic, boron, calcium, chloride, fluoride, lithium, lead, sulfate, and total dissolved solids. The LCLs that exceed GPS at SSLs identified for Unit 3A/B Impoundments are shown in **Table 6** and include boron, calcium, chloride, cobalt, lithium, sulfate, and total dissolved solids. These LCL values include 11 sample events collected between November 2022 and April 2024.

The calculation of SSLs requires at least 4 sampling events to account for temporal and seasonal variability. As the additional nature and extent monitoring wells for each unit have only been sampled during one assessment monitoring event, SSLs were not calculated for the following wells from each unit:

- Units 1/2 Impoundment – MW-16, MW-17, MW-28, MW-36, and MW-37
- Unit 3A/B Impoundments – MW-38

However, when the water quality values from the wells listed above are compared to state and federal GPS, several are found to exceed. This indicates that the existing monitoring well network will need to be expanded further to completely delineate the extent of contamination.

Table 3. Federal Compliance Program Groundwater Protection Standards			
Parameter	Site-Specific Background Level Upper Tolerance Limit (UTL) (mg/L)	Federal Maximum Contaminant Level (mg/L)	Federal Program Groundwater Protection Standards (mg/L)
Antimony	0.0012	0.0060	0.0060
Arsenic	0.0040	0.010	0.010
Barium	0.58	2.0	2.0
Beryllium	0.000059	0.0040	0.0040
Cadmium	0.00015	0.0050	0.0050
Chromium	0.042	0.10	0.10
Cobalt	0.0021	0.0060*	0.0060
Fluoride	0.45	4.0	4.0
Lead	0.0016	0.015*	0.015
Lithium	0.10	0.040*	0.10
Mercury	0.00016	0.0020	0.0020
Molybdenum	0.0093	0.10*	0.10
Radium-226/228	2.6	5.0	5.0
Selenium	0.00089	0.050	0.050
Thallium	0.000075	0.0020	0.0020

*EPA adopted health-based value for constituents with no MCL.

Table 4. State Compliance Program Groundwater Protection Standards					
Parameter	Site-Specific Background Level Upper Tolerance Limit (UTL) (mg/L)	Federal Maximum Contaminant Level (mg/L)	State Non-Residential Drinking Water Cleanup Criteria for Groundwater (mg/L)*	State Groundwater Surface Water Interface (mg/L)*	Groundwater Protection Standards for Site (mg/L)
Boron	4.0	NV	0.50	7.20	4.0
Calcium	250	NV	N/A	N/A	250
Chloride	120	NV	250	50	120
Fluoride	0.45	4.00	2.00	NV	2.00
Sulfate	100	NV	250	NV	250
Total Dissolved Solids	950	500	500	500	950
Antimony	0.0012	0.0060	0.0060	0.13	0.0060
Arsenic	0.0040	0.010	0.010	0.010	0.010
Barium	0.58	2.00	2.00	1.3[1]	1.3[1]
Beryllium	0.000059	0.0040	0.0040	0.036[1]	0.0040
Cadmium	0.00015	0.0050	0.0050	0.0025[1]	0.0025[1]
Chromium	0.042	0.10	0.10	0.12[1]	0.10
Cobalt	0.0021	0.0060	0.10	0.10	0.0060
Fluoride	0.45	4.0	2.0	NV	2.0
Lead	0.0016	0.0015	0.0040	0.014[1]	0.0016
Lithium	0.10	0.040	0.35	0.44	0.10
Mercury	0.00016	0.0020	0.0020	0.0000013	0.00016
Molybdenum	0.0093	0.10	0.210	3.20	0.10
Radium 226 and 228	2.6	5.0	NV	NV	5.0
Selenium	0.00089	0.050	0.050	0.0050	0.0050
Thallium	0.000075	0.0020	0.0020	0.0037	0.0020
Copper	0.020	1.3	1.0	0.021[1]	0.021[1]
Iron	83	0.30	0.30	NV	83
Nickel	0.023	NV	0.10	0.12[1]	0.10
Silver	0.00011	0.10	0.0098	0.00020	0.00020
Vanadium	0.00093	NV	0.0062	0.027	0.0062
Zinc	0.038	5.0	5.0	0.27[1]	0.27[1]

*Cleanup Criteria Requirements for Response Activity (Formerly the Part 201 Generic Cleanup Criteria and Screening Levels) found in Michigan Administrative Code R 299.44 Generic groundwater cleanup criteria.

NV=no value

[1]Per Footnote G of Table 1 Cleanup Criteria Requirements for Response Activity (Formerly the Part 201 Generic Cleanup Criteria and Screening Levels) of the Groundwater Surface Water (GSI) criteria list, values noted are calculated based on the hardness (expressed as $CaCO_3$) of the receiving waters. Surface water sample from the Grand River (SG-01) had a hardness of 270 mg/L was used in the calculation of specific GSI values. The Grand River discharges into Lake Michigan, thus the GSI Criteria for Surface Water Protected for Drinking Water Use, is provided above.

Table 5. April 2024 LCLs that Exceed State and Federal GPS for the Units 1/2 Impoundment

Constituent	Federal GPS (mg/L)	State GPS (mg/L)	Well	95LCL (mg/L)
Arsenic	0.010	0.010	MW-08	0.025
			MW-18	0.022
Boron	None	4.0	MW-06	8.3
			MW-07	11
			MW-08	5.3
			MW-31	4.2
			MW-10	11
Calcium	None	250	MW-18	310
			MW-19	450
			MW-30	430
Chloride	None	120	MW-10	160
Fluoride	4.0	2.0	MW-18	3.4
			MW-31	4.7
			MW-10	4.2
Lead	0.015	0.0016	MW-20	0.0017
Lithium	0.10	0.10	MW-06	0.16
			MW-30	0.11
			MW-10	0.77
			MW-32	0.11
Sulfate	None	250	MW-18	700
			MW-19	910
			MW-30	810
			MW-10	380
Total Dissolved Solids	None	950	MW-06	1,200
			MW-18	1,300
			MW-19	1,800
			MW-30	2,100
			MW-10	1,700

Table 6. April 2024 LCLs that Exceed State and Federal GPS for Unit 3A/B Impoundments				
Constituent	Federal GPS (mg/L)	State GPS (mg/L)	Well	95LCL (mg/L)
Boron	None	4.0	MW-01R	78
			MW-02	91
			MW-09	5.5
			MW-10	11
Calcium	None	250	MW-03	350
			MW-04	350
			MW-09	320
Chloride	None	120	MW-02	140
			MW-03	150
			MW-04	160
			MW-10	160
Fluoride	4.0	2.0	MW-01R	8.9
			MW-02	9.2
			MW-09	2.4
			MW-10	4.2
Lithium	0.10	0.10	MW-01R	1.7
			MW-02	1.2
			MW-09	0.29
			MW-10	0.77
Sulfate	None	250	MW-01R	310
			MW-03	320
			MW-04	530
			MW-09	300
			MW-10	380
Total Dissolved Solids	None	950	MW-01R	2,300
			MW-02	1,700
			MW-03	2,000
			MW-04	1,800
			MW-09	1,200
			MW-10	1,700

4.0 Constituents of Concern in Groundwater

4.1 Constituents Exceeding Groundwater Protection Standards

4.1.1 CCR Constituents of Concern

In accordance with CCR Rule §257.95(f) and Michigan Administrative Code R 299.4441(1), downgradient well concentrations from the assessment monitoring events were compared against GPS and found to exceed GPS. Therefore, following CCR Rule §257.95(g) and Michigan Administrative Code R 299.4441(7), downgradient well data for April 2024 was statistically compared against GPS. Downgradient monitoring wells for Units 1/2 Impoundment have SSLs above the state and or federal GPS for arsenic, boron, calcium, chloride, fluoride, lead, lithium, sulfate, and total dissolved solids (TDS). Downgradient monitoring wells for Unit 3A/B Impoundments have SSLs above the GPS for boron, calcium, chloride, fluoride, lithium, sulfate, and total dissolved solids (TDS).

Constituents of Concern (COCs) are the analytical parameters that exceed GPS at statistically significant levels and trigger corrective measures. Therefore, arsenic, boron, calcium, chloride, fluoride, lead, lithium, sulfate, and TDS are considered the CCR COCs. Corrective measures assessment will be focused on evaluating attainment of GPS for these 9 CCR COCs plus the non-CCR groundwater impacts.

4.1.2 Non-CCR Constituents of Concern

Non-CCR constituents of concern include specific PFAS compounds. Groundwater elevations indicate that groundwater is discharging to surface water, including to the Grand River on the west side of the Island, to the South Channel on the south side of the Island, to the north wetland area, to the interior wetland areas, and to the Units 1/2 Impoundment. Therefore, the groundwater-surface water interface pathway is relevant because impacted groundwater can reasonably be expected to discharge to surface waters at the Site. Based on the concentrations of PFOS, PFOA, and PFHxS in monitoring wells located near the groundwater-surface water interface at the Grand River and at Harbor Island wetlands, as well as the groundwater flow directions measured during 2022 and 2023, there is the potential for PFOS, PFOA, PFHxS in groundwater to discharge to surface water at concentrations exceeding the Groundwater Surface Water Interface (GSI) Criteria. WSP (2023) identified PFAS compounds that exceed the Part 201 GSI cleanup criteria (shown in **Table 7**) and the distribution PFAS across the Island (see maps in **Appendix D** (WSP, 2023)).

Corrective measures assessment will be focused on evaluating attainment of GSI for PFOS, PFOA, and PFHxS as the non-CCR COC compounds, as well as the CCR COCs. The GSI will be considered the GPS for the non-CCR COCs.

Table 7. Summary of Vertical Aquifer Sampling of Shallow Groundwater Results with GSI Exceedances (WSP, 2023)

PFAS Compounds with GSI are Exceedances	Total Number of Groundwater Samples Collected	Number of Samples with Detections	Maximum Detection (Location)	GSI Criteria (ng/L)	Number of Results > GSI	Residential &Non-Residential Drinking Water Criteria (ng/L)	Number of Results > DWC
PFOA	40	35	110 ng/L (VAS34-3-7)	66	4	8	24
PFOS	40	36	250 ng/L (VAS34-3-7)	11	17	16	14
PFHxS	40	29	110 ng/L (VAS21-5-9)	59	1	51	1

4.2 Source Areas and Source Characterization

Data suggests that inactive Units 1/2 Impoundment and Unit 3A/B Impoundments may be the source for the CCR COCs in groundwater due to leaching of coal ash.

4.2.1 Units 1/2 Impoundment

Documented in the Golder report *Preliminary Groundwater Data Summary Through October 2020*, historical records indicate the Island operated as a municipal dump site in the 1950s and 1960s. During this period, waste was placed into the low interior marshland (Golder, 2020b). When the J.B. Sims Generating Station began operation in the early 1960s, the CCR also was disposed into the internal marshland, which was later delineated as the Units 1/2 Impoundment. According to Golder's *2021 Annual Groundwater Monitoring and Corrective Action Report*, CCR waste streams into the units ceased in 2012 (Golder, 2022).

The Units 1/2 Impoundment was not formally constructed but existed as a depression within the Island into which CCR was sluiced. Therefore, no formal historical documentation regarding the construction of the Units 1/2 Impoundment is available. Boring logs from ERM (2016) were completed within the footprint of the unit boundary and confirm no liner is present. Additionally, based on cross-sections, deposits of ash within the unit are in contact and below the water table (ERM, 2016). Further delineation of the vertical and horizontal extent of the ash will be done prior to remedy selection.

The following reports document borings completed within the footprint of the units and provide analytical characterization data for the coal ash within the unit:

Superior Environmental Corp (Superior) - Ash Pond Assessment published August 1, 2014.
A total of 10 ash samples from within the Units 1/2 Impoundment ponds on the western side of the unit were analyzed for a subset of the CCR metals required for groundwater monitoring under the state and federal compliance programs. A summary of analytical data for ash samples is provided in **Table 8**. Additionally, Synthetic Precipitation Leaching Procedure (SPLP) samples were analyzed to evaluate the leaching potential of the ash. A subset of CCR constituents were run that included arsenic, lithium, mercury, selenium, and silver. Of the SPLP results, arsenic was detected in one of ten samples and did not exceed GSI criteria. Selenium was detected in three of ten samples and exceeded GSI criteria at one sample location. The remaining constituents of mercury, lithium, and silver were non-detect in all samples. The sampling locations are shown on
Figure 3.

Table 8. Summary of Superior Environmental (2014) and ERM (2016) Coal Ash Characterization

Constituent	Statewide Default Background Levels (mg/kg)	Groundwater/ Surface Water Interface Protection Criteria for Reference (mg/kg)	Superior Environmental (2014) Ash Samples – Total Metals (mg/kg)	Superior Environmental (2014) Ash Samples - SPLP (mg/L)	ERM (2016) Soil Samples with Ash - Total Metals (mg/kg)
Aluminum	6900	None	5800-16000	NA	NA
Antimony	None	94	NA	NA	ND
Arsenic	5.8	4.6	6.8-56	ND-0.0053	5-29

Constituent	Statewide Default Background Levels (mg/kg)	Groundwater/ Surface Water Interface Protection Criteria for Reference (mg/kg)	Superior Environmental (2014) Ash Samples – Total Metals (mg/kg)	Superior Environmental (2014) Ash Samples - SPLP (mg/L)	ERM (2016) Soil Samples with Ash - Total Metals (mg/kg)
Barium	75	4,400	45-670	NA	28-170
Beryllium	None	85	NA	NA	ND-1.5
Boron	None	140	32-130	NA	ND-72
Cadmium	1.2	3.6	0.93-46	NA	ND-1.7
Chromium	18	2,900,000	15-260	NA	9.2-54
Cobalt	6.8	2	NA	NA	2.4-7.0
Copper	32	75	17-320	NA	16-95
Fluoride	None	None	NA	ND	2.7-4.6
Iron	12000	None	14000-44000	NA	7200-21000
Lead	21	5,100	15-6500	NA	16-260
Lithium	9.8	8.8	4.4-12	ND	4.0-15
Manganese	440	56	120-960	NA	39-400
Molybdenum	None	64	4-34	NA	ND-64
Mercury	0.130	0.0010	0.25-1.7	NA	0.046-0.55
Nickel	20	76	25-550	NA	9.2-33
Radium 226	None	None	NA	NA	ND-3.16
Radium 228	None	None	NA	NA	ND-1.76
Selenium	0.410	0.4	2.6-29	0.0039-0.072	ND-3.4
Silver	1	0.027	0.25-1.6	ND	ND
Thallium	None	4.2	NA	NA	ND
Vanadium	None	430	NA	NA	9-35
Zinc	47	170	80-1000	NA	36-300

Table 8. Summary of Superior Environmental (2014) and ERM (2016) Coal Ash Characterization

*ERM 2016 results only reflect soil samples with ash noted on boring log.
NA – Not analyzed, ND – Non-detect

Environmental Resources Management (ERM) (2016) - Coal Ash Delineation Sampling Results published February 8, 2016.

In total, 25 soil samples were collected from various locations within or near the Units 1/2 Impoundment and analyzed for some of the CCR metals regulated under state and federal compliance programs. Of the 25 total soil samples collected, five were collected directly from ash encountered in the subsurface. The sampling locations are shown on **Figure 3**. Results of the coal ash solids total metals data are in **Table 8**. Samples collected above and below the water table had similar concentrations. Data collected by ERM was compared to, and is consistent with, the Superior ash analytical results.

Borings from both studies determined no liner is present beneath the Units 1/2 Impoundment, indicating the source of contamination is CCR and historical municipal solid waste.

4.2.2 Unit 3A/B Impoundments

Documented in the 1983 report, Unit 3A/B Impoundments was constructed as an above-ground ash impoundment consisting of clay dikes and a minimum 3-foot compacted clay bottom (Black and Veatch, 1983). The liner was verified in the 2014 S&S report, in which borings were completed through the impoundment berms and sediment samples were tested for permeability. According to Golder's *Documentation of Liner Construction*, however, no composite liner is present and thus the liner design criteria of 40 CFR 257.71 have not been met (Golder, 2017).

The GHBLP ceased all waste disposal into Unit 3A/B Impoundments on July 30, 2020. The GHBLP commenced removal of CCR from Unit 3A/B in July 2020. On December 10, 2020, Golder considered the unit at final closure to 95 percent confidence of CCR removal (Golder, 2020b). Following the submission of closure documentation on January 27, 2021, EGLE denied the closure certification for the following reasons:

- GHBLP did not have a groundwater monitoring system that represented background water quality. [As discussed, the monitoring well network has been expanded to represent the background water quality and to address groundwater exiting the waste boundary.]
- GHBLP only utilized one of six total soil samples to verify ash removal using colorimetric methods. EGLE stated no demonstration had been made that would justify how one sample could represent all liner areas accurately.
- The methodology for microscopy did not include preprocessing of samples to ensure bottom ash could properly be identified.
- GHBLP did not address the contamination of the clay liner itself beneath Unit 3A/B Impoundments. Soil sample analysis showed elevated concentrations of lithium and selenium have impacted the liner, consistent with coal ash or coal ash leachate.
- GHBLP did not provide sufficient demonstration that the horizontal extent of coal ash had been defined, noting a 2014 EPA report showing photographic evidence that coal ash was present outside the Unit 3A/B Impoundments boundary (e.g. on roadways).
- Photographic evidence collected during the ash removal showed a large amount of cracking observed in the clay liner, which could indicate a pathway for impacted water to enter groundwater beneath the impoundment.

Based on available information, the potential sources of contamination detected in groundwater surrounding the Unit 3A/B Impoundments are leaching of coal ash historically present in the impoundments to groundwater, the suspected "field of ash" below the Unit 3A/B Impoundments, and any remaining CCR impacted material within the unit footprint, any CCR on areas adjacent to the impoundment, and the impacted clay liner of Unit 3A/B Impoundments. A summary of the ash analysis is summarized in **Table 9**.

Table 9. Summary of Golder (2020) Coal Sampling Results			
Constituent	Statewide Default Background Levels (mg/kg)	Groundwater/ Surface Water Interface Protection Criteria for Reference (mg/kg)	Golder (2020a) Ash Samples - SPLP (mg/L)
Aluminum	6900	None	ND
Antimony	None	94	ND
Arsenic	5.8	4.6	ND
Barium	75	4,400	0.043
Beryllium	None	85	ND
Boron	None	140	0.069
Cadmium	1.2	3.6	280
Chromium	18	2,900,000	ND
Cobalt	6.8	2	ND
Copper	32	75	NA
Fluoride	None	None	1.8
Iron	12000	None	NA
Lead	21	5,100	ND
Lithium	9.8	8.8	ND
Manganese	440	56	NA
Molybdenum	None	64	ND
Mercury	0.130	0.0010	ND
Nickel	20	76	NA
Radium 226	None	None	NA
Radium 228	None	None	NA
Selenium	0.410	0.4	ND
Silver	1	0.027	NA
Thallium	None	4.2	ND
Vanadium	None	430	NA
Zinc	47	170	NA

NA – Not analyzed, ND – Non-detect

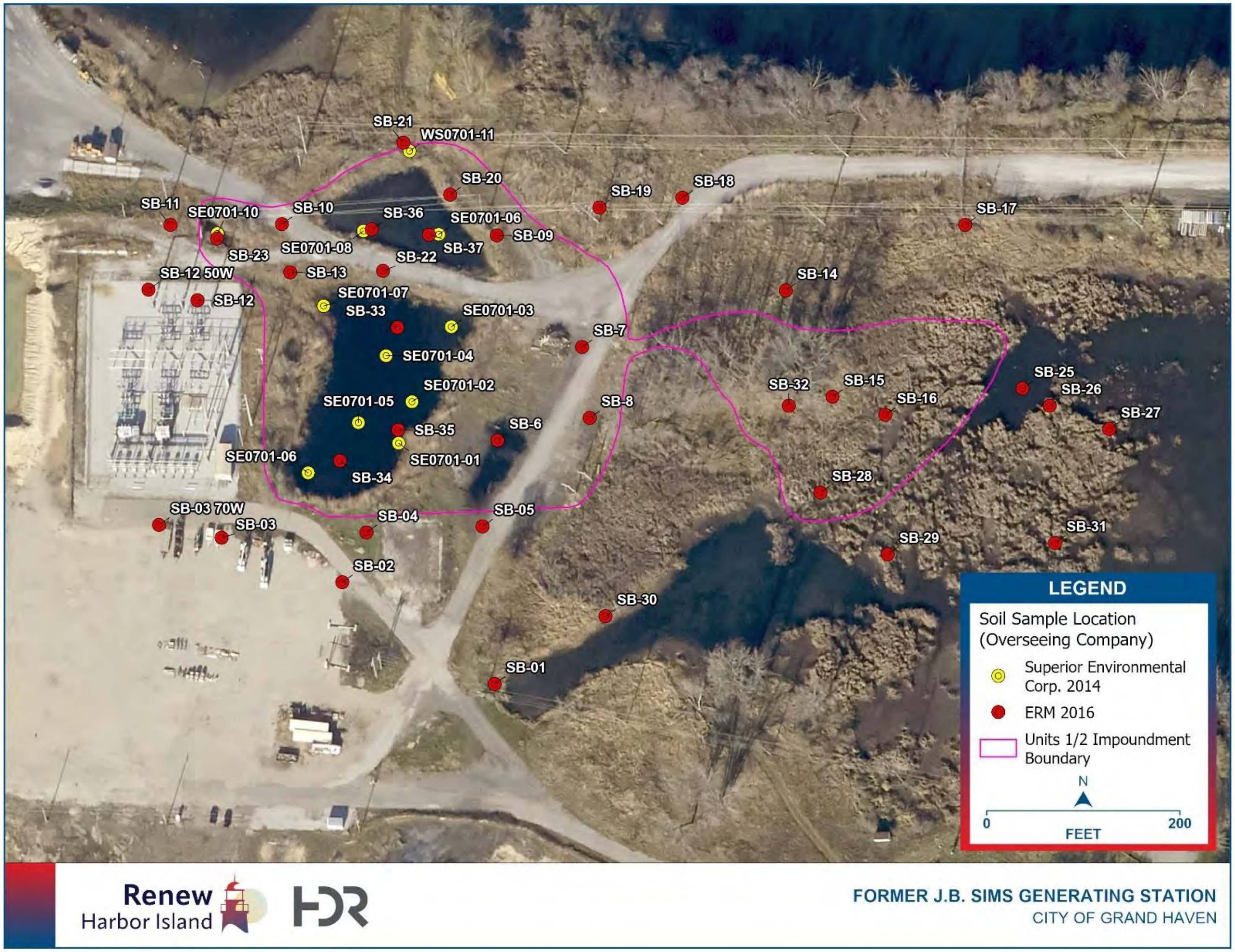

Figure 3 | Locations of Ash Characterization Sampling for Units 1/2 Impoundment

4.2.3 Non-CCR

Concentration maps representing PFOS and PFOA, the PFAS compounds that exceeded Part 201 criteria, are provided in **Appendix D**. A map showing PFHxS was not developed because there was only one exceedance and it is located at MW-37, the same location of PFOS and PFOA exceedances. The following PFAS observations were made:

- PFOA – The highest concentration observed is on the northern side of the Island near MW-08; however nearby sampling locations are noticeably lower in concentration. Wells MW-36, MW-37, and MW-38 exceed the GSI in the footprint of the former J.B. Sims plant.
- PFOS –GSI exceedances are widespread across the Island, with the highest concentrations observed along the road between the internal wetland and the north wetland, and along the western edge near the Grand River.

Based on limited research to date, no historical information regarding any specific PFAS source areas on Harbor Island has been identified. Potential PFAS sources could be associated with historical filling, including municipal and industrial waste, dredge materials, and other unknown fill activities, as well as the historical operations of the J.B. Sims Generating Station.

Certain PFAS compounds that have been detected at Harbor Island first were manufactured and used after the municipal landfill activities ceased. For example, 6:2 fluorotelomer sulfonic acid (6:2 FTS) was detected on the western portion of the Site in the area of the former J.B. Sims plant. The 6:2 FTS compound was developed after the municipal waste dump was closed in 1970, which indicates a newer release of PFAS on the Island not related to the City's dump. Researching historical activities at Harbor Island, and the development and use of different compounds, may provide information about additional potential sources.

Limited soil samples were collected at VAS locations along the northern access road (just south of the northern wetland) and in the area of the former J.B. Sims Generating Station. Soil samples had detections of various PFAS compounds, however, there currently are no Part 201 Generic Cleanup Criteria for PFAS in soil.

4.3 Plume Delineation

In accordance with 40 CFR §257.95(g)(1)(i) and Michigan R 299.4441(6)(c) additional monitoring wells will be installed to define the areas where groundwater exceeds GPS, these areas are referred to as "plumes". The potential groundwater plume is defined as an area inside of which concentrations of COCs in groundwater are present at concentrations exceeding the respective GPS. Maps have been developed for COCs that have been observed exceeding GPS at SSLs. (**Appendix C**). The majority of the plumes have been delineated and there remain only a few locations that require additional investigation.

Units 1/2 Impoundment Monitoring Well Network

The monitoring well network justification for the Units 1/2 Impoundment is provided in the Hydraulic Monitoring Plan (HDR, 2024c). The following wells are utilized as the groundwater monitoring network:

- Background Wells: MW-27, MW-33, and MW-34.
- Point of Compliance Wells (i.e. waste boundary wells): MW-06, MW-08, MW-18, MW-19, MW-20, MW-30, and MW-31.
- Nature and Extent Wells: MW-07, MW-10, MW-16, MW-17, MW-28, MW-32, MW-36, and MW-37.

Unit 3A/B Impoundments Monitoring Well Network

The monitoring well network justification for the Unit 3A/B Impoundments is provided in the Hydrologic Monitoring Plan (HDR, 2024c). The well network utilized is as follows:

- Background Wells: MW-27, MW-33, and MW-34.
- Point of Compliance Wells (i.e. waste boundary wells): MW-02, MW-03, MW-04, MW-11, and MW-12.
- Nature and Extent Wells: MW-01R, MW-09, MW-10, and MW-38.

Data from these nature and extent wells was used to evaluate the nature and extent of exceedances and define the plume, which is an important component of an ACM. Following the statistical evaluation of February 2024 assessment monitoring sampling data, SSLs were identified in nature and extent wells shown below:

- Units 1/2 Impoundment: MW-10 and MW-32.
- Unit 3A/B Impoundments: MW-01R, MW-09, and MW-10.

During the 2nd quarter 2024 sampling event in April 2024, the following additional nature and extent wells were added to each unit to further delineate the COC plumes:

- Units 1/2 Impoundment: MW-16, MW-17, MW-28, MW-36, and MW-37.
- Unit 3A/B Impoundments: MW-38.

As of July 2024, the newly added nature and extent wells listed above have been sampled during two events (April and July 2024). The GPS exceedances to date indicate that further expansion of the monitoring well network may be necessary in a few locations to further delineate and refine the contaminant plume if SSLs are identified. Potential expansions of the monitoring well network would include the following areas:

- MW-39 and MW-13 will be added as nature and extent wells for Unit 3A/B Impoundments; and
- North of MW-10 for Units 1/2 Impoundment and Unit 3A/B Impoundments.
- The area around MW-07 and MW-08 may need further investigation to determine the source and extent of CCR COCs.

The existing well locations of MW-13 and MW-39 will be sampled during the 4th quarter assessment monitoring event. Monitoring wells deemed necessary to refine the CCR contaminant plumes will be installed in the 1st quarter 2025. This work will be completed as additional data is gathered for remedy selection.

4.4 Potential for Offsite Contaminant Transport

40 CFR §257.95(g)(1)(iii) and Michigan R 299.4441(6)(c) require that at least one additional monitoring well be installed at the facility boundary in the direction of plume migration and sampled in accordance with 40 CFR §257.95(d)(1) and Michigan R 299.4441(4), respectively. At Harbor Island, the Facility boundary is the surface water or wetland in all directions, and there are existing monitoring wells along the Facility boundary in the well network as shown in **Figure 2**.

Groundwater elevations indicate that groundwater is discharging to surface water, including the Grand River on the west side of the Island, the South Channel on the south side of the Island, the north wetland area, the interior wetland areas, and Units 1/2 Impoundment (**Figure 2**). Groundwater flow patterns on the Island are generally consistent and change seasonally. Shallow (ranging from 1 to 9 ft bgs) groundwater is migrating offsite into the surface waters.

The potential for deeper (16 to 20 ft bgs) groundwater to migrate offsite under the surface water is not yet understood and is a data gap. A Data Gap Work Plan is in progress and includes a plan to install additional deeper wells at the groundwater/surface water interface to characterize the potential for deeper groundwater flow under the Island (**Figure 2**).

4.5 Potential Receptors and Exposure Pathways

The conceptual site model for groundwater is complex due to the extensive fill and the groundwater/surface water interactions on Harbor Island resulting in groundwater flow that has temporal and spatial variability. As shown in **Figure 1**, Harbor Island is surrounded by surface water bodies including the Grand River to the west, the South Channel on the south and east, as well as a wetland to the north that appears to be connected to the Grand River. The rise and fall of the Grand River's water level influences the groundwater flow rate and direction throughout the Island. Groundwater level monitoring shows that localized flow direction and gradients are variable and influenced by surface water levels, precipitation, and the seasonal freeze thaw cycle.

The Michigan Generic Residential and Nonresidential Drinking Water Criteria (DWC) are developed based on the ingestion of groundwater for drinking water. The drinking water pathway must be considered for all groundwater in an aquifer but is considered an incomplete exposure pathway where groundwater is not used for consumption as is the case on Harbor Island.

The Groundwater-Surface Water Interface (GSI) pathway is relevant when hazardous substances in groundwater can reasonably be expected to discharge to surface waters of the State. Based on the concentrations of PFOS, PFOA, and PFHxS in monitoring wells located near the groundwater-surface water interface at the Grand River and Harbor Island wetlands, as well as the groundwater flow directions measured during 2023 and 2024, there is the potential for PFOS, PFOA, and PFHxS in groundwater to discharge to surface water at concentrations exceeding the GSI criteria. Similarly, based on the concentrations of CCR COCs in monitoring wells located near the GSI at the Grand River and Harbor Island wetlands, there is the potential for CCR COCs in groundwater to discharge to surface water at concentrations exceeding the GSI criteria. Grand Haven's municipal water intake is located in Lake Michigan, just south of the mouth of the Grand River. As such, all groundwater concentrations were compared to the generic GSI criteria for a drinking water source.

According to the EGLE's *Wellogic* online database, there are no groundwater wells located on Harbor Island. There are, however, 21 groundwater wells that are located within one mile of the Harbor Island study area boundary. Construction details for these wells are listed in **Table 10** and locations are provided in **Figure 3**. According to *Wellogic*, most of the water wells located closest to Harbor Island are not used for drinking water. One water well located northwest of Harbor Island is identified as a household use water well. This well is screened from 38 to 43 ft bgs. Based on the flow of the Grand River, this water well is likely located upgradient of the groundwater impacts on Harbor Island (WSP 2023). Despite being located within the one-mile buffer, the wells are all separated from Harbor Island by the Grand River or South Channel. An investigation of potential flow beneath the Island utilizing deep monitoring wells is currently being proposed and is anticipated to be completed by the 4th quarter 2024.

Wetlands are also regulated as surface waters of the State and are subject to GSI statutory provisions. The wetlands on Harbor Island are not used as a drinking water source, however, they are hydraulically connected to the Grand River.

Table 10. Public Wells within One Mile of Study Area

Wellogic ID Number	Well Depth (ft. bgs)	Date of Construction	Static Water Level (ft. bgs)	Latitude	Longitude	Elevation (ft)	Well Type
70000002390	87	4/30/1971	68	43.085	-86.231	610	Residential
70000002391	83	6/30/1971	63	43.084	-86.227	591	Residential
70000007379	30	10/19/2006	4	43.086	-86.225	587	Residential
70000009583	50	7/25/2012	0	43.069	-86.229	582	Commercial
70000009584	21	8/15/2012	6	43.069	-86.229	582	Commercial
70000009733	30	2/12/2013	2	43.086	-86.226	592	Residential
70000009941	63	9/10/2013	43	43.062	-86.236	605	Commercial
70000012737	58	1/25/2019	26	43.058	-86.234	614	Residential
70000015545	65	10/20/1971	37	43.061	-86.228	611	Residential
70000017244	52	3/31/1972	30	43.066	-86.250	597	Residential
70000018690	52	Not Provided	0	43.063	-86.236	595	Commercial
70000018789	35	2/14/1972	22	43.078	-86.252	595	Residential
70000018907	43	6/11/1990	6	43.078	-86.239	586	Residential
70000018967	42	7/12/1990	9	43.086	-86.232	607	Commercial
70000019132	53	8/18/1966	17	43.084	-86.235	609	Public Supply
70000019882	42	4/24/1972	5	43.086	-86.241	607	Residential
70000020443	35	10/7/1967	10	43.084	-86.232	600	Residential
70000020445	38	5/1/1997	3	43.086	-86.236	602	Commercial
70000020454	21	6/10/1972	9	43.078	-86.252	596	Residential

Table 10. Public Wells within One Mile of Study Area

Wellogic ID Number	Well Depth (ft. bgs)	Date of Construction	Static Water Level (ft. bgs)	Latitude	Longitude	Elevation (ft)	Well Type
70000020524	37	6/6/1973	10	43.075	-86.251	593	Residential
70000020527	40	5/25/1971	0	43.076	-86.252	599	Residential

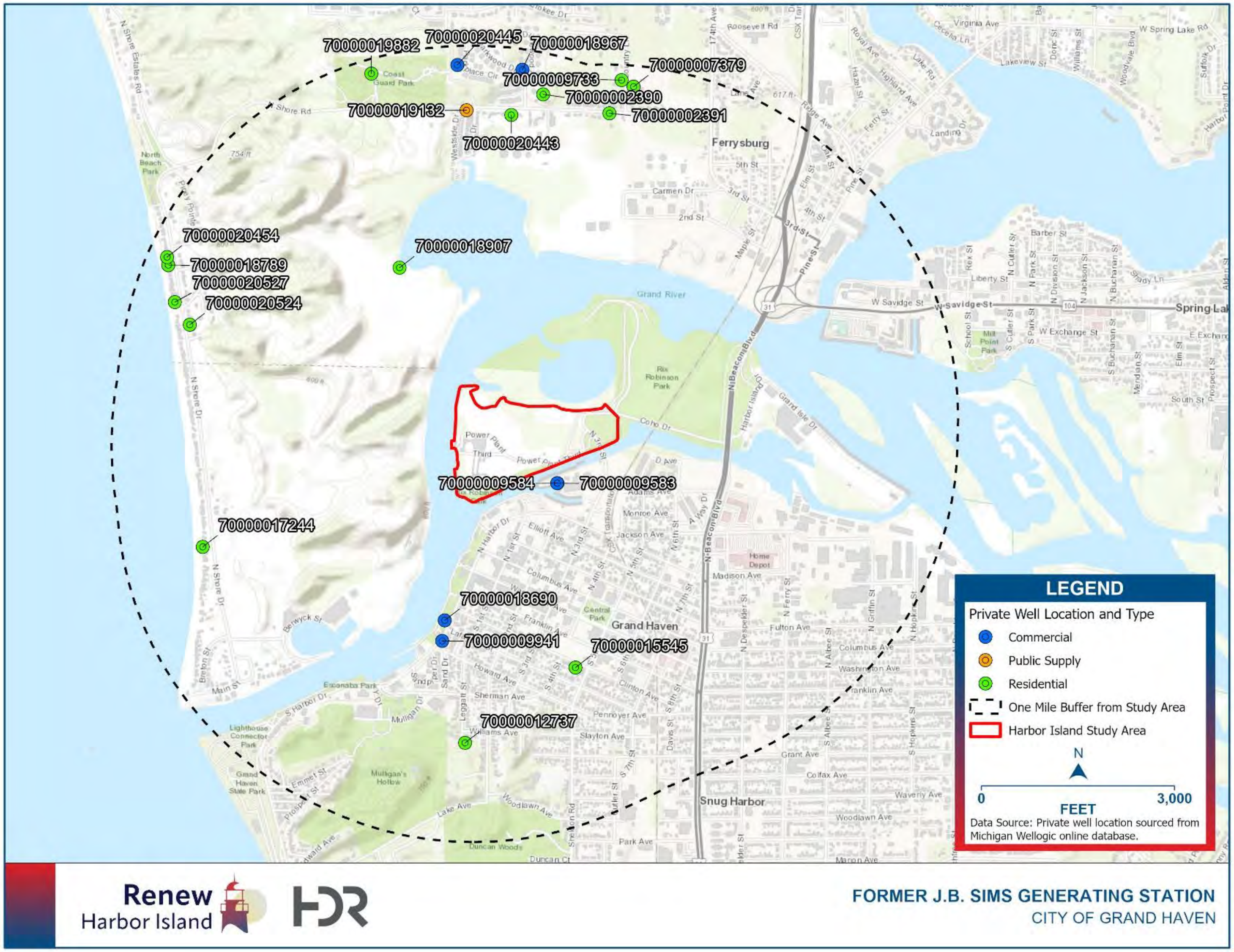

Figure 4 | Private Wells within One Mile of Study Area

5.0 Corrective Measures Alternatives Evaluation

Consideration of corrective measures to address both the CCR related groundwater impacts from the two CCR units and the non-CCR related groundwater impacts are discussed in this section. Included below are the descriptions of the evaluation criteria, shared components of the corrective measure alternatives, each potential alternative, screening of the alternatives, and a summary of additional data needs to support the future remedy selection.

5.1 Evaluation Criteria

Consistent with 40 CFR §257.96 and Michigan Administrative Code R 299.4443, evaluation criteria considered in the assessment of corrective measures are discussed below.

Performance

Factors considered for evaluating performance of a corrective measure alternative include the degree to which the alternative removes COCs from the environment; and the ability of the alternative to achieve GPS for these constituents at point(s) of compliance.

Reliability

Factors considered for evaluating the reliability of a corrective measure alternative include the effectiveness of engineering and institutional controls to maintain the alternative; potential need for replacement or maintenance of components of the alternative; and any other operational reliability issues that may arise for the alternative that will limit its use or effectiveness in meeting corrective action objectives.

Ease of Implementation

Factors considered for evaluating ease of implementation of a corrective measure alternative include the degree of difficulty associated with installing or constructing the alternative given site conditions, including the need to obtain necessary access, approvals and/or permits; the availability of necessary equipment and/or specialists to implement; and the available capacity and location of treatment, storage, or disposal services needed.

Potential Impacts of the Alternative

Factors considered for evaluating potential impacts of a corrective measure alternative include risks that may impact the community or environment during implementation of the alternative (e.g., due to excavation, transportation, disposal, or containment of CCR material), potential human health or environmental receptor exposure to COC material following implementation, and cross-media impacts due to the corrective measure alternative implementation.

Time Required to Begin and Complete the Alternative

Factors considered for evaluating the time to begin and complete the corrective measure alternative include the time needed to completely design and implement (i.e., begin) the alternative; and the time it will take to achieve applicable GPS at point(s) of compliance.

Institutional Requirements
Factors considered for evaluating the time to begin and complete the corrective measure alternative include the time needed to completely design and implement (i.e., begin) the alternative; and the time it will take to achieve applicable GPS at point(s) of compliance.

Michigan Administrative Code R 299.4443 also requires that the analyses address the costs of remedy implementation. Due to the potential additional requirements associated with CCRMU at the Site, it is anticipated that closure and groundwater remediation requirements for CCR may increase beyond what is identified herein. These costs cannot be quantified until the Facility Evaluation, associated field work, and groundwater monitoring are completed. Additional information derived from the CCRMU evaluation may alter the corrective measure alternatives and will alter any cost estimates. Because there is knowledge that the costs may increase after the CCRMU are incorporated, this ACM does not include cost estimates and will be revised after this information is available.

5.2 Potential Groundwater Corrective Measure Alternative Evaluation

This section presents potential corrective measures alternatives and an evaluation of each in accordance with 40 CFR §257.96 and Parts 115 and 201 to address CCR constituents in groundwater at SSLs exceeding GPS and non-CCR constituents in groundwater at levels exceeding the GPS at the Site. There are no stand-alone corrective measure alternatives for this Site. However, by grouping individual corrective measures together, a holistic remedy for the Site can be assembled to remediate CCR and PFAS.

The presence of non-CCR constituents may require different or additional measures be implemented. Treatment of groundwater and surface water collected during the corrective measures must address both the CCR constituents and the PFAS before discharge. PFAS compounds present challenges to the corrective measures used to address CCR constituents because no alternative is available to separate the CCR constituents from the PFAS in the groundwater that will be extracted for treatment. Emphasis will be placed on alternatives that consider both the CCR COCs and the co-mingled PFAS so as to save time and conserve financial resources. This is referred to as a holistic approach to remediation at the Site.

Other considerations include the requirement to close the CCR units as part of source control. Source control would include either CCR removal and decontamination, or closure in place and elimination, to the maximum extent feasible, of post-closure infiltration of liquids into the waste, including groundwater infiltration.

Sections 5.2.1 through **5.2.5** describe the corrective measure alternatives evaluated, and **Table 11** provides a summary of each potential alternative compared to the evaluation criteria. Each potential alternative is assigned a numerical ranking of 1 to 3; 1 indicating least favorable and 3 is most favorable. This ranking has been assigned to each criterion for each alternative based on the evaluation of each alternative and site-specific conditions. An evaluation of each potential alternative and a summary of the results are presented below.

In addition to the evaluation criteria, corrective measure alternatives determined to be viable for the Site were also evaluated considering the following remedy selection standards from 40 CFR §257.97(b):

- Be protective of human health and the environment.
- Attain groundwater protection standard(s) pursuant to 40 CFR §257.95(h).
- Control the source(s) of releases to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment; and
- Comply with standards for management of wastes as specified in 40 CFR §257.98(d).

A cross-check summary of how each alternative compares to these remedy selection standards is provided in **Table 11**.

5.2.1 Source Control – Removal and In-situ Solidification and Stabilization

Source control of the CCR will be a key component of any corrective measures approach and will be one of the initial steps of the remediation. Closure is required under §257 for the CCR units and includes either closure by removal or closure in place. Removal and In-Situ Solidification and Stabilization (ISS) are the two source control alternatives being evaluated. It is likely that a combination of both removal and ISS may be used to accomplish source control because the majority of the ash previously was removed from the Unit 3A/B impoundments. Minimal amounts of ash may be present around the periphery of the unit that was associated with ash removal truck loading. In addition, if any PFAS source material is identified, then such sources may be removed. PFAS source locations are not well defined. Groundwater with exceedances of PFAS compounds could have migrated from an as yet unknown source. There are locations, however, where groundwater concentrations appear higher than others that in some cases coincide with solid waste in borings. Therefore, removal of waste and soil in those areas may be considered. Demolition, removal and relocation of on-site structure and utilities could also be part of this remedy.

Source Removal

Removal of CCR and PFAS containing waste prevents the ongoing potential migration of contaminants to the groundwater and surface water. Source removal maximizes the groundwater cleanup effectiveness of the other alternative components for this corrective measure discussed below. The corrective measures will continue to target the removal of the CCR and PFAS containing waste wherever possible. Excavation and offsite disposal will be used to accomplish this removal.

Excavation of source materials is straightforward and uses common construction equipment to eliminate the ongoing migration of contaminants to the air, groundwater and surface water. Removal of these sources reduces the time to achieve GPS at compliance points, reduces corrective action costs and reduces potential risk human health and the environment. Removal can be implemented concurrently with implementation of other alternatives for groundwater remediation. Excavation is a relatively quick form of source control, taking the least amount of time of all the alternative components to complete. The high groundwater table at the Site, however, potentially means that extensive and costly dewatering may be required during any removal.

The GHBLP ceased all waste disposal into Unit 3A/B Impoundments on July 30, 2020. The GHBLP commenced removal of CCR from Unit 3A/B Impoundments in July 2020 and excavated the CCR down to the clay liner. On December 10, 2020, Golder considered the unit at final closure to 95 percent confidence of CCR removal (Golder, 2020a). However, the closure documentation was denied by EGLE on January 27, 2021. Additional data collection is planned to delineate the areas that require additional excavation.

CCR dewatering and excavation of source material from the inactive Units 1/2 Impoundment and the former Unit 3 A/B Impoundments is one method of source control and closure for the CCR impoundment. Demolition, removal and relocation of on-site structures and utilities could be part of this remedy. Under a removal closure strategy, the ash from the impoundment will be dewatered, excavated and disposed of at an off-site landfill or beneficially used offsite pursuant to any applicable federal and state regulatory requirements. Confirmation samples will be collected from the impoundment's footprint after CCR removal and statistically evaluated to demonstrate that all areas affected by releases of CCR have been removed. A preliminary report documenting the closure by removal will be prepared and certified by an HDR Professional Engineer. The closure report will be finalized once the COC concentrations in groundwater are confirmed to meet the GPS according to the requirements of the CCR Rule and Part 115.

Source control using removal will be retained for further site-specific evaluation.

Site Considerations: The performance and effectiveness of a removal action is based on the ability to characterize the areas where CCR and PFAS are located and to excavate to the horizontal and vertical depth of the waste. Further PFAS delineation to identify potential source areas for removal may be conducted for costing purposes. Sources of PFAS are unknown. It is possible that historical fill material, prior operation of the power plant and/or other historical activities may have resulted in the PFAS contamination.

The Site geology (as described above) is not expected to present any obstacle to excavation. However, the high-water table and surrounding surface water could cause the hydraulic control of the groundwater and surface water infiltration to be burdensome, increasing the cost and time to complete this task. Removal will be retained for further site-specific evaluations to determine how best to apply this alternative at the Site.

Solidification and Stabilization

Solidification and stabilization (SS) are a group of cleanup methods that can prevent the release of harmful chemicals from waste, such as contaminated ash, soils, sediments, and sludge. Solidification binds waste in a solid block of material and traps it in place. This block is also less permeable to water than the waste. Stabilization causes a chemical reaction that makes contaminants less likely to leach into the environment. These methods do not destroy the contaminants but keep them from migrating as air born particles or leaching into surface water and groundwater. SS can be conducted while the waste is still in the ground (in-situ) (ISS) or excavated (ex-situ) and mixed with an agent above ground. When used in-situ, these methods can replace the need for excavation. Controlling the source with ISS also avoids time-consuming and costly dewatering required by excavation and may result in expedited groundwater remediation at a potentially lower cost.

These alternatives are simple construction activities using heavy equipment like a crane and auger to mix a binding agent such as cement into the waste material. ISS leaves areas of contamination in place as a solid block in the ground providing a relatively quick and lower cost way to control a source and prevent human and ecological exposure to contaminants. Currently, proven technology exists to perform ISS for the CCR COCs, but such technologies are still in the experimental stage for PFAS.

These methods are reliable remediation methods and have been successfully used at several CCR sites across the Country. Under the ISS closure strategy, the ash would be mechanically mixed with a binding agent to form a block on-site. Confirmation samples would be collected from the impoundment's footprint after the SS process is complete to determine if the process was successful. Leaching tests are performed on the treated material to confirm that the CCR has been encapsulated. Statistical evaluation would be conducted to demonstrate that areas affected by releases of CCR are stable. A preliminary report documenting the closure by SS would be prepared.

Site Considerations: The performance and effectiveness of this alternative technology is based on the ability to characterize the areas where CCR is located, select the appropriate agent and deliver the agent to those impacted areas. The site geology should not be an impediment to mixing. Knowing the horizontal and vertical depth of the CCR impacted materials is critical because as the vertical depth increases, it becomes more difficult to mix the agent with the waste materials. Compatibility with the Site material is also a key concern and may require bench testing to determine which agents are the most effective in binding the contaminants. It is not known if these alternative technologies would effectively bind PFAS constituents, however the addition of a binder for CCR also may effectively bind PFAS. SS will be retained for further site-specific evaluations at the Site.

Source control is recommended as one component of the assembly of corrective measures alternatives used to achieve the corrective action objectives and should be retained for further evaluation. The ACM will retain source control for further site-specific evaluation.

5.2.2 Containment Wall

Containment walls provide a hydraulic barrier that can be used for groundwater cutoff, controlling groundwater flow or completely encircling a contaminated area and preventing contaminated groundwater migration off-site. Containment walls are a proven technology. The containment wall alternative can be effective in containing the CCR and PFAS comingled contamination and controlling contaminant migration. Containment walls are very effective when paired with an extraction and treatment system for the remediation of groundwater. Two types of containment walls are being evaluated for this corrective measure: (1) interlocking steel sheet pile wall and (2) slurry wall.

Interlocking sealed steel sheet pile containment wall

Interlocking sealed steel sheet pile containment wall (sheet pile wall) can be used to provide a barrier to impacted groundwater flow, preventing off-site migration of dissolved COCs. A sheet pile wall also provides a barrier preventing clean surface water and groundwater from entering the treatment system, thus reducing the volume of water being treated and consequently reducing the time and cost of corrective action.

Construction of a sheet pile wall entails driving steel sheet piles through the soil column and into the top portion of a low permeability geological barrier to groundwater movement such as a clay material. The sheet pile wall would be composed of sheets of steel approximately 45 feet long, 3 feet wide and 1.5 to 2 inches thick with an interlocking sealed edge between each steel sheet making it watertight. These steel sheets are driven into the top of the clay by a crane using an impact hammer or vibratory hammer. The permeability of the sheet piles is essentially zero and they are compatible with both the CCR and non-CCRCOCs at this Site.

Site Considerations: Interlocking sealed steel sheet pile walls perform well when installed properly. The Harbor Island Site presents several challenges. If the COCs exceeding GPSs are located both on- and off-site, the containment wall may need to encapsulate areas off Harbor Island and out into the river. It must be determined if there is sufficient land area between the shoreline and the areas where the wall needs to be installed.

Sheet pile walls are useful because they are not hindered by surface or groundwater. Their installation requires no excavation or associated costly dewatering. They possess structural integrity and can be installed at the water's edge or beyond if necessary to capture a plume. Sheet pile walls have a permeability of essentially zero, making them excellent for groundwater containment and are compatible with the COCs on this Site, including PFAS.

A steel sheet pile wall is superior to a slurry wall option (discussed next) in most applications because of its versatility and ease of construction. Unlike slurry walls, sheet pile walls allow for pinpoint placement in tight areas (e.g., between Island and river), COC compatibility and require no excavation or associated costly groundwater management. Also, if construction is required at or beyond the edge of the Island such due to a plume extending beyond the Island property boundary and into the river, only the sheet pile can address this situation.

Slurry wall

The second type of containment wall under consideration is the slurry wall. The construction of a slurry wall involves excavating a narrow trench or trenches approximately 4 feet wide by 35 feet deep and injecting a high slump slurry that when solidified forms a wall. The slurry wall would also be keyed at least 3 feet into the low permeability underlying barrier such as clay. The slurry used for wall construction is typically a combination of excavated trench soils, bentonite, and other potential additives depending on the COCs at the Site. The slurry mixture forms into a material similar to soft, clayey soil. This method typically results in a cutoff wall with a permeability ranging from $1x10^{-6}$ to $1x10^{-8}$ cm/sec.

Site Considerations: Slurry walls have a good track record when installed properly. As discussed above, the Harbor Island Site presents several challenges. A competent slurry wall would be difficult to construct under these conditions without significant additional efforts and cost.

The construction of a slurry wall is limited to areas where excavation can be completed without side wall collapses, where the infiltration of groundwater and surface water can be controlled, and where the soil of the trench provides the structural integrity. The historical fill material used to construct the Island may not possess the structural integrity needed for the trench and may not be suitable as a slurry component.

Installation at the edge or out into the river may not be possible. Slurry wall construction at this Site requires trenching through approximately 35 feet of overburden soil and then approximately 3 feet of confining clay layer. There may not be room to construct a slurry wall on the property due to the limitation imposed by the surrounding surface water. Because the Site is an island, placement of the slurry wall at the edge of land would be difficult because surface water and groundwater infiltration into the trench would be continuous and difficult to control.

Containment walls can be a reliable vertical barrier for cutting off groundwater flow and generally are coupled with a groundwater treatment technology, such as groundwater extraction and treatment. Another consideration is managing groundwater within the containment wall which may be required in the overall corrective action strategy due to groundwater mounding. Groundwater extraction alternatives would provide greater versatility in dealing with groundwater mounding.

Containment walls are recommended as one component of the assembly of corrective measures alternatives used to achieve the corrective action objectives and should be retained for further evaluation. The ACM will retain both types of walls for further site-specific evaluation.

5.2.3 Hydraulic Containment - Extraction and Treatment

Extraction and Treatment (E&T) is an effective type of hydraulic containment used to capture and control the migration of impacted groundwater. E&T is considered a reliable corrective action technology for application at CCR sites as it has been used to address metals-contaminated groundwater for decades at sites with varying geologies across the Country. It is also one of the few technologies that also is applicable for remediation of PFAS. The approach consists of using extraction wells to capture groundwater for ex-situ treatment prior to being discharged to a receiving water body (like the Grand River), reinjection to the aquifer, beneficial reuse, discharge to a publicly owned treatment works, or evaporation. E&T has successfully been employed as a stand-alone remedy, in combination with other corrective measure alternatives, or as an interim measure to provide hydraulic containment and prevent migration of constituents toward a potential receptor.

Site Considerations: The viability of this technology is dependent on the ability to characterize the extent of the groundwater contamination. Modeling of the impacted groundwater is typically used to design a network of extraction wells to capture the groundwater. Bench or pilot testing is often necessary to design a water treatment plant that can effectively remove contaminants (CCR and PFAS) from the extracted groundwater and develop a long-term monitoring program to track the success of the corrective action. Groundwater evaluations collected to date identified the uppermost aquifer as high conductivity which is ideal for E&T. The geology is described as fine sand with gravel, silt lenses, clay, peat, ash, and municipal solid waste in the uppermost aquifer. Geology impacts how groundwater can effectively be extracted from the subsurface.

Evaluation of the use of extraction wells will require additional site-specific data by conducting pump tests in the immediate vicinity of existing monitoring wells. The pump test results will be used to estimate the zone of capture for extraction wells screened in the upper aquifer so as to determine the extraction wells needed to intercept groundwater flowing from the impacted area. Reporting for the pump tests would be provided under separate cover in the semi-annual remedy selection progress report.

Once groundwater is collected, reliability of treatment will be dependent on the performance of the above ground treatment system to remove the CCR and PFAS contaminants from groundwater. The contaminants of concern for Units 1/2 Impoundment include arsenic, boron, calcium, chloride, fluoride, lead, lithium, sulfate, and total dissolved solids (TDS) and for Unit 3A/B Impoundments include boron, calcium, chloride, fluoride, sulfate, and TDS. These CCR constituents and PFAS can be removed from extracted groundwater using currently available technology.

The hydraulic containment technology will be retained for further site-specific evaluation. Hydraulic containment should be used in combination with other corrective measure alternatives such as a cap and containment wall to achieve the corrective action objectives.

5.2.4 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve GPS within a time frame that is reasonable compared to active methods. Natural attenuation processes that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater (USEPA, 1999). Attenuation mechanisms for inorganic constituents can include physical (e.g., dilution, dispersion, flushing, and related processes) or biological/ chemical (e.g., adsorption, sorption (co-precipitation) processes (EPRI 2015a; USEPA 2015). MNA is relatively efficient to implement.

Evaluating the performance and reliability of MNA requires a detailed understanding of hydrogeologic conditions and a monitoring and assessment program. While model predictions can simulate long-term attenuation using soil-water partitioning coefficients to estimate adsorption, natural conditions will dictate how COCs migrate through the strata and how much is intrinsically removed or immobilized. Empirical data are good indicators of natural attenuation mechanisms, but long-term groundwater monitoring is required. (EPRI, 2015; USEPA, 1999, 2007a,b).

To assess MNA's potential performance and reliability at a site, the USEPA has established a tiered lines of evidence approach where information is collected as necessary to identify attenuation mechanisms at a site, the capacity for attenuation, and the estimated time to achieve corrective action objectives. The four tiers to establish whether MNA may be successfully implemented for inorganics at a given site are summarized below (USEPA, 2015):

Tier 1: Demonstration that COCs above GPS in groundwater are delineated and stable.

Tier 2: Determination of the mechanisms and rates of attenuation.

Tier 3: Determination of the aquifer's capacity to sufficiently attenuate the mass of constituents in groundwater and whether the stability of the immobilized constituents is sufficient to resist re-mobilization.

Tier 4: Design of a performance monitoring program based on the mechanisms of attenuation and establishment of contingency remedies tailored to site-specific conditions should MNA not perform adequately.

MNA is well-accepted by state and federal regulators as an appropriate mitigation factor that should be considered when evaluating passive and active remedial options (USEPA, 1999, 2007a,b).

Site Considerations: MNA requires a long time to achieve GPS and, during that retention period, impacted groundwater must not vent to surface water. At Harbor Island, the groundwater is not retained for a period sufficient to achieve MNA before it discharges to surface water or wetland. Additionally, there is no known MNA for PFAS which is a COC at the Site.

For these two reasons MNA is not retained for further evaluation.

5.2.5 Capping

Capping is the placement of a cover over contaminated materials to prevent the movement of contaminants. For example, a cap can 1) stop infiltration of rain and snowmelt from seeping through the material and carrying contaminants to the groundwater, 2) keep stormwater runoff from carrying contaminants off-site into lakes and rivers, 3) prevent wind from blowing contaminants off-site, and 4) keep people and wildlife from coming into contact with contaminants. A cap on this Site would primarily serve to minimize infiltration of precipitation. Preventing infiltration and recharge is critical for achieving hydraulic control and containment and would increase the efficiency of the E&T, resulting in the reduction of both cost of water treatment, and potentially less time for remediation.

A cap design must take into consideration several factors, including the type and concentrations of contaminants present, size of the site, the amount of rainfall at the site, and future use of the property. Construction of a cap can be as simple as placing a single layer of material over the area as a contact barrier, or a solid waste cap requiring several engineered layers to prevent precipitation infiltration. The cap for this Site would need to be the later design. Design and construction of a cap takes several months, depending on the size of the area, the complexity of the design and the availability of materials and equipment.

The primary benefit of a cap is its ability to prevent precipitation from infiltrating into an E&T system and thus decreasing the amount of contaminated groundwater to be extracted and treated. The more impacted groundwater that needs extraction and treatment, the longer a corrective action will take to meet the GPS and the more it will cost.

Site Considerations: The performance and effectiveness of a cap are based on design, appropriate construction materials and complete coverage of waste area. Low areas in the topography will need to be filled before capping to provide the proper slope for drainage.

Depending on the footprint of the waste and groundwater contamination, capping may require the elimination of the ponds and wetlands on Harbor Island. Removal of these features would eliminate significant areas of surface water infiltration, eliminate both human health and ecological exposure pathways, and provide source control, while also decreasing both the cost and time needed for the cleanup.

When used in combination with other corrective measure alternatives to help achieve the corrective action objectives, capping is an effective method and will be retained for further evaluation.

5.3 Summary of Potential Corrective Measures Alternative Evaluation

Following consideration of the evaluation criteria for each potential alternative in **Section 5.2**, this section presents the recommended groundwater corrective measure alternatives to be evaluated further to support remedy selection. It should be noted that in-situ treatment by injection or via permeable reactive barrier (PRB) was also considered but not evaluated because there is no proven technology to treat PFAS in-situ.

As stated in **Section 5.2**, a common component of the alternatives is source removal or SS of CCR from the inactive Units 1/2 Impoundment and the former Unit 3 A/B Impoundments. Combined with source control, the following corrective measure alternatives were retained for further evaluation and potential remedy selection:

- Source control through removal and/or SS of source material from Units 1/2 Impoundment, Unit 3 A/B Impoundments and other areas as needed.
- Containment wall (Interlocking sealed steel sheet pile wall and/or slurry wall).
- Hydraulic containment by Extraction and Treatment (E&T).
- Capping.

Additionally, an adaptive management strategy will be implemented at the Site focused on continual plume management, remedy performance evaluation, and improvements. As data collection, source control, and groundwater corrective measures are implemented, groundwater conditions will continue to be monitored and results interpreted. Provided in **Table 12** is a cross check of each proposed remedy with the federal standards set forth at 40 CFR 257.97(b). Any additional data collection needs will be identified, and corrective measure adjustments will be made as necessary to achieve corrective action objectives within a reasonable time frame.

There are no stand-alone alternatives available to address the CCR and PFAS groundwater impact. However, by assembling several alternatives that work together a remedy may be developed. The corrective measure alternatives listed in **Table 12** is that assemblage of alternatives and must be evaluated accordingly.

Table 11. Evaluation of Potential Remedial Alternative Measures

Corrective Measure Alternative	Description	Performance	Reliability	Ease of Implementation	Potential Impacts of the Alternative	Time to Implement Alternative	Time to Achieve GPS at Compliance Points	Institutional Requirements	Overall Score	Screening Outcome
Hydraulic Containment by Extraction and Treatment (E&T)	Hydraulic containment with extraction and treatment (E&T) is the use of groundwater extraction to induce a hydraulic gradient for capture or control of impacted groundwater. Extraction wells and/or trenches can be used to capture groundwater for ex-situ treatment prior to being discharged to a receiving water feature, reinjection to the aquifer, evaporation, or reuse. Groundwater extraction is applicable as a means of hydraulic control in the site geology and treatment of impacted groundwater.	E&T removes Appendix IV constituents and PFAS from the environment and has been proven to actively provide hydraulic control and have the ability to achieve GPS for these constituents at point(s) of compliance. E&T removes constituents in groundwater through treatment. Additional assessment activities are needed to assess potential performance of E&T, including performing pump tests capture zone analysis in additional areas of collection and treatment and flow model simulations for optimization. Effective PFAS removal processes will be identified during design. These processes include granular activated carbon, ion exchange resins, and high-pressure membrane systems.	E&T is a reliable hydraulic containment and treatment technology. This alternative is dependent on engineering and institutional controls. System operations and maintenance is key to providing optimal performance and uninterrupted operation, This alternative has no operational reliability issues that may arise for the alternative that will limit its use or effectiveness in meeting corrective action objectives. There is sufficient access for installation of extraction wells onsite. No offsite wells are anticipated to be needed at this time. Treatment of groundwater may be conducted onsite, offsite at the POTW or a combination of both. The location of a treatment system may need to be onsite so source removal and other site activities will need to be considered when locating an onsite treatment system.	Design and installation of E&T system is straight forward. E&T has a low degree of difficulty associated with its construction. Access to the Site is under the control of the city. Approvals and/or permits can be obtained for these activities as needed. The construction equipment needed is common and locally availability. Extraction wells may be both under and outside the impoundment footprint as prescribed by modeling. The hydraulic conductivity and the relatively shallow depth of the upper aquifer and Island geology are well suited for effective E&T. This will allow the remedy to meet performance criteria everywhere in the plume. Both onsite and offsite treatment services are possible and available.	Removal of ponds and wetland areas may be necessary to prevent infiltration of precipitation/surface water which will make the E&T less effective and increase both cost and time or remediation. Access to areas of Harbor Island will be restricted. Road and area closures with fencing to restrict access. NPDES permit for discharge to the river may be necessary or a permit for discharge through the POTW or offsite treatment.	12 to 24 months Time to implement will largely depend on pre-design investigation activities, modeling, and engineering as well as permitting and Agency approvals. Time required to obtain permit approval for selected discharge method of treated water could extend implementation time frame.	>30 years Can be implemented concurrently with removal source control to expedite groundwater remediation. Remedy completion is dependent on removal of sources and implementing a combination of alternatives that work together to provide hydraulic control and groundwater treatment.	May require environmental covenant or deed restrictions to control groundwater use until GPS have been achieved. Fencing will be necessary on a temporary basis during construction and possibly duration of remediation in some areas. NPDES permits may be necessary and permits for wetlands work as well.	19	Retained for further analysis. Not stand-alone alternative.
	Evaluation Score (1-3):	3	3	3	2	2	3	3		

Table 11. Evaluation of Potential Remedial Alternative Measures

Corrective Measure Alternative	Description	Performance	Reliability	Ease of Implementation	Potential Impacts of the Alternative	Time to Implement Alternative	Time to Achieve GPS at Compliance Points	Institutional Requirements	Overall Score	Screening Outcome
Surface Capping	Capping involves placing a cover over contaminated materials such as contaminated soils or sediments. Caps don't destroy or remove contaminants. Instead, they isolate the contamination and keep them in place to avoid the spread of contamination. Capping prevents infiltration of precipitation and will increase the efficiency of the E&T, reduce the cost of water treatment, and reduce the time of remediation.	Caps are a proven method to inhibit contaminant movement through the environment Caps prevent infiltration of rain and snow melt from seeping through the material and carrying contaminants to the groundwater. Caps prevent stormwater runoff from carrying contaminants off-site into lakes and rivers and prevents wind from blowing contaminants off-site. Keeps people and wildlife from coming into contact with contaminants.	When properly built and maintained, a cap can safely keep contaminants in place and prevent contaminant migration to groundwater. This alternative is dependent on engineering and institutional controls to maintain the alternative. It requires ongoing general minimum maintenance of the cover but has no operational reliability issues that may arise for the alternative that will limit its use or effectiveness in meeting corrective action objectives.	Cap design and implementation are straight forward. Capping has a low degree of difficulty associated with its construction. Access to the areas is under the control of the city. Approvals and/or permits can be obtained for these activities. The construction equipment needed is common and locally availability. The materials for construction are also readily available.	Potential impacts to the community or environment from cap construction will be low. Access restrictions, dust suppression, erosion controls will be in place to minimize any potential impacts. Transportation routes for equipment and materials will all be controlled and monitored. Caps will eliminate the possibility of direct contact to waste, reducing or eliminating both human health and ecological risk pathways. Construction of the cap will modify the surface of Harbor Island eliminating potential contact with contamination and would eliminate the contaminated ponds and wetlands that act as attractive nuisance to humans and animals.	10 to 20 months The design and construction of the cap is straight forward. However, remedy completion is dependent on implementing a combination of alternatives that work together to provide hydraulic control and treatment.	> 30 years Will reduce time of compliance and cost of remedy. Can be implemented concurrently with removal source control to expedite groundwater remediation.	Fencing may be necessary on at least a temporary basis during construction and possibly for the duration of remediation in some areas. Wetland delineation and rehabilitation or removal and replacement may be needed.	20	Retained for further analysis. Not stand alone alternative.
	Evaluation Score (1-3):	3	3	3	3	3	3	2		

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Table 11. Evaluation of Potential Remedial Alternative Measures										
Corrective Measure Alternative	Description	Performance	Reliability	Ease of Implementation	Potential Impacts of the Alternative	Time to Implement Alternative	Time to Achieve GPS at Compliance Points	Institutional Requirements	Overall Score	Screening Outcome
Monitored Natural Attenuation (MNA)	MNA relies on natural attenuation processes to achieve corrective action objectives within a reasonable time period at lower cost relative to more active methods. Depending on site-specific conditions, MNA can effectively reduce dissolved concentrations of inorganic constituents in groundwater through sorption, mineral precipitation, or oxidation-reduction reactions. Regular monitoring of select groundwater monitoring wells for specific parameters is required to ensure COC concentrations in groundwater are attenuating over time. Dilution from recharge to shallow groundwater, mineral precipitation, and COC adsorption will occur over time, thus reducing COC concentrations through attenuation.	MNA is a way to remove CCR constituents from the environment through natural attenuation processes. The processes are likely to be more physical than chemical. Chemical attenuation is not typically as prominent in the Site geology. MNA removes CCR constituents from the environment and under certain conditions has the ability to achieve GPS for these constituents at point(s) of compliance. Short retention time of impacted groundwater in the aquifer before discharging to the river may not be suitable for MNA processes to be successful. Another consideration is PFAS contamination in the CCR impacted groundwater. There is no data that supports MNA for PFAS.	Under appropriate aquifer conditions, MNA is reliable and can be used as either a stand-alone corrective measure or in combination with other technologies. However, the unique Island setting and groundwater flow to surface water at the site is not ideal for MNA. MNA alternative is dependent on engineering and institutional controls to maintain the alternative. System operations and maintenance is key to providing optimal performance and uninterrupted operation, Fowling of well points and equipment issues will limit its use or effectiveness in meeting corrective action objectives. No PFAS treatment.	Easily implementable but requires additional upfront data and documentation to confirm attenuation capacity is sufficient to meet GPS within a reasonable time frame. New groundwater monitoring network will be needed for MNA performance monitoring. However, some of the existing network may be used. Access to the Site is under the control of the city. Approvals and/or permits can be obtained for these activities as needed. Will require environmental covenants or deed restrictions for areas where groundwater is above GPS for CCR and PFAS.	MNA potential impacts to the community or environment will be low. Access restrictions, dust suppression, erosion controls will be in place to minimize any potential impacts. Transportation routes for equipment and materials will be controlled and monitored. MNA relies on natural processes in the aquifer matrix to reduce COCs in groundwater without additional site disturbance but cannot address PFAS.	12 to 24 months New monitoring infrastructure will be needed. Demonstrating attenuation mechanisms and capacity can be time consuming especially given the complex groundwater flow.	>30 years Following source control and pending a tiered MNA evaluation, MNA may not be successful within a reasonable time frame. Intensive groundwater monitoring will be necessary to verify COC concentrations in groundwater are decreasing over time. Will not achieve GPS for PFAS at compliance points.	Will require environmental covenant or deed restrictions if there are areas where groundwater is above GPS for CCR or PFAS.	10	Not retained for further analysis.
	Evaluation Score (1-3):	1	1	2	1	2	1	2		

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Table 11. Evaluation of Potential Remedial Alternative Measures										
Corrective Measure Alternative	Description	Performance	Reliability	Ease of Implementation	Potential Impacts of the Alternative	Time to Implement Alternative	Time to Achieve GPS at Compliance Points	Institutional Requirements	Overall Score	Screening Outcome
Source Control (Removal and/or Solidification & Stabilization)	The key component to any corrective measure is source control. This is accomplished by removal and/or Solidification & Stabilization (ISS) of the CCR waste from the (1) inactive Units 1 / 2 Impoundment, (2) the former Unit 3 A/B Impoundments, and (3) other areas such as PFAS source areas. This is one of the first corrective measure alternative implemented. Both removal and ISS may be used to meet the corrective action objectives at the Site. Solidification involves injecting a binding agent and water into the waste while mixing it together with a large auger driven by a crane. The binding agent is a cement-like substance that makes loose material stick together and form a block trapping the contaminants inside the block. Stabilization uses the same process only the agent causes a chemical reaction changing their form preventing them from migrating.	Removal of the waste removes the source of the CCR COCs and PFAS COCs from the environment preventing any future leaching into groundwater. Eliminating the source of CCR and PFAS COCs helps maximize the groundwater cleanup effectiveness of other measures such as E&T.	The removal or ISS of the source material is a key component to any successful corrective action. It is permanent and eliminates ongoing migration of CCR constituents from known sources. This alternative is not dependent on engineering and institutional controls to maintain the alternative, does not require replacement or maintenance of components of the alternative and has no operational reliability issues that may arise for the alternative that will limit its use or effectiveness in meeting corrective action objectives. Removal can eliminate PFAS from known sources, but ISS will not address the PFAS in groundwater.	Source control has a low degree of difficulty associated with its construction. Access to the areas is under the control of the city. Approvals and/or permits can be obtained for these activities. The construction equipment needed is common and locally available. There is available capacity at local disposal services. The excavation of source materials is straightforward and uses common construction equipment to eliminate the ongoing migration of contaminants and risk pathways. Source removal would likely require dewatering, water treatment for PFAS and CCR COCs, and potentially an NPDES permit for discharge or permit to discharge into a POTW. This alternative could include the installation of a hydraulic barrier like sheet piling in order to decrease the volume of water required to be managed. ISS uses mechanical mixing of agents such as cement. It uses common construction equipment to eliminate the ongoing migration of contaminants.	Potential impacts to the community or environment will be low. Access restrictions, dust suppression, erosion controls will be in place to minimize any potential impacts. Transportation routes for equipment, materials and waste will all be controlled and monitored. Removal and ISS can eliminate the potential ecological risk and human health risk pathways that potentially exist. Removal may modify the surface of Harbor Island and could result in faster cleanup at less cost. ISS will leave the CCR or solid waste in place as a cemented block preventing impacts to groundwater resulting in faster cleanup at less cost.	9 to 18 months The removal is straight forward and takes the least amount of time of all the alternative to complete. ISS is also straightforward and relatively quick to implement. The most significant time component for implementation is associated with permitting, such as discharge permitting from dewatering or wetland disturbance.	>30 years Removal of the sources will reduce the time to achieve GPS at compliance points, reduce the cost of other corrective actions and eliminate the direct contact risk pathway. Removal can be implemented concurrently with implementation of other alternatives addressing groundwater remediation. ISS will reduce the time to achieve GPS at compliance points for CCR, reduce the cost of other corrective actions and eliminate the direct contact risk pathway. ISS also eliminates the need for excavation and costly dewatering, further reducing the overall cost of corrective measures. ISS can also be implemented concurrently with implementation of other alternatives addressing groundwater remediation.	Fencing may be necessary, at least on a temporary basis during construction and possibly for the duration of corrective action in some areas. CCR removal in a delineated wetland would require wetland disturbance permits from EGLE, which can take a year or more.	19	Retained for further analysis. Not a stand-alone alternative.
	Evaluation Score (1-3):	3	3	3	3	3	2	2		

Table 11. Evaluation of Potential Remedial Alternative Measures

Corrective Measure Alternative	Description	Performance	Reliability	Ease of Implementation	Potential Impacts of the Alternative	Time to Implement Alternative	Time to Achieve GPS at Compliance Points	Institutional Requirements	Overall Score	Screening Outcome
Containment Wall (Interlocking Sealed Steel Sheet Pile and/or Slurry Wall)	Two types of containment walls are under consideration. Interlocking sealed steel sheet pile containment wall or slurry wall (Walls) will provide a barrier to impacted groundwater flow and prevent future off-site migration of dissolved COCs. These Walls will also provide a barrier to unimpacted surface and groundwater reducing the volume of water being treated by the E&T to achieve corrective action objectives within a reasonable period at lower cost. In general, a wall keyed into the top of the confining layer would be designed to provide containment and would be combined with groundwater extraction (E&T) for hydraulic control and treatment.	Hydraulic barriers remove Appendix IV constituents and PFAS from the environment through isolation provided by containment walls such as interlocking sealed steel sheet pile containment wall or slurry wall. These alternatives are a proven technology for groundwater cutoff and containment having the ability to achieve GPS for these constituents at point(s) of compliance when teamed with E&T and given the proper site conditions (i.e., site geology, depth to low permeability key-in layer). These favorable conditions exist at the Site.	Reliability of the containment wall is dependent on proper engineering. Institutional controls to maintain the alternative are not anticipated to be necessary. Wall maintenance is key to providing optimal performance and uninterrupted operation. This alternative has no operational reliability issues that may arise for the alternative that will limit its use or effectiveness in meeting corrective action objectives. Hydraulic containment will require E&T to manage groundwater mounding. Another benefit to the wall is the prevention of surface water from the river and unimpacted groundwater entering the groundwater capture area, becoming impacted, and requiring treatment. The interlocking sealed steel sheet pile containment wall and slurry walls both have provide performance records.	Containment walls have a low degree of difficulty associated with their construction. Access to the Site is under the control of the city. Approvals and/or permits can be obtained for these activities as needed. The construction equipment needed is common and locally available. The interlocking sealed steel sheet pile is the most versatile and easiest to implement of all the containment walls technologies. This type of wall can be constructed at the edge of the island or in the river and requires no excavation or hydraulic management. Slurry wall construction will require hydraulic control of groundwater and surface water infiltration. This is a routine activity with the potential to increase the cost because the Site is on an island.	Containment walls are intended to change groundwater flow patterns. However, there are no wells on the island for this change to effect. Wetland hydrology may be affected by changes in groundwater flow patterns.	12 -18 months Time to implement will depend on per-design investigation activities, modeling, and engineering as well as permitting and Agency approvals.	>30 years Remedy completion is dependent on implementing a combination of alternatives that work together to provide hydraulic control.	May require environmental permits for work in wetlands or river. Fencing will be necessary on a temporary bases during construction and possibly duration of remediation in some areas.	19	Retained for further analysis. Not stand-alone alternative
	Evaluation Score (1-3):	3	3	3	3	2	2	3		

Table 12. Checklist of Requirements Per 40 CFR §257.97(b)		
Corrective Measure Alternative	Remedy Selection Standards per 40 CFR §258.97(b)	Standards Met by Remedy? (Y/N)
CCR Source Control (Removal and/or Solidification and Stabilization)	Protective of human health and the environment	Y
	Attain groundwater protection standard(s)	Y
	Control the source(s) of releases to reduce or eliminate, to the maximum extent practicable	Y
	Removal of released constituents that may pose a threat to human health and the environment	Y
	Comply with standards for management of wastes as specified in 40 CFR 258.58(D)	Y
Hydraulic Containment and Treatment (Extraction and Treat (E&T))	Protective of human health and the environment	Y
	Attain groundwater protection standard(s)	Y
	Control the source(s) of releases to reduce or eliminate, to the maximum extent practicable	Y
	Removal of released constituents that may pose a threat to human health and the environment	Y
	Comply with standards for management of wastes as specified in 40 CFR 258.58(D)	Y
Containment Wall (Steel Sheet Pile Wall and/or Slurry Wall)	Protective of human health and the environment	Y
	Attain groundwater protection standard(s)	Y
	Control the source(s) of releases to reduce or eliminate, to the maximum extent practicable	Y
	Removal of released constituents that may pose a threat to human health and the environment	Y
	Comply with standards for management of wastes as specified in 40 CFR 258.58(D)	Y
Capping	Protective of human health and the environment	Y
	Attain groundwater protection standard(s)	Y
	Control the source(s) of releases to reduce or eliminate, to the maximum extent practicable	Y
	Removal of released constituents that may pose a threat to human health and the environment	Y
	Comply with standards for management of wastes as specified in 40 CFR 258.58(D)	Y

5.4 Remedial Investigation Needs

Collection of data to date has been for the Site investigation and characterization. Additional data and analysis may be required to perform a thorough Site-specific evaluation of the potential groundwater corrective measures prior to remedy selection. The measures described herein are included for consideration. In order to determine site-specific feasibility of these alternatives, remedial investigation data will be collected. Priority will be given to fill data gaps for the recommended corrective measure alternatives to support remedy selection. Below is a summary of additional data needs that have been identified to date. The anticipated timelines provided may be impacted by available funding and approvals. A summary of the anticipated timeline to conduct the remedial investigation needs is provided in **Table 13**.

Potential Ash Characterization and Ash Delineation

As noted in **Section 4.2.1**, the characterization of the ash within Units 1/2 Impoundment was limited. Analysis of additional ash samples may be needed to develop remedial alternatives. Samples may be collected and analyzed for leachate and sediment properties by a contracted laboratory. Sample volume will also be provided to contractors for bench testing for design of ISS methods. The anticipated timeline of this task is 4th quarter 2024.

Facility Evaluation for Potential CCRMU

As discussed above, the boundaries of the Units 1/2 Impoundment were unclear and potentially could include parts of the North Channel. Recently, in a July 12, 2024 email, EGLE and EPA determined that the former north outlet channel would not be considered part of the Units 1/2 Impoundment, and would not be considered a release from the Units 1/2 Impoundment. This area will be evaluated under the new the CCR Legacy Rule, and that is anticipated to be conducted 4th quarter 2024.

Aquifer Testing

Additional slug testing was completed in the 3rd quarter of 2024, however the analysis is incomplete and further analysis is anticipated for late 3rd quarter 2024. In order to design an efficient aquifer pump test, slug test data is required. A pump test will be implemented to collect hydrogeologic data to evaluate the feasibility of groundwater extraction at the Site and later to support design of a groundwater extraction and treatment (GWET) system. Initial information needed to support design of a GWET system includes determining sustainable yield, determining potential capture zone for extraction wells, and obtaining additional aquifer characterization data. The anticipated timeline for this task is 2nd quarter 2025.

Subsurface Utility Exploration

A survey will be conducted to locate subsurface utilities that may provide preferential pathways for migration of impacted groundwater. The anticipated timeline for this task is the 4th quarter 2024.

Expansion of the Monitoring Well Network

As noted in **Section 4.3**, the GPS exceedances to date indicate that further expansion of the monitoring well network may be necessary in few locations to further delineate and refine the plume location, including the following areas:

- MW-39 and MW-13 will be added as nature and extent wells for Unit 3A/B Impoundments; and
- North of MW-10 for Units 1/2 Impoundment and Unit 3A/B Impoundments.
- The area around MW-07 and MW-08 may need further investigation to determine the source and extent of CCR COCs.

The existing well locations of MW-13 and MW-39 will be sampled during the 4th quarter assessment monitoring event. Monitoring wells deemed necessary to refine the CCR contaminant plumes will be installed in the 1st quarter 2025. This work will be completed as additional data is gathered for remedy selection.

Further Delineation of CCR Source Materials

Due to the distribution of groundwater concentrations exceeding GPS, further delineation of source material is required to ensure all potential source areas are addressed prior to selecting a remedial option. The anticipated timeline of this task is 1st quarter 2025.

Nested Monitoring Wells

Since the existing monitoring wells are screened at shallow depths, little is known about the properties of the deep aquifer. The following objectives will be addressed as part of the deep well installation:

- During drilling, soil samples will be collected for containment wall bench testing. Analysis of these samples will include permeability, porosity, and hydraulic conductivity conducted by a subcontracted lab.
- The borehole will be advanced through the shallow aquifer into the anticipated confining unit. Samples of the confining unit material will be retained for permeability, porosity and grain size analysis testing by a subcontracted laboratory for use in development of groundwater modeling.
- At least two monitoring wells will be screened deep within the aquifer and above the confining unit to monitor groundwater flow beneath the Island.
- One monitoring well will be screened within the confining unit to assess the groundwater flow within the suspected confining unit.
- Deep monitoring wells will be paired with existing shallow monitoring wells to evaluate the horizontal hydraulic gradient.

The anticipated timeline for the task above is 1st quarter 2025.

Sediment Bench Testing

Bench testing of onsite sediment will be conducted to evaluate in-situ stabilization agents, to inform CCR and PFAS treatment methods, and selection of slurry wall materials. The anticipated timeline to collect material and submit for bench testing is 2nd quarter 2025.

Potential PFAS Delineation

Further delineation of PFAS is anticipated to ensure the selected remedy addresses the areas of potential PFAS contamination. The anticipated timeline for this task is 2nd quarter 2025.

Wetland Function Assessment

Delineation of wetlands on the Island was completed in the 2nd quarter 2024, however additional data may be required to better understand the function of the wetland as a potential contaminant sink, area of surface water infiltration, and understanding the needs and requirements for removal and rehabilitation. The anticipated timeline of this task is 2nd quarter 2025.

Topographical, Light Detecting and Ranging (LiDAR), and Bathymetric Survey

Survey data is required to determine the following:

- Surface configuration of the Island.
- The location and volume of clean fill material.
- Estimate the land surface for designing potential remedial alternative measures.
- The size and depth of each internal water body and wetland as well as depths for the northern wetland, Grand River, and south channel.

The anticipated timeline for this task is 2nd quarter 2025.

Groundwater Model

Due to the heterogeneous nature of the lithology encountered, and the variable flow observed, a groundwater model will be necessary to efficiently design remedial alternatives. The data collection tasks above will be utilized for the refinement of this model. The anticipated timeline of this task is 3rd quarter 2025.

Table 13. Additional Data Need Anticipated Timeline

Data Collection Task	Initiated*
Potential Ash Characterization and Ash Delineation	4th quarter 2024
Facility Evaluation for Potential CCRMU	4th quarter 2024
Aquifer Testing	Pump Test: 4th quarter 2024 Slug Tests: performed in 2nd quarter 2024
Subsurface Utility Exploration	4th quarter 2024
Expansion of Monitoring Well Network	1st quarter 2025
Further Delineation of Source Materials	1st quarter 2025
Nested Monitoring Wells	1st quarter 2025
Sediment Bench Testing	2nd quarter 2025
Potential PFAS Delineation	2nd quarter 2025
Wetland Function Assessment	Initial delineation done in 2nd quarter 2024. Follow on studies to be performed in 2nd quarter 2025.
Topographical, Light Detecting and Ranging (LiDAR), and Bathymetric Survey	2nd quarter 2025
Groundwater Model	3rd quarter 2025

*Dates may be impacted by available funding and city council & GHBLP approvals

5.5 Estimated Schedule

The general conceptual schedule for evaluating additional information to support remedy selection is provided below in **Table 14**. Note, the estimated completion dates may change due to regulatory approvals or unexpected circumstances.

Table 14. Estimated Schedule of Remedy Selection

Action	Estimated Completion Date
Collecting data to fill data gaps	3rd quarter 2025
Remedial Action Plan	4th quarter 2026
Closure Plans and Closure Work Plans for Units 1/2 Impoundment and Unit 3A/B Impoundment.	3rd quarter 2027
Submit Remedy Selection Report	2nd quarter 2027
Additional Data Collection required for Remediation Conceptual Design	2025 - 2026
Evaluation of Remediation Alternatives	2025 -2026
Public Meeting of Remediation Alternatives	30 Days before Remedy Selection
Remedy Selection Report and Remedial Action Plan	2026
Closure Plan – Units 1/2 Impoundment	2026
Closure Plan – Unit 3A/B Impoundments	2026
Remediation Final Design and Remedy Implementation	2026 +

6.0 Next Steps

To select a groundwater remedy, additional data collection and analyses are required to understand COC concentrations and potential onsite and offsite human and ecological receptors. It was determined that the risk from exposure associated with private wells is considered extremely low because there are no drinking water wells on the Island and off-site wells were not in use for drinking water or they are a great distance from the Site. During additional off-site investigation sampling may need to be conducted to confirm the extent of plume stops at the river. Monitoring well installation is scheduled for the second half of 2024 and collection of additional data needs identified for the corrective measure alternatives is being carried forward. Updates will be provided in semi-annual remedy selection progress reports. EGLE and EPA will select a remedy that meets the performance standards listed in 40 CFR §257.97(b) and the evaluation factors listed in 40 CFR §257.97(c) along with applicable provisions of Part 115.

The anticipated schedule and process for remedy selection is as follows, however, this may be impacted by the CCRMU Rule implementation:

- Public meeting pursuant to 40 CFR §257.96(e) and Michigan Administrative Code R 299.4443(4) will be held at least 30 days prior to remedy selection.
- Publish a Remedy Selection Report (RSR). The RSR will include a schedule for final design and how the remedy will be implemented.

- Preparation of a proposed Remedial Action Plan in compliance with R 299.4319(7) of the Part 115 Rules and in compliance with the provisions of Part 201.
- Begin the remedy implementation within 90 days of Remedy Selection Report.
- Once selected, the remedy will be designed, implemented, and continually evaluated in accordance with the adaptive management strategy. Based on evaluation during the phased implementation, additional site characterization needs may be identified, and remedy implementation adjustments will be made as necessary, leading to continuous improvement and optimal remedy performance.

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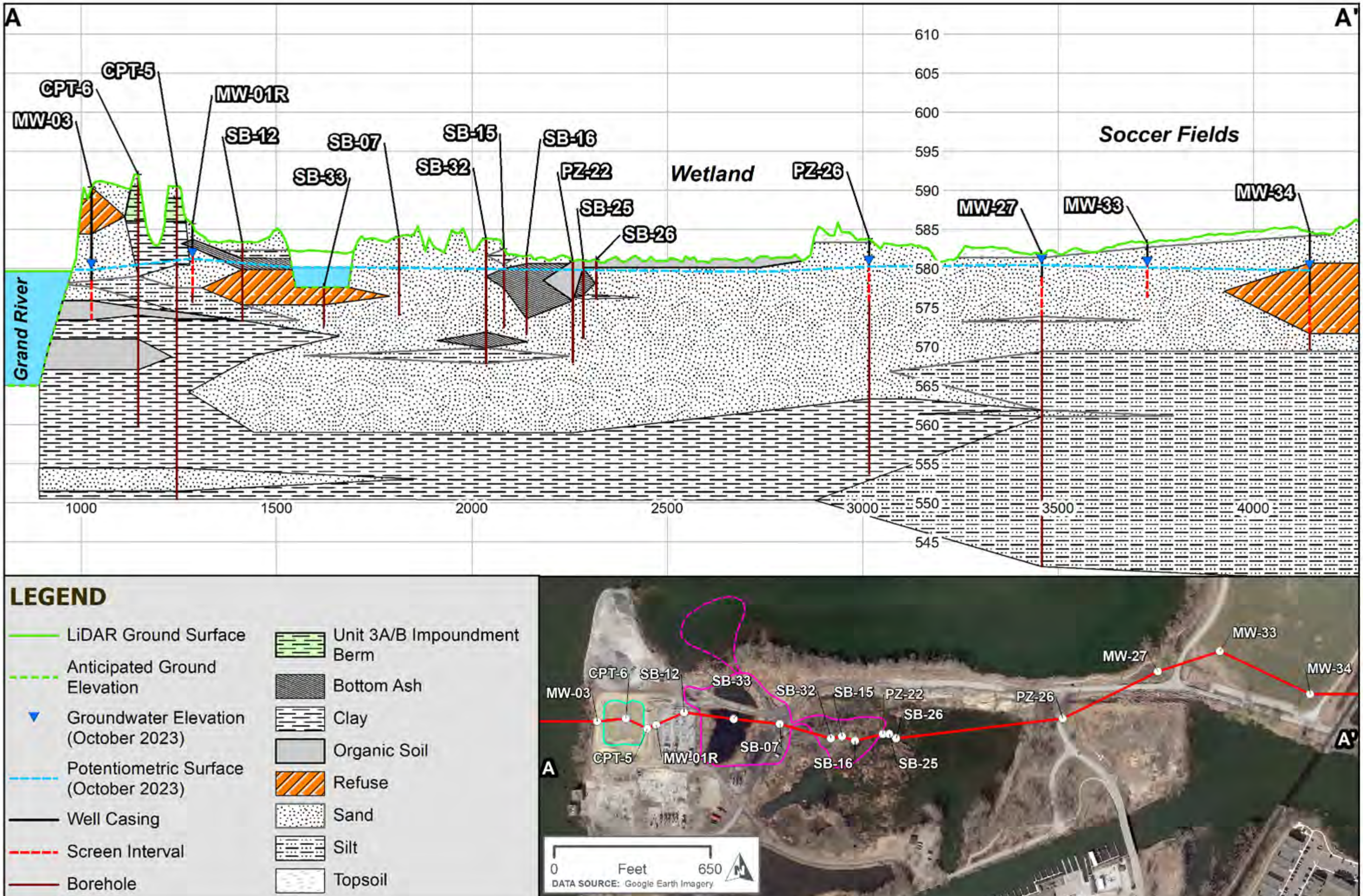
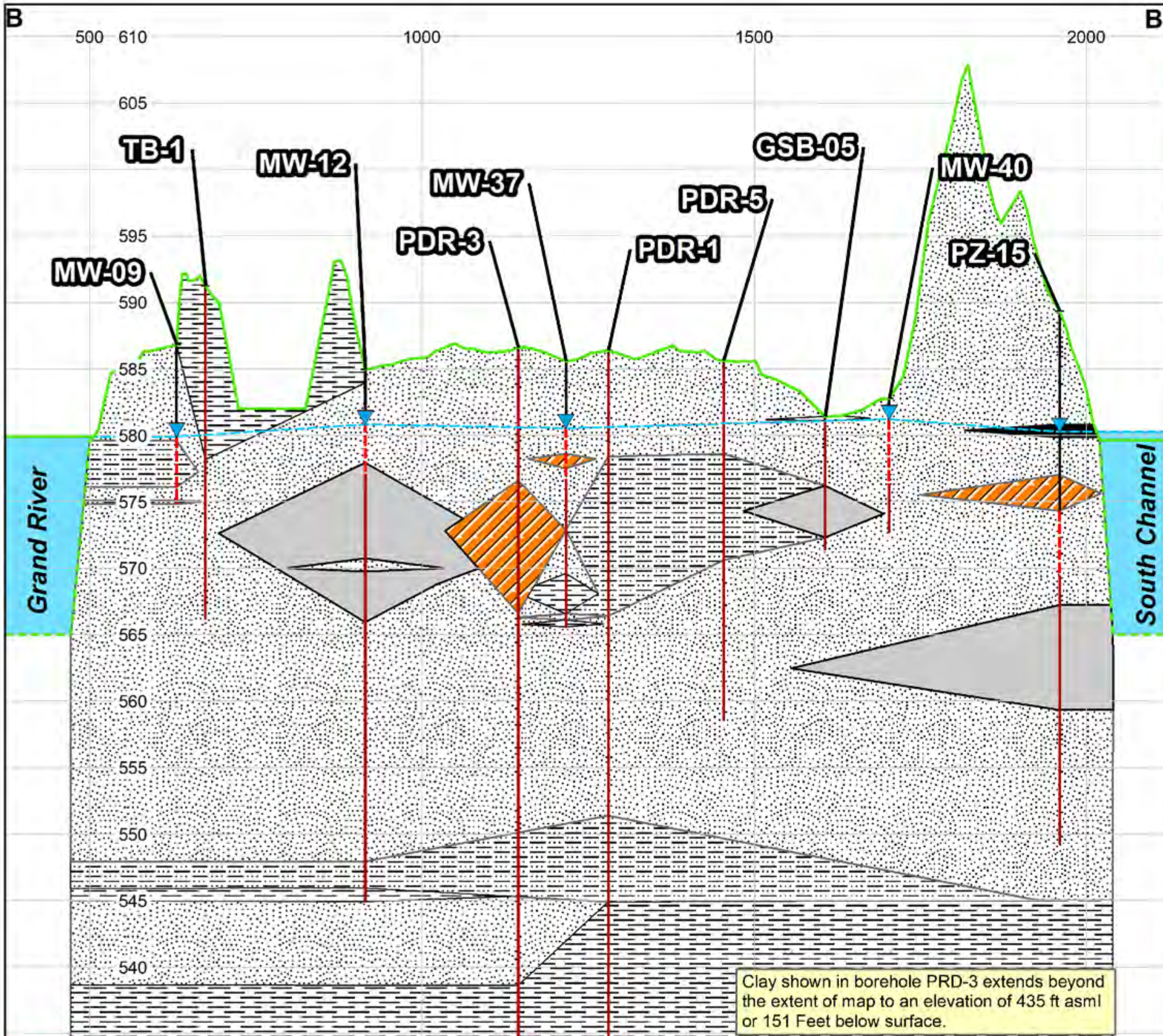
Appendix A

Geologic Cross Sections



FORMER J.B. SIMS GENERATING STATION

GRAND HAVEN, MI



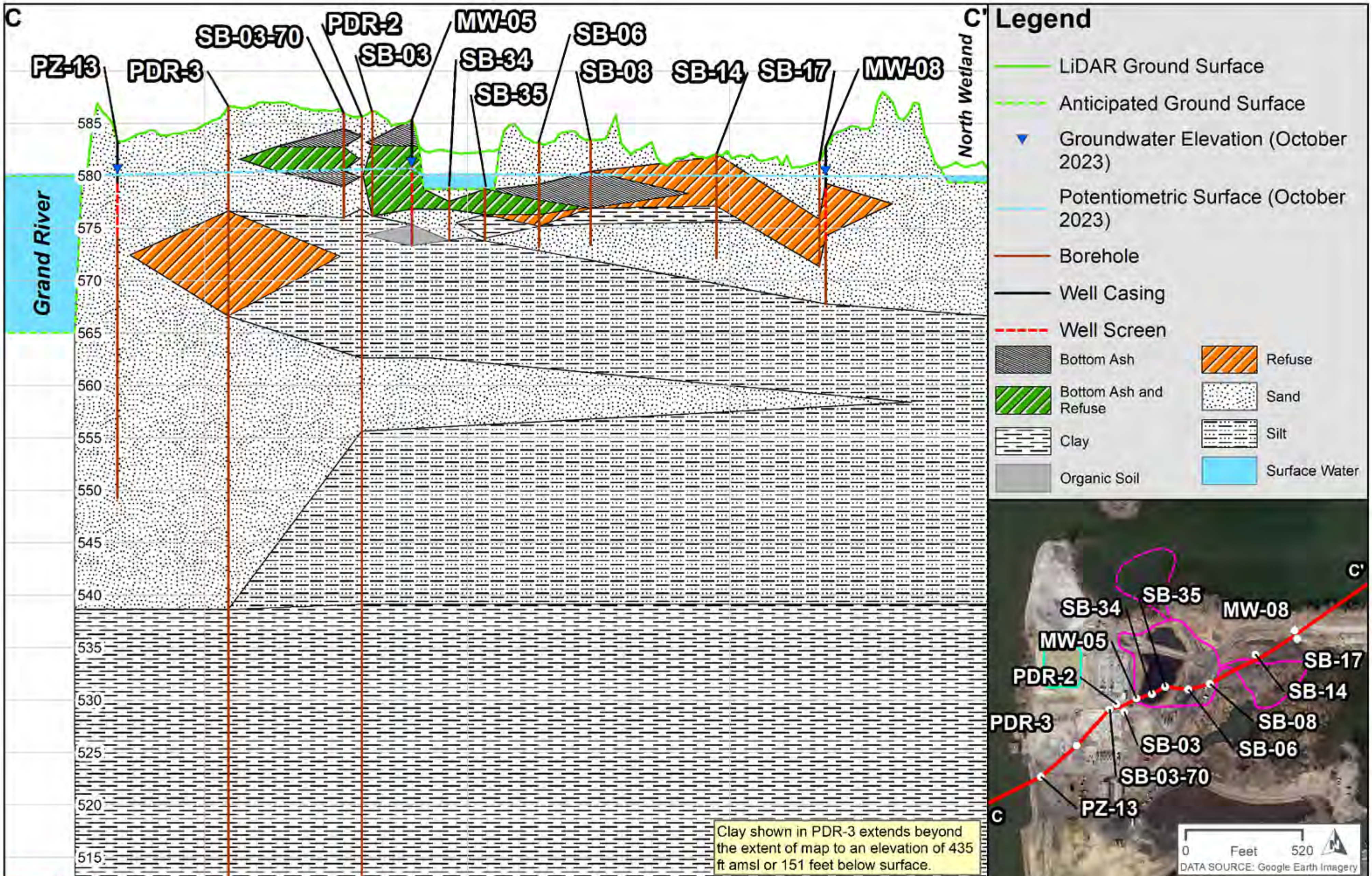
LEGEND

- LiDAR Ground Surface
- Anticipated Ground Surface
- October 2023 Groundwater Elevation
- Potentiometric Surface (October 2023)
- Well Casing
- Screen Interval
- Borehole
- Bottom Ash
- Sand
- Coal
- Silt
- Clays
- Surface Water
- Organic Soil
- Refuse

HDR

FORMER J.B. SIMS GENERATING STATION

GRAND HAVEN, MI



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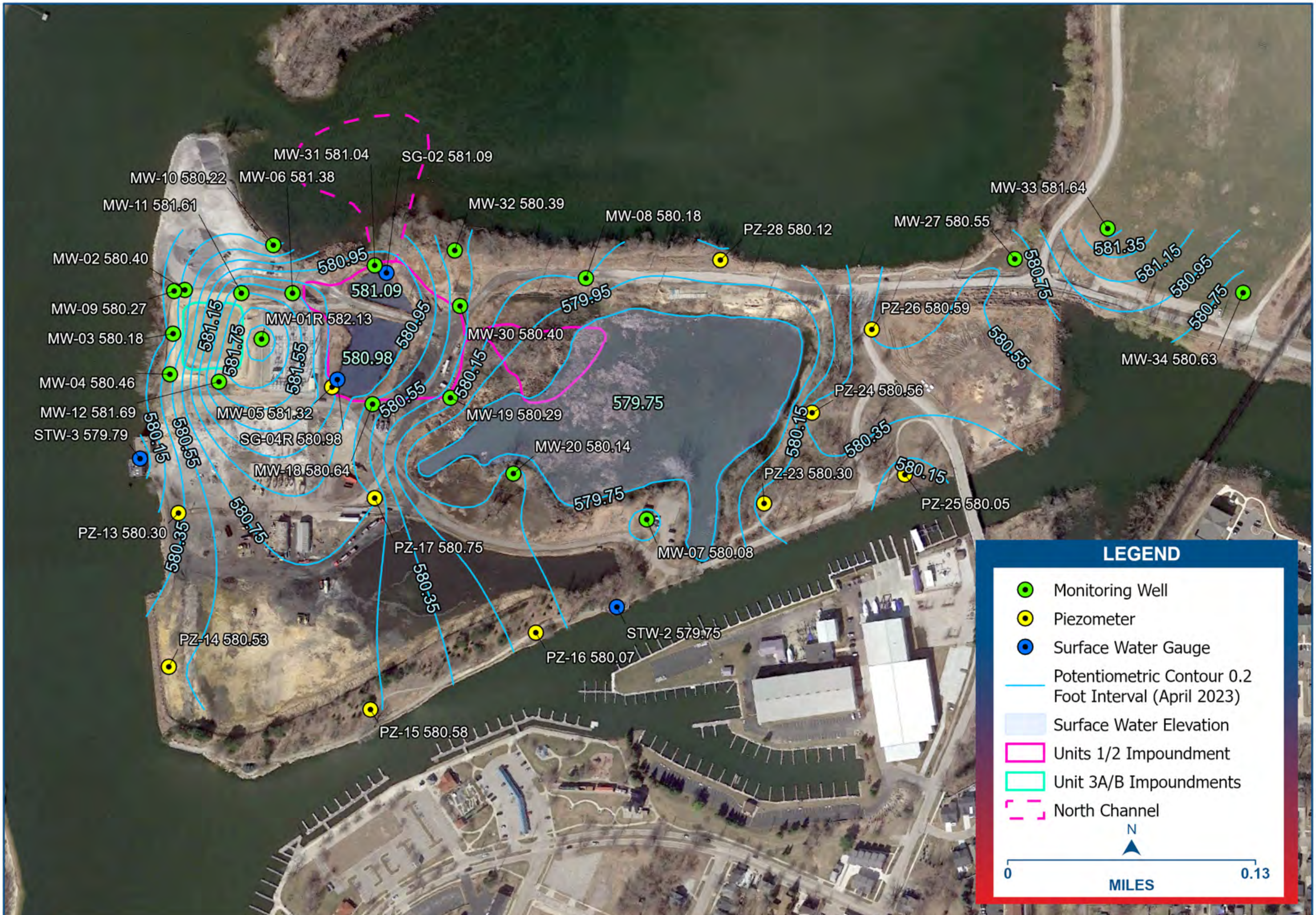
FORMER J.B. SIMS GENERATING STATION

GRAND HAVEN, MI

Appendix B

Potentiometric Contour Maps



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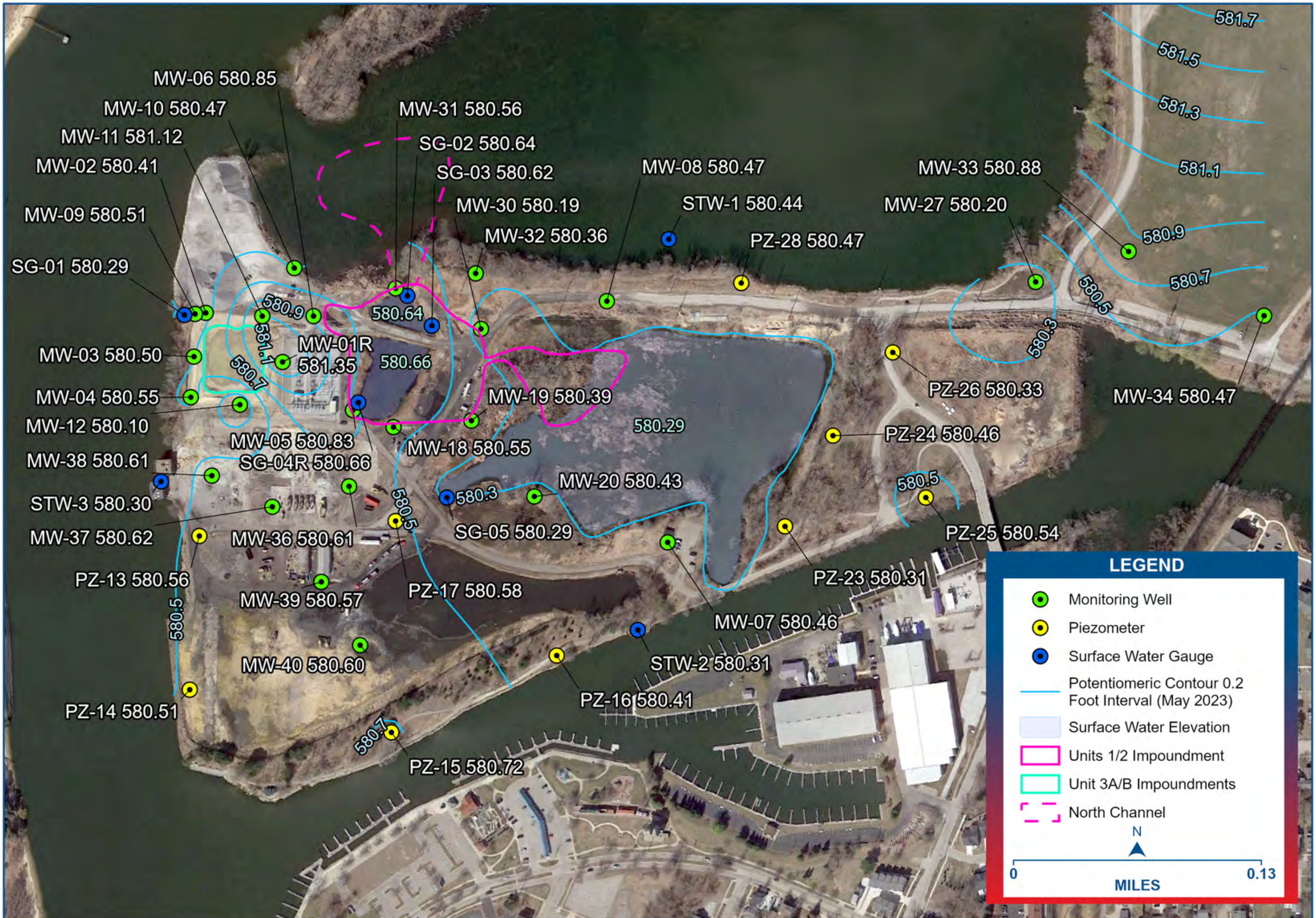
CITY OF GRAND HAVEN



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Renew Harbor Island

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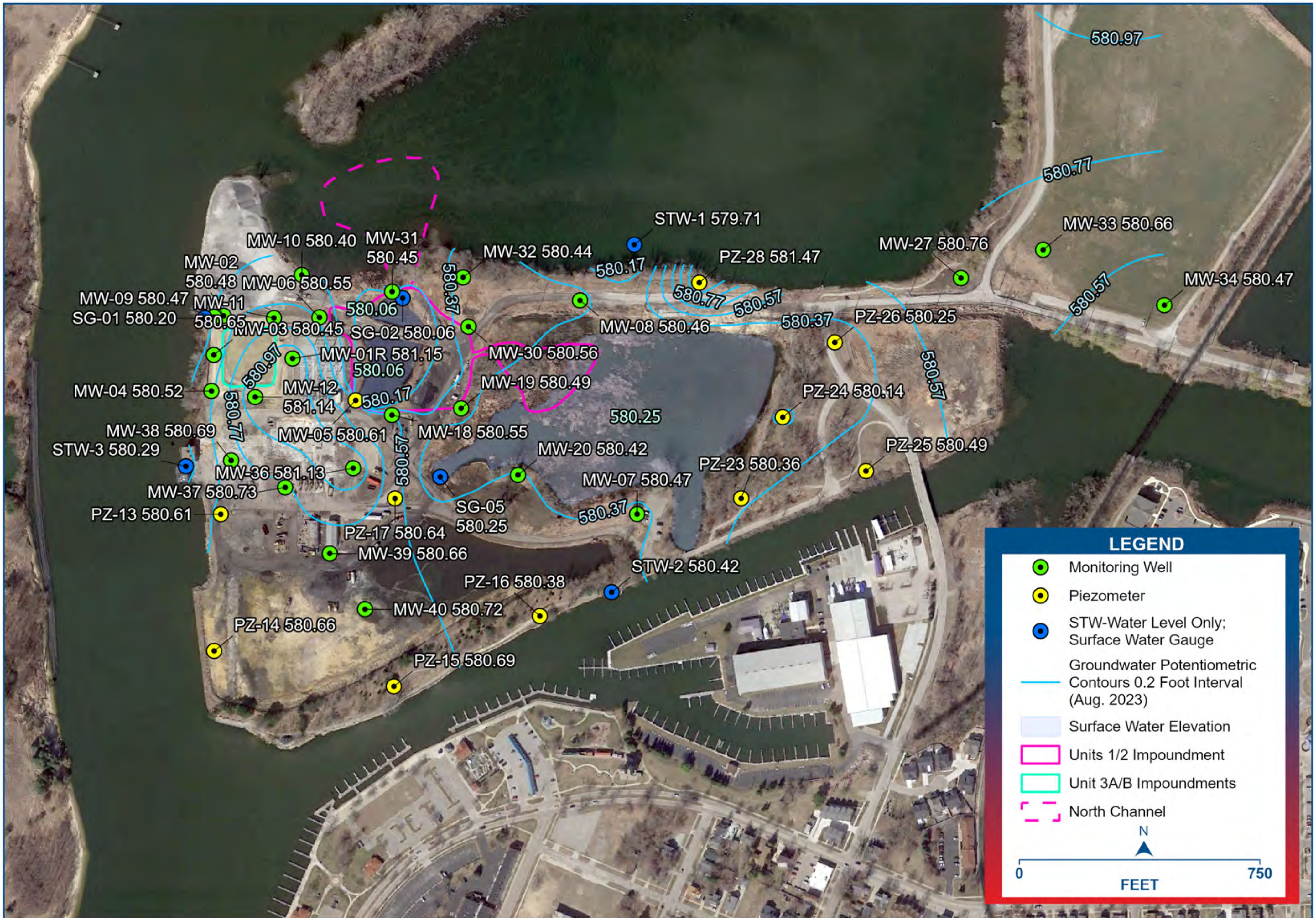
CITY OF GRAND HAVEN



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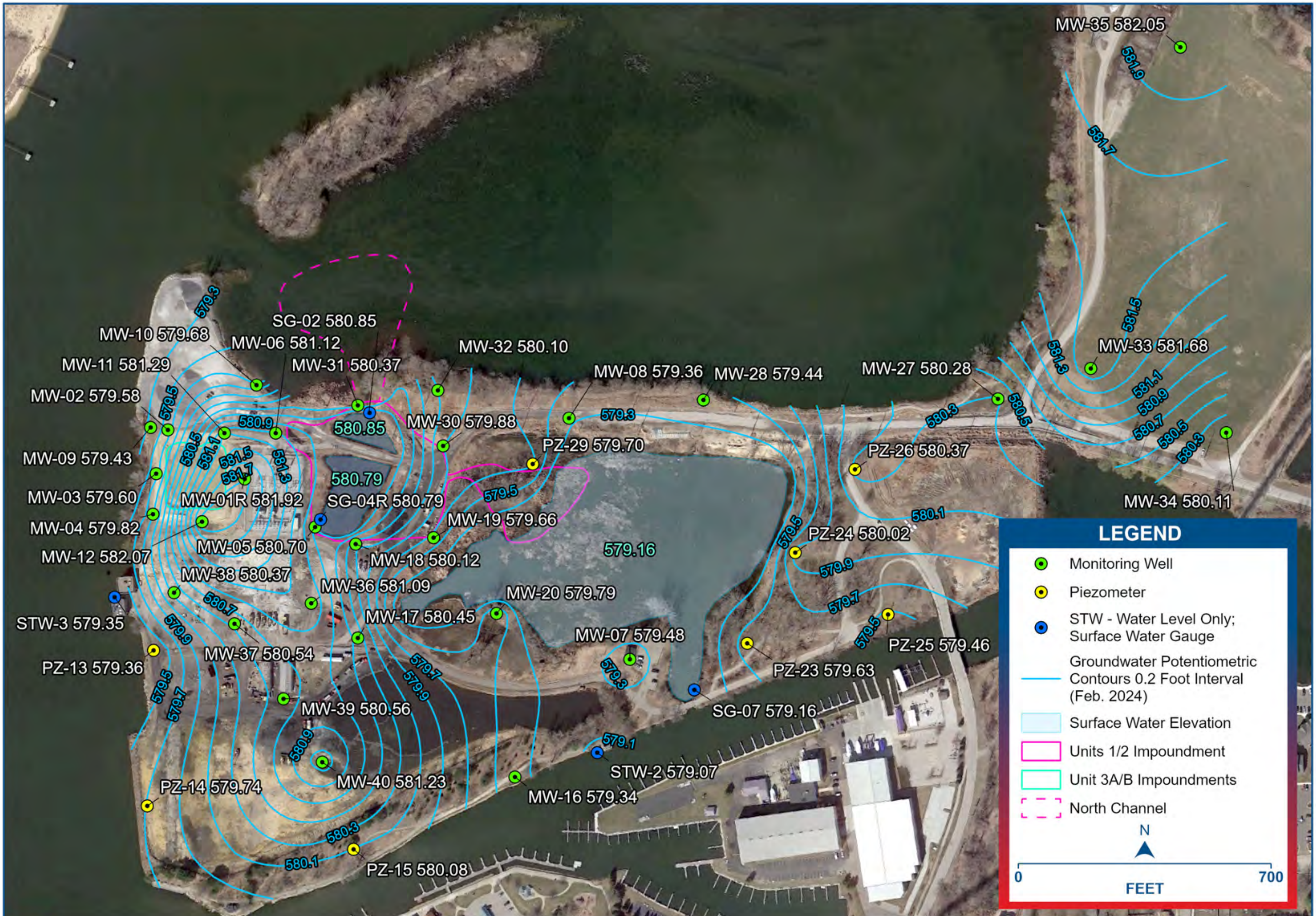

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CITY OF GRAND HAVEN

Appendix C

CCR Constituents of Concern GPS Exceedance Maps

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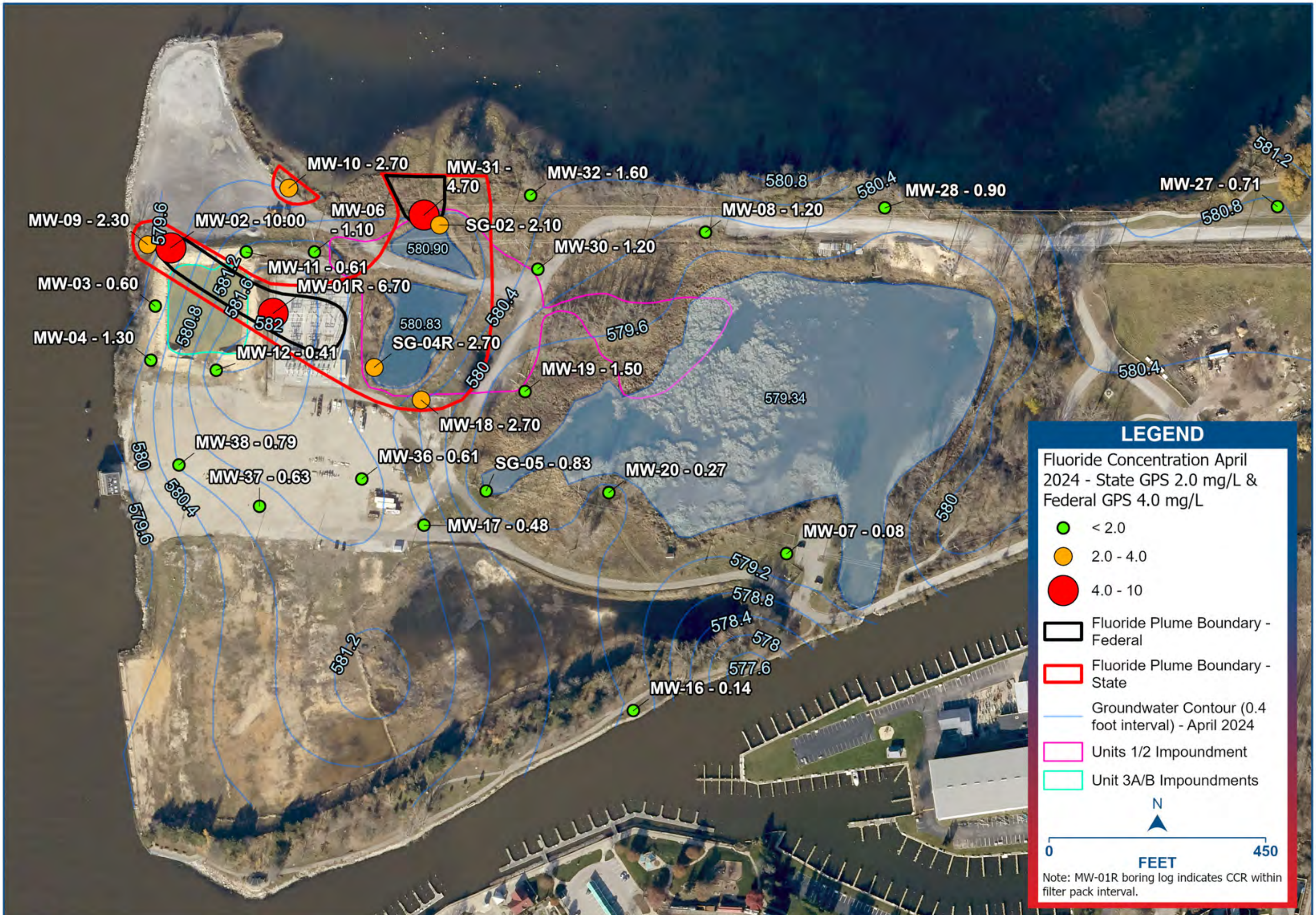

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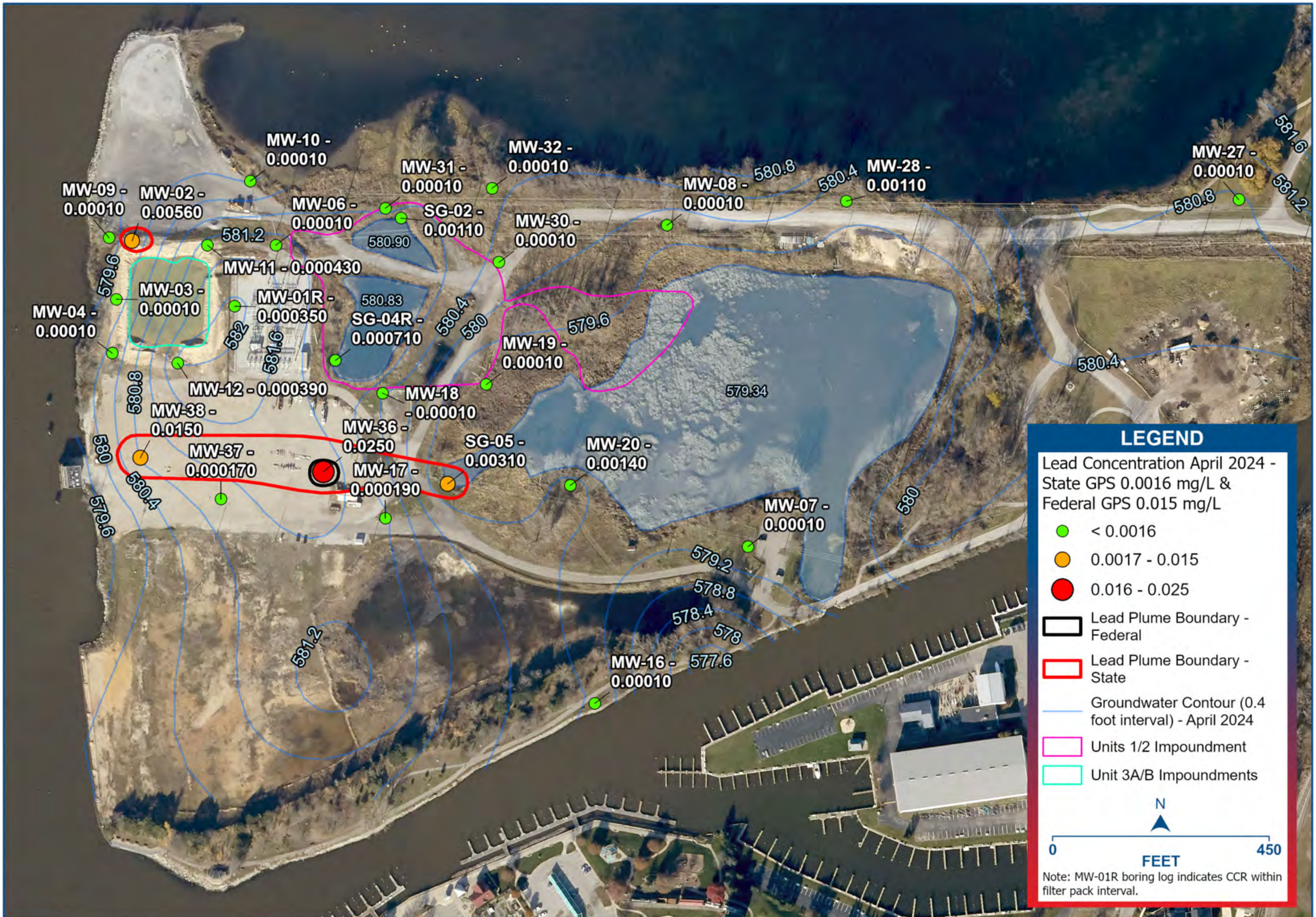

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Appendix D

PFAS Concentration Maps

Document Path: G:\GrandHaven\a_MXD\PFOA_Results_2022_grdsym.mxd

FORMER JB SIMS GENERATING STATION HARBOR ISLAND GRAND HAVEN, MICHIGAN

PERFLUOROOCTANOIC ACID (PFOA) DETECTIONS IN GROUNDWATER NOVEMBER/DECEMBER 2022 AND JANUARY/FEBRUARY 2023

Imagery provided by google

Document Path: G:\GrandHaven\a_MXD\PFOS_Results_2022_grdsym.mxd

PFOS Results (ng/L)
- ND
- >ND - <11
- 11 – 110
- >110

Note:
-Yellow halo indicates exceedance of Groundwater Surface Water Interface (GSI) criteria (Human Noncancer Value - drinking water source)
-Co-Located Sample locations displaying the greater value

Prepared/Date: DGJ 6/2/2023
Checked/Date: DH 6/2/2023

FORMER JB SIMS GENERATING STATION HARBOR ISLAND GRAND HAVEN, MICHIGAN	Renew Harbor Island	PERFLUOROOCTANESULFONIC ACID {PFOS} DETECTIONS IN GROUNDWATER NOVEMBER/DECEMBER 2022 AND JANUARY/FEBRUARY 2023

Imagery provided by google