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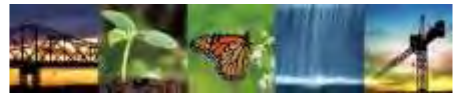

Sent Via Email Only

February 19, 2021
File No. 16.0062961.80

Ms. Karen Vorce, Project Manager
Grand Rapids District Office
Remediation and Redevelopment Division
Michigan Department of Environment, Great Lakes, and Energy
350 Ottawa Avenue NW, Unit 10
Grand Rapids, Michigan 49503
vorcek@michigan.gov

Re: Feasibility Study – Remedial Options
Wolverine World Wide, Inc. – House Street Property
Plainfield Township, Kent County, Michigan

Dear Ms. Vorce:

On behalf of Wolverine World Wide, Inc. (Wolverine), Rose & Westra, a Division of GZA GeoEnvironmental, Inc. (R&W/GZA), is submitting this cover letter and enclosure in response to the referenced Consent Decree, effective February 19, 2020.

This submittal includes the Feasibility Study for remedial options identified in Paragraph 7.8 of the Consent Decree. If you have any questions, please contact us.

Very truly yours,

Rose & Westra, a Division of GZA GeoEnvironmental, Inc.

Loretta J. Powers
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ljp/maw/mms/jcf

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Attachment: House Street Property Feasibility Study

Rose & Westra
A Division of GZA

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FEASIBILITY STUDY – REMEDIAL OPTIONS
HOUSE STREET PROPERTY

1855 HOUSE STREET NE
Plainfield Township, Kent County, Michigan

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Disclaimer: This document is a DRAFT document that has not received approval from the Michigan Department of Environment, Great Lakes, and Energy (EGLE). This document was prepared pursuant to a court Consent Decree. The opinions, findings and conclusions expressed are those of the authors and not those of EGLE.

February 19, 2021
File No. 16.0062961.80

PREPARED FOR:
Wolverine World Wide, Inc.
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ACRONYMS

bgs	Below Ground Surface
CD	Consent Decree, effective February 19, 2020 (No. 1:18-cv-0039-JTN-ESC)
CY	Cubic Yards
EGLE	Michigan Department of Environment, Great Lakes and Energy
FS	Feasibility Study
ft	Feet
GPM	Gallons Per Minute
GAC	Granular Activated Carbon
GSI	Groundwater-Surface Water Interface
HSP	House Street Property
K_{OC}	Organic Carbon-Water Partition Coefficient
MCL	Maximum Contaminant Level
NE	Northeast
OMM	Operation, Maintenance, and Monitoring
PFAS	Per- and Polyfluoroalkyl Substances
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
pKa	Acid Dissociation Constant
PPE	Personal Protective Equipment
R&W/GZA	Rose & Westra, a Division of GZA GeoEnvironmental, Inc.
µg/kg	Micrograms per Kilogram
USEPA	United States Environmental Protection Agency
Wolverine	Wolverine World Wide, Inc.

1.0 INTRODUCTION

R&W/GZA submits this FS on behalf of Wolverine to evaluate options for response activities at the HSP, as required in Section 7.8 of the CD. The FS evaluates the two required options described in the CD: an approximately 30-acre cap and an approximately 20-acre landfill cell. This FS also evaluates four additional options for response activities, including: no further action, excavation and off-site disposal, groundwater pump and treat, and Wolverine's proposed option of phytoremediation plus strategic capping.

1.1 RECOMMENDED RESPONSE OPTION SUMMARY

As set forth in Paragraph 7.8(b) of the CD: "Subject to Section XVIII (Dispute Resolution for MDEQ and Defendant), if MDEQ does not approve of the proposed remedy in the Feasibility Study for the House Street Disposal Site, the final remedy shall be an approximately 30-acre surface cap without a bottom liner." A cap is a cover of varying materials constructed on top of waste. Caps are often found on top of closed landfills. A cap covers contaminated material, but it does not remove or destroy contaminants or lessen the toxicity or volume of the contaminated material. It also does not prevent horizontal movement of water through waste. A cap helps reduce the spread of contamination by preventing rain and snowmelt from seeping through waste material and further impacting groundwater.

Construction of an approximately 30-acre cap at HSP could take as long as three years. To begin, at least 30 acres of the site would be clear cut and grubbed, and after the cap is constructed that area would be replaced with grass but could not be replaced with trees. The cleared and grubbed biomass will be buried and capped or removed from the site for disposal. The site will be graded, and the current topography of the site will be significantly altered to facilitate proper surface drainage away from the cap. It is estimated the HSP will be 6 to 8 feet higher than the current House Street road elevation. During construction there will be increased truck traffic and disturbance. Construction of the cap would involve bulldozers, backhoes, and other noisy equipment, and soil will need to be excavated and relocated onsite.

Once the cap is constructed, the site would resemble a closed landfill, covered in low-lying grass. Portions of the HSP would remain fenced and unavailable for use, to ensure the cap is not damaged from aggressive recreational use (i.e., ATVs, etc.).

In contrast, Wolverine is proposing a mixed remediation option that includes phytoremediation and strategic capping. Phytoremediation is a process demonstrated on many sites, for many contaminants. Numerous studies have shown that a variety of plants accumulate PFAS in both roots and above-ground tissues, with accumulation depending on plant species, type of PFAS, and PFAS soil and water concentrations. Based on those studies, particular trees and herbaceous plants will be planted at the HSP to create favorable conditions in areas that collect runoff and store perched water.

As they grow, those trees will extract PFAS from beneath the surface and accumulate it within their tissue. Unlike a cap, which only restricts vertical migration of surface water down through the waste material to groundwater, Wolverine's proposed remediation option will remove the PFAS from the HSP over time. It will not only reduce the spread of contamination but also decrease the mass of PFAS beneath the surface as fallen trees are removed and disposed off-site.

In the areas of the HSP where phytoremediation is not preferred or feasible, or where waste is the thickest, Wolverine's proposal provides for the installation of strategic capping. This combination of phytoremediation and strategic capping will preserve existing vegetation and trees to the extent possible, and provide for planting as many as 4,000 new trees to enhance the greenspace and create a natural preserve setting. Development and regrading of the existing topography will generally be limited to areas or design features that may require additional cover and development (e.g. strategic cap area(s), and areas where additional surficial cover is required). Wolverine will retain the HSP and maintain the long-term maintenance associated with both the capping and phytoremediation management (i.e. fallen timber removal and proper disposal, replanting).

Compared to the HSP's pre-2018 appearance, the HSP will appear largely unaffected. It will return to an open, wooded, primarily undeveloped parcel, and access will be controlled through gate(s). In addition, the use of phytoremediation and strategic capping preserves the possibility, either now or in the future, of creating limited use and controlled access nature trails or other recreational features. Construction disturbances will be minimal, and once complete the existing fence will be removed. Smaller fenced areas will be installed around the strategic capping areas.

2.0 BACKGROUND

The HSP, located at 1855 House Street NE, Plainfield Township, Kent County, Michigan, encompasses approximately 76 acres (**Figure 1**). The HSP is currently undeveloped and, according to available information, no buildings were previously present. An electric utility right-of-way and associated high-voltage transmission lines cross the northern portion of the HSP, and a maintenance access road from House Street runs south to north across the HSP.

Approximately the northern 12 acres and eastern 16 acres are covered in mature forest growth. The central portion of the HSP is a mix of grasslands, low lying vegetation, and mature woodland. Driving and walking trails are present throughout the HSP, and have been for a number of years. The HSP and surrounding features are shown on **Figure 2.**

The HSP was a State of Michigan licensed and regulated disposal facility from the mid-1960s through 1978. Until 1970, the HSP received leather tanning byproducts over a portion of time. The volume of waste materials and soil with waste materials is estimated to be approximately 34,000 CY. The native soil in which the waste materials were disposed included sand, gravel, and clay. The waste materials and waste material mixed with soil is the primary contaminant source at the HSP.

Some of the waste at the HSP contained PFOS and PFOA and their precursors, which are part of a larger group of PFAS. PFAS were in Scotchgard™, a waterproofing material manufactured by 3M Company, that was applied to some leather goods manufactured at the former Wolverine Tannery site in Rockford, Michigan. Some PFAS from the byproducts at the HSP has come to be located in groundwater beneath and migrating from the HSP.

The maximum identified depth to the bottom of known waste materials from existing grade is approximately 20 ft bgs. On-site soil borings identify up to 80 ft of primarily well-sorted sand between the bottom of the waste materials and the groundwater table. Because PFAS compounds have been detected in the groundwater, the soil column between the waste materials and groundwater would be considered a secondary source of PFOA+PFOS to groundwater.

Additional information regarding the HSP, its historical use, the physical setting (i.e., hydrology, geology, and hydrogeology), and contaminant distribution and concentrations is detailed in R&W/GZA's February 9, 2018 *Conceptual Site Model Update and Status Report* (R&W/GZA, 2018), 2018 Summary Report (R&W/GZA, 2019), 2019 Summary Report (R&W/GZA, 2020), and SOWs included in the CD.

The approximate extent of known waste material and soil with waste material on the HSP is shown on **Figure 3**.

The approximate extent of known groundwater contamination on the HSP is shown on **Figure 4**. The extent of off-site groundwater contamination, including the groundwater-surface water interface, is being further investigated and monitored per separate requirements in the CD. The estimated extent of off-site groundwater plume is shown on **Figure 4A**.

The depth to top and thickness of the waste materials and soil with waste materials varies across the areas of waste materials on the Site. For example, the waste thickness in the south-central portion of the Site is up to 20 ft while certain areas in the central portion are less than 3 ft of thickness. Cross sections of the estimated extent of the waste materials and waste with soil are included as **Figures 5 and 5A-5D**, respectively.

The strength of the carbon-fluorine bond makes PFAS stable chemicals, both thermally and chemically. PFAS are relatively soluble in water and have low volatility. The high electronegativity of fluorine results in low acid dissociation constants (pKa). Therefore PFAS, such as PFOS and PFOA, exist in aqueous solutions as the dissociated acids and in the anionic state at typical environmental pH conditions. These anions have surfactant properties. In addition to their anionic properties, their behavior in the environment results from the differences in properties of the hydrophilic "head" of the molecule and the hydrophobic "tail" of the molecule. In the laboratory, PFOS and PFOA (and other PFAS) form hydrophobic spheres at the concentration known as the "critical micelle concentration" (ITRC, 2020). Recent studies have suggested that similar molecular aggregations, known as hemi-micelles, may occur at lower concentrations within the environment, particularly in groundwater systems. This is hypothesized to be due to interactions with particles or because of spatially variable concentrations within soil matrices (Brusseau, 2018 as referenced in ITRC, 2020). PFAS transport properties and partitioning near the water table within groundwater systems may be influenced by these molecular aggregations in addition to its other chemical properties (ITRC, 2020).

The organic carbon-partitioning coefficient (K_{OC}), is a parameter commonly used to represent the potential of a compound to sorb to organic matter occurring in soil. The higher the value, the more strongly the substance sorbs to the soil particles. Shorter-chained PFAS generally have lower K_{OC} values and are generally more soluble in water, while the longer chain PFAS sorb and partition more into the soil matrix. However, according to ITRC's review (ITRC, 2020), the sorption process of PFAS at the field scale is more complex and variable than the relationship represented by the single parameter K_{oc}. Partitioning of PFAS to soil is also dependent upon the electrostatic interactions between their individually charged surfaces. In addition, the temporal and spatial variability in hydrological and geological parameters contribute to the variability of PFAS partitioning between soil and groundwater in the field-scale. Therefore, K_{OC} is currently being reported in relatively broad ranges. For example, the K_{OC} value for PFOS ranges from 251 to 5,012 and the K_{OC} value for PFOA ranges from 77 to 427 (ITRC, 2020). As these values suggest, both PFOA and PFOS are likely to partition from the water column onto organic matter (i.e., sorb) in sediments and soil particles. The lower K_{OC} values for PFOA indicate that it is generally less strongly sorbed than PFOS.

Due to their stability and persistence, PFAS can be transported relatively long distances. The primary transport mechanisms for PFAS include advective groundwater flow velocity, hydrodynamic dispersion, adsorption, and desorption. Lateral hydrodynamic dispersion associated with the HSP is expected to be relatively limited due to the relatively well sorted sands and high groundwater pore velocities that are present throughout the area. Adsorption to organic matter, as described above, has the potential to remove PFAS from aqueous solution, and hence reduce the total contaminant mass migration rate in water. Additionally, PFAS may adsorb at differing rates due to their different K_{OC} values, thereby resulting in differing characteristics within the plume as it migrates downgradient from the source area. The partitioning of PFAS between water, soil, and sediment is complex, with numerous factors influencing partitioning such as the transport characteristics of the individual PFAS constituents present in groundwater, the organic content and composition of the soil/sediment, and the pH and geochemistry of the groundwater.

Generally, shorter-chain PFAS are more mobile in groundwater and will leach from soil to groundwater at a faster rate. This property also results in shorter-chain PFAS at the leading edge of a groundwater plume. Other factors affecting PFAS sorption in the subsurface include but are not limited to characteristics of the aquifer matrix (e.g., organic carbon content and surface charge), and co-contaminant interference at sorption sites.

As we consider the chemical properties of PFAS and their presence within waste deposited at the HSP, it is also important to consider the hydrologic and geologic setting. The waste was placed within shallow glacial deposits. The fate and transport of constituents in the HSP environment are affected by hydrological and geological parameters such as precipitation, surface run-off, evapotranspiration, soil-moisture retention, fraction organic carbon in the soil, the presence of other chemicals in the soil, and soil permeability.

The conditions and characteristics of the HSP historically resulted in infiltration of precipitation into surficial soil, mobilization of PFAS compounds from waste residuals to underlying unsaturated sandy soil, with infiltrating water ultimately reaching the saturated zone, undergoing mixing, dilution, and then transport with groundwater flow. These conditions remain ongoing. Additional adsorption and desorption as well as interactions with dissolved and suspended constituents is a continuous process with groundwater flow. The rate of these interactions is dependent upon the differing groundwater and soil characteristics throughout the groundwater flow area.

3.0 SCOPE OF ANALYSIS

Paragraph 7.8 of the CD governs the scope and contents of this FS:

The Feasibility Study shall set forth and evaluate the remedy options under Part 201. At a minimum, the Feasibility Study shall include the following information:

(A) Definition of remedial objective;

(B) Analysis of each potential remedy options, including an analysis of:

(1) The performance, reliability, ease of implementation, and potential impacts of the potential remedy, including safety impacts, and control of exposure to any residual contamination;

(2) The time required to begin and complete implementation of the remedy;

(3) The cost of remedy implementation;

(4) The institutional requirements that may substantially affect implementation of the remedy; and

(5) The remedy's ability to reduce toxicity and the mobility of PFAS compounds.

(C) A proposed selected remedy based on the analysis.

4.0 ANALYSIS

4.1 DEFINITION OF REMEDIAL OBJECTIVE

4.1.1 Remedial Objective

Paragraph 7.8(iii) of the CD provides that this "Feasibility Study shall set forth and evaluate the remedy options under Part 201." Under Part 201, rather than actively addressing the mere presence of contamination in groundwater, the objective of any remedy is to "*eliminate unacceptable risks* to public health, safety, or welfare, or to the environment from environmental contamination at facilities" MCL 324.20102(c) (emphasis added). In practice, this encourages remediation of property by eliminating unacceptable exposure to contamination rather than actively cleaning up contamination to which no one would be exposed.

Accordingly, the remedial objective used to compare the performance of the remedy options in this FS is to eliminate unacceptable risk of exposure to PFAS at the HSP by meeting relevant and applicable cleanup criteria at their exposure points, if any.

4.1.2 Identification of Exposure Pathways and Risk of Exposure to PFAS at the HSP

There is not an unacceptable risk of exposure to PFAS in soil at the HSP. Pathways such as direct contact with soil, particulate inhalation, and soil volatilization are either not exceeded, criteria do not exist, or the pathways are not complete. Criteria for direct contact with soil, particulate inhalation, and soil volatilization do not exist for PFAS.

There is no longer an unacceptable risk of exposure to PFAS from the HSP in drinking water. The drinking water pathway is applicable but no longer complete or relevant. Wolverine is providing protection to these receptors through both installation of municipal water and maintenance of water filtration (see CD Paragraphs 7.5 and 7.11).

This FS evaluates the performance of remedy options to address the potential risk of exposure to groundwater from the HSP. The GSI pathway is applicable because PFOA+PFOS-containing groundwater migrating from the HSP discharges to the Rogue River. Wolverine is already investigating the GSI pathway under Paragraph 7.10 of the CD. Wolverine's investigation at the GSI, where PFAS-impacted groundwater intersects the Rogue River, will inform more impactful ways of addressing the potential surface water receptor.

4.2 PRELIMINARY IDENTIFICATION AND SCREENING OF REMEDY OPTIONS

USEPA 2020 identifies only three destruction and disposal technologies for PFAS: thermal treatment (destruction), landfilling (disposal), and underground injection (disposal). USEPA also explains that "[w]hile significant uncertainties remain with respect to the potential for migration to the environment associated with destruction and disposal of PFAS and PFAS-containing material using the technologies identified, this guidance may enable a manager of PFAS and PFAS-containing materials to make informed decisions in the evaluation of existing destruction and disposal options." This is also contemplated in *Disposal of Products and Materials Containing Per- and Polyfluoroalkyl substances (PFAS): A Cyclical Problem* (Stoiber et al., 2020).

Initial screening eliminated remedy options that would not either control mobility or remove impacted material from acting as a source to groundwater. Technologies that are effective at reducing or destroying many other contaminants, such as chemical oxidation were not carried forward for additional analysis given their unproved performance with PFAS and/or potential to have negative consequences. **Table 1** summarizes information from the initial screening.

As required in Section 7.8(e), Wolverine retained R&W/GZA to perform and supervise landfill-related work. R&W/GZAs landfill design and construction qualifications were previously provided to EGLE per the CD and are included in **Appendix A**.

4.3 ANALYSIS OF IDENTIFIED REMEDY OPTIONS

Consistent with Paragraph 7.8(a)(ii) of the CD, Wolverine is evaluating the following options to "(1) manage solid wastes at the House Street Disposal Site and (2) reduce and control potential migration of PFAS Compounds from soils and sludges into the groundwater from the House Street [D]isposal Site."

- Remedy Option 1: maintaining the status quo (the "**No Further Action Option**").

- Remedy Option 2: constructing an approximately 30-acre surface cap without a bottom liner that complies with Part 201 and meets the applicable substantive requirements of Michigan's Part 115 (the "**Cap Option**").

- Remedy Option 3: constructing an approximately 20-acre surface cap over an area in which waste materials are consolidated and placed above a liner with leachate collection, as required, that comply with Part 201 and meet the applicable substantive requirements of Michigan's Part 115 (the "**Landfill Cell Option**").

- Remedy Option 4: excavating, transporting, and disposing of waste material from the HSP offsite (the "**Offsite Disposal Option**").

- Remedy Option 5: collecting and treating or disposing of groundwater beneath the HSP (the "**Pump and Treat Option**").

- Remedy Option 6: maintaining existing on-site caps, constructing an additional cap over the thickest waste area, and enhancing onsite vegetative uptake of PFAS through phytoremediation (the "**Phyto-Cap Option**").

As noted in Section 4.1.2, because Wolverine has provided municipal water throughout the area, there is no longer an unacceptable risk to drinking water. Likewise, there is not an unacceptable risk of exposure to soils at the HSP. As a result, only the GSI pathway remains relevant for this FS.

Due to the size and scope of the HSP, and the fact PFAS have migrated offsite, there are no remediation options that will achieve the remedial objective of this FS in the near-term. Rather, all options evaluated in this FS are all long-term actions and none will make measurable progress toward achieving the remedial objective (i.e., result in reductions of PFOA and PFOS concentrations reaching the Rogue River from the HSP at levels below GSI criteria) within EPA's and EGLE's assumed lifetime of 70 years.

4.3.1 The No Further Action Option

The No Further Action Option is analyzed only as a baseline to inform the evaluation of the feasibility of the other potential remedy options discussed below. The No Further Action Option is not a do-nothing option. Rather, it is an option that would maintain the status quo.

Under the No Further Action Option, the HSP will remain enclosed by chain link fence with locked gates. Wolverine will maintain the fence and limit access to the HSP. Similarly, Wolverine will continue long-term property maintenance, including controlling vegetative growth and maintaining the existing onsite caps. Deed restrictions will be imposed to limit soil and groundwater use.

4.3.1.1 Performance

The No Further Action Option will not make measurable progress toward achieving the remedial objective (i.e., result in reductions of PFOA and PFOS concentrations reaching the Rogue River from the HSP at levels below GSI criteria) within EPA's and EGLE's assumed lifetime of 70 years.

The direct contact and drinking water pathways will remain controlled. Wolverine will continue to manage the HSP by maintaining the fence with locked gates, controlling vegetative growth, and properly maintaining the existing onsite caps. Wolverine will also continue to investigate the GSI pathway under the CD.

Existing vegetation will continue to uptake at least some amount of PFAS from beneath the surface, thereby preventing at least some PFAS from migrating to groundwater and ultimately to surface water. Residual concentrations of PFAS at the HSP will slowly attenuate over hundreds of years.

4.3.1.2 Reliability

The No Further Action Option will require ongoing maintenance of existing onsite caps and fencing at the HSP. Caps have greater than 30-year operational life with the potential for (localized leakage) typically limited to design and/or construction errors. Well-established means and methods for construction as well as quality control procedures will enhance overall performance and verify integrity of the cap(s). The fence will be inspected and repaired as needed.

4.3.1.3 Ease of Implementation

There are no technical or practical impediments to implementation of the No Further Action Option.

4.3.1.4 Potential Impacts

There will be no additional impacts arising from the implementation of the No Further Action Option. The HSP will remain inaccessible to the public and the site will remain unchanged from current conditions.

4.3.1.5 Control of Exposure to Residual Contamination

Fencing will remain and access to the HSP will be restricted. Water will continue to infiltrate through affected media, existing vegetation will continue to uptake some amount of PFAS, and the concentration of PFAS in groundwater at the HSP will slowly attenuate as groundwater continues to migrate from the HSP.

4.3.1.6 Time to Implement

The No Further Action Option is currently being implemented.

4.3.1.7 Estimated Cost

The cost of the No Further Action Option consists of ongoing annual OMM: $20,000 - $30,000

4.3.1.8 Institutional Requirements

Deed restrictions will be imposed to limit soil and groundwater use, and additional exposure controls currently at the HSP, such as existing caps and fencing, will continue.

4.3.1.9 Ability to Reduce Toxicity and Mobility of PFAS Compounds

Mobility and toxicity will remain unchanged from the status quo: over time, vegetation at the HSP will uptake some PFAS from beneath the surface, and the concentration of PFAS in groundwater will attenuate.

4.3.2 The Cap Option

Paragraph 7.8(a)(ii)(A) of the CD provides that this FS will evaluate "an approximately 30-acre surface cap without a bottom liner that complies with Part 201 and meets the applicable substantive requirements of Michigan's Part 115."

Under this option, at least 30 acres of the site will be clear cut, with all trees, vegetation, and roots removed. Three low permeability caps of synthetic High-Density Polyethylene (HDPE), Linear Low-Density Polyethylene (LLDPE), or geocomposite materials will be installed over delineated waste material areas: one cap north of the power line easement, another cap in the northern area of the southern portion of the HSP, and a third cap where waste from the southern portion would be consolidated near surface-impacted material in the southwest corner. Localized and select areas of near-surface waste materials will be excavated and moved to within the capping footprints. The aggregate footprint to encompass the waste materials of the three caps would approach 27 acres.

The cap design and construction will comply with applicable Michigan Part 115 Type II Solid Waste Landfill regulations. Because the caps will overlap with the five areas previously capped during USEPA response actions, those five areas will be removed and ultimately incorporated within the new capped areas.

Run-off from the southern caps will be directed to a retention basin to the southeast and then possibly pumped or directed to the eastern wooded portion of HSP and allowed to naturally infiltrate in an area not previously used for waste disposal. Runoff from the northern cap will naturally infiltrate with proper erosion control around the cap on the surrounding HSP. Stormwater control will need to be sufficient to meet Part 115 requirements and any Plainfield Township requirements, if applicable. This runoff design may require a significant area of the HSP as well as engineering and approval of a high-water contingency.

Areas disturbed outside the capped footprints (access roads, laydown areas, areas of excavation for near surface waste materials) will be re-graded to facilitate drainage, covered with topsoil, and hydroseeded. A portion of the HSP will remained fenced and secure to ensure the integrity of the caps is not compromised. This will include the capped and immediately surrounding areas.

Figure 6 is a conceptual site plan for the Cap Option showing the likely locations of capping (red outline) and limits of the work area (black outline). Areas within the black outline that are not capped would be regraded and filled after excavation and construction is complete. The stormwater retention area is shown in the southeastern portion of the HSP.

4.3.2.1 Performance

Like the No Further Action Option, the Cap Option will not have a performance benefit within a lifetime. Waste will remain onsite under both options. The direct contact and drinking water pathways will remain controlled under both options. And under both options, Wolverine will continue to manage the HSP by maintaining the fence with locked gates, controlling vegetative growth, and properly maintaining onsite caps.

It will take over 100 years for the Cap Option to make measurable progress toward achieving the remedial objective of this FS.

4.3.2.2 Reliability

The Cap Option's reliability is similar to the No Further Action Option. Both options will require ongoing maintenance of caps at the HSP. While the No Further Action Option has fewer potential failure points, caps have greater than 30-year life with the potential for (localized) leakage typically limited to design and/or construction errors. Well-established means and methods for construction as well as quality control procedures will verify integrity of the cap(s).

4.3.2.3 Ease of Implementation

The Cap Option is significantly more difficult to implement than the No Further Action Option. In addition to typical earthwork associated with site development and landfill construction, it will require utilization of specialized heavy equipment for backfilling and compacting deep excavation to limit differential settlement and reduce strain on the cap. The most significant technical concern with the cap option is relocating and grading waste material to limit exposure during handling (i.e., considerations of odor and worker exposure).

There are also practical implementation considerations, including pedestrian and non-construction traffic safety, truck traffic, wear and tear on roadways, disturbance from vegetation and tree removal, erosion and soil control, construction of access roads, and air monitoring during waste handling during construction activities.

Additional information that would be needed before final design and construction include confirming engineering properties of the waste material, refining the limits of near-surface waste, and confirming stormwater infiltration location(s) for the cap areas.

4.3.2.4 Potential Impacts

The Cap Option will include clear cutting and grubbing over 30 acres of wooded land. Construction and implementation impacts will involve typical construction safety and worker exposure, which will be mitigated by training and PPE. There will be a short-term increase in runoff and infiltration during construction when vegetation is removed. Temporary covers will be used to control the wind-borne spread of exposed waste and the potential for inhalation exposure during clearing, grubbing and waste material relocation during dry, windy weather conditions will be mitigated with other control measures.

For the area residents, there will be safety considerations with an increase of truck and general construction traffic to the area of the HSP. The construction process will be loud, may be odorous during waste excavation, and will have a long duration.

4.3.2.5 Control of Exposure to Residual Contamination

For the Cap Option, residual contamination on the HSP will be limited because waste (primary source) and the majority of the soil beneath the waste (secondary source) will be under a cap. Some secondary source soil will remain in areas not capped. However, the portions of the HSP will remain fenced and access restricted.

4.3.2.6 Time to Implement

Design and permitting work can begin immediately upon acceptance of a work plan, and the expected time to completion after initiation is 30 months, with ongoing long-term operation and maintenance from there. This does not include design and permitting process or long-term OMM.

4.3.2.7 Estimated Cost

Design: $200,000 - $400,000

Construction: $15,000,000 - $18,000,000

Annual OMM: $100,000 - $120,000

4.3.2.8 Institutional Requirements

Deed restrictions will be imposed to limit soil and groundwater use, and additional exposure controls such as the existing fencing, will continue. Cap inspection and maintenance will be required long-term.

4.3.2.9 Ability to Reduce Toxicity and Mobility of PFAS Compounds

The cap option will not reduce the toxicity of PFAS. Compared to the No Further Action Option, the Cap Option will reduce mobility by reducing infiltration through onsite waste material and the soil beneath it while leaving the materials in place.

4.3.3 The Landfill Cell Option

Paragraph 7.8(a)(ii)(B) of the CD provides that this FS will evaluate "an approximately 20-acre surface cap over an area in which materials are consolidated and placed above a liner with leachate collection, as required, that comply with Part 201 and meet the applicable substantive requirements of Michigan's Part 115."

The Landfill Cell Option will consolidate waste onsite within a synthetically lined and capped containment cell with a leachate collection system. Based on the volume, location, and depth of waste material and soil with waste material, the containment cell will only require approximately 15 acres.

After clear cutting and grubbing at least 30 acres of the Site, excavation of waste materials will begin. The overburden, waste, and impacted soil will need to be double-handled. It will be excavated, stockpiled outside the cell footprint while the containment cell is being constructed, and then relocated again within the cell. Runoff that accumulates during cell excavation and backfilling will be collected and either disposed of or treated until the low-permeability cap is completely installed.

Precipitation during construction (limited to water retained over exposed waste material) would need to be managed to limit interfering with excavation and transportation. Collected water would be either treated on-site or transferred off-site for disposal or treatment.

Upon excavation of the cell footprint, a bottom liner and leachate collection system to comply with applicable Michigan Part 115 Type II Solid Waste Landfill regulations will be installed. Impacted material, including the five areas previously capped during USEPA response actions, will be relocated to the lined cell and the cell will be capped once relocation is completed.

After construction is complete, runoff from the containment cell cap will be directed to a retention basin then possibly pumped or directed to the eastern wooded portion of HSP and allowed to naturally infiltrate. Leachate would be periodically collected and transported off-site for disposal or treatment.

Areas disturbed outside the capped footprints (access roads, laydown areas, areas of excavation for near surface waste materials) will be re-graded to facilitate drainage, covered with topsoil, and hydroseeded. At a minimum the containment cell area of the HSP will remain fenced.

Figures 7 and 8 are conceptual site plans for the Landfill Cell Option. Figure 7 depicts a possible containment cell floor design and location. Figure 8 depicts a possible containment cell capping design. Both figures show storm water retention in the southeast portion of the HSP.

4.3.3.1 Performance

Like the No Further Action Option, the Landfill Cell Option will not have a performance benefit within a lifetime. Waste will remain onsite under both options. The direct contact and drinking water pathways will remain controlled under both options. And under both options Wolverine will continue to manage the site by maintaining a fence, controlling vegetative growth, and properly maintaining onsite caps. Collection, transportation, and disposal of leachate from within the cell would also be required under the Landfill Cell Option. Additionally, the secondary source material would remain outside of the cell area, resulting in equal or increased infiltration in some areas. This will result in the Landfill Cell Option likely taking longer to meet the same performance objective as the Cap Option.

It will take over 100 years for the Landfill Cell Option to make measurable progress toward achieving the remedial objective of this FS.

4.3.3.2 Reliability

The Landfill Cell Option is no more reliable than the No Further Action Option and the Cap Option. Lined and capped landfill cells have greater than 30-year life history with the potential for (localized) leakage limited to design and/or construction errors. Well-established means and methods exist for construction as well as Quality Control procedures to verify integrity of the low permeable membrane. However, USEPA 2020 describes multiple uncertainties regarding landfilling PFAS-containing material, including their behavior in the landfill itself and effect on the liner systems.

4.3.3.3 Ease of Implementation

The Landfill Cell Option is significantly more difficult to implement than either the No Further Action Option or the Cap Option. The Landfill Cell Option will require more construction traffic and a longer construction period to complete than the Cap Option. Suitability of subgrade below the containment cell is currently unknown and may require imported material before placing the synthetic liner. Removal of impacted material from the deep ravine at the southern end of the Site likely to require use of specialty construction equipment or installation of temporary support system to limit over excavation. Simultaneous construction and storage/maintenance of waste and impacted material may require additional laydown area east of currently delineated waste footprint. Backfilling and compacting deep excavation to limit differential settlement and reduce strain on synthetic cap also require specialized heavy equipment. Water collected (from precipitation) while filling the containment cell will require a collection system and treatment/disposal system. Collection and temporary storage onsite with periodic removal and off-site disposal. Dust control during dry, windy periods to limit air borne particulates will require specialized material handling techniques. Stormwater control will need to be sufficient to meet Part 115 and Plainfield Township requirements, if applicable. The runoff design may require a significant area of the HSP as well as engineering and approval of a high-water contingency.

Additional information that would be needed before final design and construction include confirming engineering properties of the waste material, refining the limits of waste, and confirming stormwater infiltration location.

4.3.3.4 Potential Impacts

The Landfill Cell Option will include clear cutting and grubbing over 30 acres of wooded land. Construction and implementation impacts will involve typical construction safety and worker exposure, which will be mitigated by training and PPE. There will be a short-term increase in runoff and infiltration during construction when vegetation is removed. Temporary covers and other control measures (e.g., water) will be used to control the wind-borne spread of exposed waste and the potential for inhalation exposure during clearing, grubbing and waste material relocation during dry, windy weather conditions.

For the area residents, there will be safety considerations with an increase of truck and general construction traffic in the area of the HSP. The construction process will be loud, may be odorous during waste excavation, and will have a long duration.

4.3.3.5 Control of Exposure to Residual Contamination

For the Landfill Cell Option, residual contamination on the HSP will be limited because the waste (primary source) will be located in a containment cell. The soil beneath the waste (secondary source) will remain in place but generally will be at least 5 ft below grade. Portions of the HSP will remain fenced and access restricted.

4.3.3.6 Time to Implement

Design and permitting can begin immediately upon acceptance of a work plan, with construction and implementation likely up to 38 months, with ongoing long-term operation and maintenance from there. This does not include design and permitting process or long-term OMM.

4.3.3.7 Estimated Cost

Design: $380,000 - $450,000

Construction: $25,000,000 - $28,500,000

Annual OMM: $550,000 - $700,000 (decreasing with time as cap is completed)

4.3.3.8 Institutional Requirements

Deed restrictions will be imposed to limit soil and groundwater use, and additional exposure controls such as the cell capping and fencing will be used. Cap and cell inspection and maintenance will be required long-term.

4.3.3.9 Ability to Reduce Toxicity and Mobility of PFAS Compounds

The Landfill Cell Option would contain the onsite waste and limit mobility from the primary source. It will not reduce the mass, volume, or toxicity of PFAS. Some PFAS, in the deeper secondary source soils, will remain outside of and beneath the beneath the cell in the secondary source on the HSP.

4.3.4 The Offsite Disposal Option

The Offsite Disposal Option will remove the waste materials from the HSP for disposal in a landfill. At least 30 acres of the HSP will be cleared and grubbed. Waste materials and soil with waste material will then be excavated and roadway transported to a secure and permitted offsite landfill.

Precipitation during construction (limited to water retained over exposed waste material) will be collected to limit interfering with excavation; runoff will either be transported and treated onsite or transferred offsite for disposal or treatment.

Clean backfill material and topsoil will be brought onto the HSP to assist with re-grading the HSP to establish property site drainage. Disturbed areas will be hydroseeded.

4.3.4.1 Performance

Like the No Further Action Option, the Offsite Disposal Option will not have a performance benefit within a lifetime. The direct contact and drinking water pathways will remain controlled under both options. Under the Offsite Disposal Option, most of the onsite waste will be removed and there will be no need for ongoing site maintenance and management of waste materials. However, with this option, the secondary source will remain in place with infiltration traveling through it indefinitely.

It will take over 100 years for the Offsite Disposal Option to make measurable progress toward achieving the remedial objective of this FS.

4.3.4.2 Reliability

The Offsite Disposal Option is a conventional remedial option. There are well-established means and methods for excavation and removal of waste material, and the ability to do so is limited only by the ability to access impacted material and find an appropriate long-term disposal location. Once the waste material is removed and properly disposed of there will be no need for ongoing site maintenance and management of waste.

4.3.4.3 Ease of Implementation

Implementation of the Offsite Disposal Option will be more difficult than the No Further Action Option, Cap Option, and Landfill Cell Option, and the difficulty of finding a suitable location (or multiple suitable locations) for offsite disposal could make implementation of the offside disposal option impractical. Nearby Subtitle D (ordinary solid waste) landfills are present, but currently unwilling to accept PFAS-containing waste. Therefore, long-distance transportation would be required. Waste/soil meeting the definition of a hazardous waste would require greater transportation distances to Subtitle C (hazardous waste) landfills.

In addition to typical earthwork associated with site development and landfill construction, it will require utilization of specialized heavy equipment for reaching the deepest waste materials. The most significant technical concern with the Offsite Disposal option is managing waste during excavation to limit exposure during handling and runoff management.

There are also practical implementation considerations, including pedestrian and non-construction traffic safety, truck traffic, wear and tear on roadways, disturbance to natural habitats from vegetation and tree removal, erosion and soil control, construction of access roads, and air monitoring during waste handling during construction activities.

4.3.4.4 Potential Impacts

The Offsite Disposal Option will include clear cutting and grubbing over 30 acres of wooded land. Construction and implementation impacts will involve typical construction safety and worker exposure, which will be mitigated by training and PPE. There will be a short-term increase in runoff and infiltration during construction when vegetation is removed. Temporary covers and other control measures will be used to control the wind-borne spread of exposed waste and the potential for inhalation exposure during clearing, grubbing and waste material removal during dry, windy weather conditions.

For the area residents, there will be safety considerations with an increase of truck and general construction traffic to the area of the HSP. The construction process will be loud, may be odorous during waste excavation, and will have a long duration. The Offsite Disposal Option has the most significant impact to daily lives of nearby residents.

4.3.4.5 Control of Exposure to Residual Contamination

Residual contamination (the remaining secondary source) will be covered by clean backfill to eliminate direct contact exposure. Institutional controls will address management of the secondary source soil and groundwater.

4.3.4.6 Time to Implement

Design and permitting work can begin immediately upon agency approval with construction implementation likely up to 40-months (provided suitable disposal facilities accept waste stream). Multiple secure disposal facilities will likely be needed to accept volume of waste and to accommodate construction timeline. Time estimate does not include design and permitting process. A security fence will be maintained until new vegetation is established.

4.3.4.7 Estimated Cost

Design: $150,000 - $220,000

Construction: $175,000,000 - $200,000,000

Annual OMM: $40,000 - $60,000

4.3.4.8 Institutional Requirements

Deed restrictions will be imposed to limit soil (i.e., remaining secondary source) and groundwater use.

4.3.4.9 Ability to Reduce Toxicity and Mobility of PFAS Compounds

The Offsite Disposal Option will remove PFAS waste from the HSP and dispose of it in a landfill. It will reduce onsite mobility by reducing the mass of PFAS at the HSP. The secondary source of PFAS-containing soil beneath the waste materials will continue to leach to groundwater. The toxicity of the waste material will not be affected, merely transferred offsite.

4.3.5 The Pump and Treat Option

The Pump and Treat Option involves installation of approximately seven (7) groundwater recovery wells spaced approximately 175 feet apart on the southern boundary of the HSP adjacent to House Street. Each approximately 200-foot deep well would generate upwards of 100 gallons per minute (GPM). Groundwater would be routed to a treatment system that would likely include aeration, sanitation, and a dual-stage granular activated carbon (GAC) carbon system. A significant limitation to the Pump and Treat Option is the logistics of where the then-treated water would be discharged. Based on groundwater flow and the need to ensure the treated water is not immediately reintroduced into the source area or the downgradient plume. The only identified option for the discharge of the treated water would be routing it to the northeast of the Site toward Clear Bottom Lake where it would be discharged side gradient of the impacted groundwater plume. The second option is deep well injection of filtered (but not treated) pumped water if a suitable subsurface strata is present below the HSP.

In addition to the recovery well installation, existing vegetation at the well pads, access roads, piping routes, and the treatment system footprint would be cleared, and the ground surface prepared for the equipment. Electrical service available on House Street would be extended to the treatment system building.

Clean backfill material and topsoil will need to be brought onto the HSP to assist with re-grading for drainage. Disturbed areas will be hydroseeded. An estimated 2.5 acres of the HSP will be cleared. A conceptual plan for this type of remedial system is included as Figure 9.

4.3.5.1 Performance

Like the No Further Action Option, the Pump and Treat Option will not have a performance benefit within a lifetime. The direct contact and drinking water pathways will remain controlled under both options. Groundwater pump and treat systems are typically employed to limit the continued migration of compounds from a site rather than source cleanup. While generally effective over a long duration, the performance of pump and treat technology with multiple wells is affected by the heterogeneity of the subsurface and the geochemistry of the groundwater. Monitoring of these conditions may be required to determine if changes to the treatment processes are needed over time.

It will take over 70 years for the Pump and Treat Option to make measurable progress toward achieving the remedial objective of this FS.

4.3.5.2 Reliability

The Pump and Treat Option is the least reliable option analyzed in this FS because mechanical components of the treatment system must be maintained and regularly serviced to operate properly. Recovery wells, instrumentation, pumps, piping, and the treatment units themselves may become fouled with time and would require flushing periodically (typically pH adjustment) and/or installation of additional wells/pumps and controls to maintain effective groundwater control.

4.3.5.3 Ease of Implementation

The Pump and Treat Option is more difficult to implement than the No Further Action Option and less difficult to construct than either the Cap Option or the Cell Option. However, pre-construction permitting and the operation and maintenance of the Pump and Treat Option are significantly more difficult than all three of the previously discussed options but similar in costs to the Landfill Cell Option.

Overall, the installation of the Pump and Treat Option wells is relatively easy with standard drilling and earthwork means and methods. Installation of wells would, however, require re-working the deep ravine area to create a stable working platform for heavy equipment and the groundwater recovery wellhead components. Dust control will be required during tree and vegetation removal required to install the subgrade piping and treatment system building. Management of drill cuttings is routine. Developing deep wells to remove sediment after installation will require collection and management of approximately 400,000 gallons of PFAS-impacted water.

Additionally, if the treated water were to be discharged at the ground surface it would require acquiring an easement through private property and a surface water discharge permit from EGLE. If the filtered (to remove particulates and avoid plugging the deep well) water were deep well injected, the deep well installation and use permitting is a significant process.

The Pump and Treat Option requires long term operation and maintenance as well as effluent monitoring.

4.3.5.4 Potential Impacts

The Pump and Treat Option may result in the lowering the water table near the HSP. If the filtered water is deep well injected, there would be a significant loss of water to the aquifer system. If treated water is discharged to the northwest, toward Clear Bottom Lake, there is potential for flooding of wetlands and real estate near the lake.

The volume of pumping required to stagnate the groundwater at the HSP may change the PFAS plume characteristics. Modeling will be needed to evaluate potential changes to the plume to predict if changes to the groundwater flow will alter the PFAS plume.

4.3.5.5 Control of Exposure to Residual Contamination

For the Pump and Treat Option, exposure to residual contamination on the HSP will remain restricted by the existing fencing and restrictions on groundwater and soil.

4.3.5.6 Time to Implement

Design and permitting can begin immediately upon agency approval with construction implementation likely up to 12-months. This time estimate does not include design and permitting process (which may be several years). Long term OMM may be required for up to 30 years, and maintenance of security fence.

4.3.5.7 Estimated Cost

Design: $200,000 - $300,000

Construction: $14,000,000 - $16,000,000

Annual OMM: $600,000 - $730,000 (based on the assumption of GAC treatment, additional evaluation needed for deep well injection)

4.3.5.8 Institutional Requirements

Deed restrictions will be imposed to limit soil and groundwater use.

4.3.5.9 Ability to Reduce Toxicity and Mobility of PFAS Compounds

The Pump and Treat Option will significantly reduce the mobility of PFAS Compounds at and from the HSP itself. There will be no reduction in toxicity, PFAS simply transferred to carbon disposal site or deep well (if injected untreated).

4.3.6 The Phytoremediation and Strategic Capping (Phyto-Cap) Option

Like the No Further Action Option, the Phyto-Cap Option will not have a performance benefit within a lifetime. The Phyto-Cap Option will maintain existing capped areas, construct an additional cap over a portion of the site (south-central portion in an area over the thickest waste), increase cover over near-surface waste to a minimum of 2 feet throughout the site, and to the extent practical plant as many as 4,000 additional trees and herbaceous plants to create phytoremediation conditions. The current fencing around the property will be removed and smaller fencing will be placed around the capped areas. This option preserves the possibility, now or in the future, of creating limited use and controlled access to nature trails or other recreational features. A conceptual plan for this mixed remediation approach is included as **Figure 10** and a rendering of the possible implementation is included as **Figure 11**.

To the extent practicable, existing vegetation and trees will remain and be supplemented. Development/regrading of the existing topography will be limited. Additional trees and native plants will be planted to create a natural preserve setting.

Particular trees and herbaceous plants will be planted to create phytoremediation conditions in areas that collect runoff and store perched water. The predominant phytoremediation mechanism for chemicals known to be in site waste and perched water is extraction and accumulation within plant tissues, aka phytoextraction and phytoaccumulation. Multiple studies have shown a variety of plants accumulate PFAS in both roots and above-ground tissues, with accumulation depending on plant species, type of PFAS, and PFAS soil and water concentrations. Soil organic carbon content and pH also affect PFAS uptake by plants, by influencing PFAS sorption/desorption from soil surfaces and availability in soil pore water (Huff et al., 2020; Wang et al., 2020).

A portion of the waste identified in the deep ravine on the southern property boundary (western side) will be stripped of vegetation, graded, capped with a geocomposite membrane, and covered with clean soil. This area was selected for capping as it has the one of the thickest areas of waste material on the HSP. The area will be re-graded and the top portion converted to parking which will effectively eliminate infiltration through the thickest waste on Site. Area around the ravine will be re-graded to mirror the surrounding land and populated with vegetation and trees that can function to limit groundwater infiltration as well as extract and accumulate PFAS. Stormwater from the capped area (approximately 1.5 acres) will be directed to a low area already present on the eastern portion of the Site. Wolverine will retain the HSP and maintain the long-term maintenance associated with both the capping and phytoremediation management (i.e. removal of fallen timber and proper disposal, replanting).

4.3.6.1 Performance

Like the other options, the Phyto-Cap Option will not have a performance benefit within a lifetime. Under the Phyto-Cap Option, the direct contact and drinking water pathways will remain controlled. Wolverine will continue to maintain the existing onsite caps and manage the waste onsite. The existing caps and additional new cap will result in (i) reduction in infiltration through the primary and secondary sources in the capped areas and (ii) a performance benefit similar in kind to the Cap Option.

In addition, phytoremediation will reduce infiltration through waste during the growing season. Species with known ability to extract PFAS include spruce, willow, birch, and herbaceous species (grasses and forbs). Extraction and accumulation of PFOS and PFOA by these plant species depends on concentrations in soil and perched water. For example, spruce trees growing in soil containing 220,000 µg/kg PFOS and 50 µg/kg PFOA can extract approximately 2,000,000 µg/kg PFOS and 800 µg/kg PFOA. Growing in the same soil, willows can extract approximately 1,100,000 µg/kg PFOS and 1,200 µg/kg PFOA, birch can extract approximately 3,100,000 µg/kg PFOS and 1,800 µg/kg PFOA, and grasses can extract approximately 2,400,000 µg/kg PFOS and 1,300 µg/kg PFOA. Grown in soil containing 10,000 µg/kg PFOS and 10 µg/kg PFOA, spruce can extract approximately 96,000 µg/kg PFOS and 200 µg/kg PFOA, while willow can extract approximately 52,000 µg/kg PFOS and 300 µg/kg PFOA.

It will take hundreds of years for the Phyto-Cap Option to make measurable progress toward achieving the remedial objective of this FS. The Phyto-Cap Option will result in less overall mass loading to the river.

4.3.6.2 Reliability

The Phyto-Cap Option is as reliable as the No Further Action Option. Concentrations of chemicals known to be in site waste, soil, and perched water are well below concentrations that inhibit plant growth. To ensure the phytoremediation is effective, the disposal of the phytoremediation biomass will be managed in a manner such that the PFAS-laden tissue is not reintroduced back into the HSP soil. Membrane and geocomposite caps have greater than 30-year operational life history; the potential for (localized) leakage is typically limited to design and/ or construction errors. Well established means and methods for construction as well as quality control procedures to verify integrity of the low permeable membrane.

4.3.6.3 Ease of Implementation

The Phyto-Cap Option is more easily implemented than any option except No Further Action. It is readily implementable with standard construction equipment and will leave much of the HSP landscape untouched. It is also the lowest carbon footprint except the No Further Action option.

4.3.6.4 Potential Impacts

The Phyto-Cap Option will result in limited construction safety concerns during limited construction and capping the waste in the ravine. This option will leave the majority of the existing HSP landscape untouched with an increase in planted trees and other vegetation. The Phyto-Cap Option encourages increased use of the Site while avoiding residential exposure.

4.3.6.5 Control of Exposure to Residual Contamination

In addition to the benefits of reduction in PFAS concentrations sub-surface and reduction of infiltration volumes from the phytoremediation, the concentration of PFAS in groundwater at the HSP will slowly attenuate as groundwater continues to migrate from the HSP.

For the Phyto-Cap Option, the waste materials on the Site will be either under caps or a minimum of 2 feet of soil cover therefore no exposure to residual contamination will be present onsite.

4.3.6.6 Time to Implement

Design and permitting can begin immediately upon acceptance of a work plan, with implementation likely up to 12 months, likely over two construction seasons.

4.3.6.7 Estimated Cost

Design: $400,000 - $500,000

Construction: $6,000,000 - $12,000,000

Annual OMM: $130,000 - $180,000

4.3.6.8 Institutional Requirements

Deed restrictions will be imposed to limit soil and groundwater use and include restrictions and requirements for phytoremediation operations. Small, fenced areas installed around the selective capping areas and the caps will be maintained. Wolverine will retain the HSP and maintain the long-term maintenance associated with both the capping and phytoremediation management (i.e. removal of fallen timber and proper disposal, replanting).

4.3.6.9 Ability to Reduce Toxicity and Mobility of PFAS Compounds

Like the No Further Action Option, the Phyto-Cap Option will not have a performance benefit within a lifetime. As compared to the No Further Action and Cap Options, over time the Phyto-Cap Option will not only result in decreased environmental mobility but also reduced volume through removal of constituents by phytoextraction and phytoaccumulation (Huff et al., 2020; Wang et al., 2020; Gobelius et al., 2017; Shahid et al., 2017). Wolverine will continue to address the GSI pathway through ongoing investigation at the surface water receptor.

5.0 PROPOSED REMEDY

Wolverine proposes moving forward with the Phyto-Cap Option because it is feasible, reliable, easily implemented, and as effective at meeting the performance objective within a lifetime as any of the other options analyzed in this FS. The existing and installed capping will reduce stormwater infiltration through PFAS-impacted material and the phytoremediation efforts will both reduce infiltration through the uptake infiltrating water and reduce the PFAS mass in shallow soil, waste materials, and perched groundwater.

Table 2 summarizes the criteria used to compare the alternatives.

Under the Phyto-Cap Option, the HSP could be reopened and available for limited use. To the extent practical, existing vegetation and trees will remain. Additional trees and plants will be planted to create a natural preserve setting. As they grow, those trees and plants will extract PFAS from the groundwater and accumulate it within their tissue. Construction disturbances will be minimal, and once complete the existing fence will be removed and the HSP will be suitable for limited recreational use by interested neighbors.

As set forth in Paragraph 7.8(b) of the CD: "Subject to Section XVIII (Dispute Resolution for MDEQ and Defendant), if MDEQ does not approve of the proposed remedy in the Feasibility Study for the House Street Disposal Site, the final remedy shall be an approximately 30-acre surface cap without a bottom liner."

6.0 REFERENCES

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TABLES

Table 1 – Summary of Initial Screening of Options

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost Range	Screening Comment
No Further Action						
None	None	No further action.	The no action alternative does not result in reduction of waste volume, toxicity, or mobility.	Good	Minimal	Required for baseline comparison.
Institutional Controls						
Access and Use Restrictions	Deed restrictions	Complete deed restriction for limitations on soil and groundwater use as well as property zoning and use. May be used in conjunction with other remedial options.	Provides limitation to direct contact human exposure. Effectiveness relies on ability to implement and enforce. Deed restrictions do not reduce the mobility or toxicity of the PFAS compounds.	Good	Minimal	Retained for likely inclusion with other actions to improve their reliability.
Containment						
On-site capping		Consolidating some waste material and then constructing an impermeable cap over affected areas. Runoff allowed to discharge into groundwater side-gradient of waste.	Limits direct contact human exposure, reduces infiltration through the waste material on the HSP. Likely to decrease the mobility of the PFAS compounds contained with the waste materials by limiting infiltration. This alternative does not reduce the toxicity of the PFAS compounds or waste volume.	Readily implementable using standard landfill capping techniques. Challenge associated with removing vegetation and re-shaping finish grade to accommodate run-off collection.	Significant Capital and long-term maintenance costs	Retained for further evaluation.
On-Site containment cell		Excavation of waste materials and soil with waste material and consolidation into a containment cell constructed on-site.	Limits direct contact human exposure, eliminates infiltration through the waste material on the HSP. Ceases mobility of the PFAS compounds contained with the waste materials and soil with waste material. This alternative does not reduce volume or the toxicity of the PFAS compounds but does contain them within the cell.	Moderately implementable due to the multiple handling required to excavate, stockpile and maintain waste material on-site and handle runoff during cell construction. Challenge associated with removing vegetation and re-shaping finish grade to accommodate run-off collection.	Significant Capital and long-term maintenance costs	Retained for further evaluation.

Table 1 – Summary of Initial Screening of Options

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Collection						
Active Filtration	Groundwater pump and treat	Installation of extraction wells to pump PFAS contaminated water through filtration and activated carbon system or other suitable media. Discharge would ideally be located significantly outside (down- or side-gradient).	Reduces contaminant migration in groundwater. Does not address primary or secondary sources. Does not reduce the toxicity or mobility of the PFAS compounds from the source material.	Moderately implementable to construct; however, the volume of groundwater pumped and treated would be significant without a logistically possible discharge location for the treated water that is outside of the groundwater plume. On-site discharge would increase leaching PFAS from waste, waste soil mixture or PFAS-saturated vadose zone soil. Fouling of the activated carbon with co-contaminants and naturally occurring metals will shorten operational life and may significantly increase OMM costs.	Significant Capital and long-term maintenance costs	Retained fur further evaluation.
Passive Filtration	Funnel and gate system	Construction of cutoff walls subgrade to modify groundwater flow (i.e., funnel) into a specific pattern. The groundwater is directed to a passive treatment zone (i.e., funnel). For PFAS this may be granular activated carbon.	Reduces the contaminant load in deep groundwater. Does not address primary or secondary sources. Does not reduce the toxicity or mobility of the PFAS compounds in the source area.	Exceptionally difficult to implement and maintain during operation. Saturated thickness approaching 120 vertical feet over length of capture zone for funnel system presents exceptional technical challenges as does installation of the cutoff wall on either side of the gate.	Significant	Dismissed from further evaluation due to depth to groundwater, groundwater thickness, and predominately high permeability saturated zone soil.
Deep Well Injection	Ultra-filtration. Stand alone or coupled with Reverse Osmosis (RO)	Installation of extraction wells to pump PFAS contaminated water, discharge to Class I injection wells.	Reduces contaminant migration in groundwater. Does not address primary or secondary sources. Causes significant water withdraw from the aquifer. Does not reduce the toxicity or mobility of the PFAS compounds from the source material. If coupled with RO, discharge volume limited to a mixture of residue (with a higher PFAS concentration) and filtrate (to allow proper discharge).	Moderately implementable depending upon location of well(s) and permit compliance. Must be coupled with groundwater extraction, filtration to remove sediment, and high-pressure pumping.	Moderate to significant based on location and geologic formation and long-term maintenance costs.	Retained for further evaluation as part of the possible groundwater pump and treatment option only.

Table 1 – Summary of Initial Screening of Options

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Treatment						
In-Situ	Waste stabilization	Consolidation of near surface waste with deeper impacted areas (ravine adjacent to House Street), mixing of surrounding soil and impacted material (i.e., primary source) using laboratory verified mix to create a stabilized mass. Covering the stabilized mass with ISS swell (excess material generated during mixing) and at least 4-feet of natural material to prevent freeze/thaw cracking.	Provides limitation to direct contact human exposure, eliminates infiltration through the waste material on the HSP. Ceases mobility of the PFAS compounds contained with the waste materials and soil with waste material. This alternative does not reduce the toxicity of the PFAS compounds but does bind them in the treatment material. Limited documented use and effectiveness for PFAS compounds. Not universally accepted by regulatory agencies.	Moderately to implement in certain areas of the site, difficult in other areas. Significant logistical challenges handing and relocating swell.	Significant+	Dismissed from further evaluation based on the significant time and resources necessary to conduct bench and pilot scale testing necessary to evaluate the applicability of the technology to solidify/stabilize PFAS compounds.
In-Situ	Thermal desorption treatment	In place heat treatment of waste material and soil to temperatures known to desorb or destroy PFAS compounds	Still experimental treatment for PFAS compounds. Not proven technology. Concerns of off-gassing.	Exceptionally difficult to implement and considered to be technically impractical.	Significant ++	Dismissed from further evaluation. Temperatures need to thermally treat 80 to 100-foot-thick column of waste and soil are technical impractical
In-Situ	Chemical oxidation	Injection of oxidants to neutralize or reduce toxicity of contaminants	Still experimental treatment for PFAS compounds. Not proven technology.	Poor	Significant	Dismissed from further evaluation because it has not been demonstrated for PFAS treatment, difficulty to apply and mix reagents, and cost relative to likely benefit.
Disposal						
Excavation, Transport, and Disposal	Excavation and removal of waste materials and waste material mixed with soil for transport for off-site disposal at a permitted landfill.	Excavate waste materials and waste materials mixed with soil as well as overburden and marginal soil using typical earthwork equipment. Permanently dispose of soil in a permitted landfill.	Highly effective as primary PFAS compound source is removed, eliminating mobility and toxicity. Secondary PFAS compound source remains on-site. Permitted landfills are designed and operated to contain disposed wastes. Based on the calculated volume of PFAS-impacted waste and soil, disposal will likely require more than one facility.	Readily implementable - Excavation is routine, well proven, and can commence almost at any time Subtitle D landfills are locally present if willing to accept PFAS-containing waste. However, there are TCLP exceeding soil and waste on-site. Waste/soil meeting the definition of a hazardous waste would require greater transportation distances.	Significant+	Retained for further evaluation due to generally accepted regulatory option.

Table 1 – Summary of Initial Screening of Options

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost Range	Screening Comment
Mixed Remediation						
	Phytoremediation and Strategic Capping	Continued maintenance of existing capped areas. Additional strategic capping. Planting of trees for phytoremediation in areas of waste not capped. Potential remains for future limited access and use.	Capping and phytoremediation will reduce stormwater infiltration and mobility of PFAS compounds from some of the waste materials (primary source).	Readily implementable. Capping exposed waste on the ravine sidewall is most disruptive component of the work. Maintenance of the vegetation used for phytoremediation would require specialized handling and disposal.	Moderate	Retained for further evaluation, can be combined with other alternatives such as institutional controls.

Table 2 – Comparative Analysis of Remedial Options

Option 1:	No Further Action						
Description:	Required for Baseline Comparison						
Performance:	Natural Attenuation Only						
Reliability	**Implementability**	**Potential Impacts**	**Control of Exposure to Residual Contamination**	**Time Required**	**Estimated Cost for Implementation**	**Institutional Requirements**	**Remedy's Ability to Reduce Toxicity of Mobility of PFAS Compounds**
Not Applicable	Good	Not Applicable	Potentially, fencing remains	Currently being implemented	Ongoing Annual OMM: $20,000 - $30,000	Could be combined with institutional controls such as deed restrictions for limitations on soil and groundwater use as well as property zoning and use. The existing security fencing would remain.	No change or reduction in volume, toxicity, or mobility of PFAS compounds

Option 2:	Cap						
Description:	Consolidate and then construct a permanent cap over affected areas.						
Performance:	A properly maintained cap will effectively limit infiltration from ground surface through the waste. 27 acre cap effectively eliminates approximately 4.2 million gallons of infiltration through waste materials.						
Reliability	**Implementability**	**Potential Impacts**	**Control of Exposure to Residual Contamination**	**Time Required**	**Estimated Cost for Implementation**	**Institutional Requirements**	**Remedy's Ability to Reduce Toxicity of Mobility of PFAS Compounds**
Membrane caps have greater than 30-year operational history with failures limited to design and/or construction errors. Well established means and methods for construction as well as quality control procedures to verify integrity of the low permeable membrane.	Care needed to clear, grub, handle, and store PFAS-impacted vegetation. Otherwise typical earthwork associated with site development and landfill construction. Backfilling and compacting deep excavation to limit differential settlement and reduce strain on synthetic cap likely to require specialized heavy equipment. Most significant technical concern is relocating and grading waste material to limit exposure during handling.	Clear cutting and grubbing of at least 30 acres of wooded land. Pedestrian and non-construction traffic safety. Truck traffic entering and leaving the Site on House Street. Curb cut and traffic control measures may be necessary. Access/egress of heavy equipment to/from House Street. Wear and tear on roadways during active construction. Vegetation & tree removal increase construction noise for duration of the project. Increase exposure of residents to truck traffic & associated safety concerns. Erosion & sedimentation control during construction. Competent (LT Stability) access roads needed to reach northern waste area. Air monitoring during waste handling of relocated near-surface impacted material (terminated once material is capped). Stormwater control will need to be sufficient to meet Part 115 and any Plainfield Township requirements, if applicable. This may require a significant area of the HSP as well as engineering and approval of a high-water contingency.	Portions of HSP will remain fenced and restricted from general public.	Can begin immediately upon agency approval with construction implementation likely up to 30 months. This does not include design and permitting process. Long term OMM.	Design: $200,000 - $400,000 Construction: $15,000,000 - $18,000,000 Annual OMM: $100,000 - $120,000	Deed restrictions for limitations on soil and groundwater use as well as property zoning and use. Fencing remaining.	No reduction in toxicity; reduced mobility of PFAS compounds by significantly reducing infiltration through waste materials.

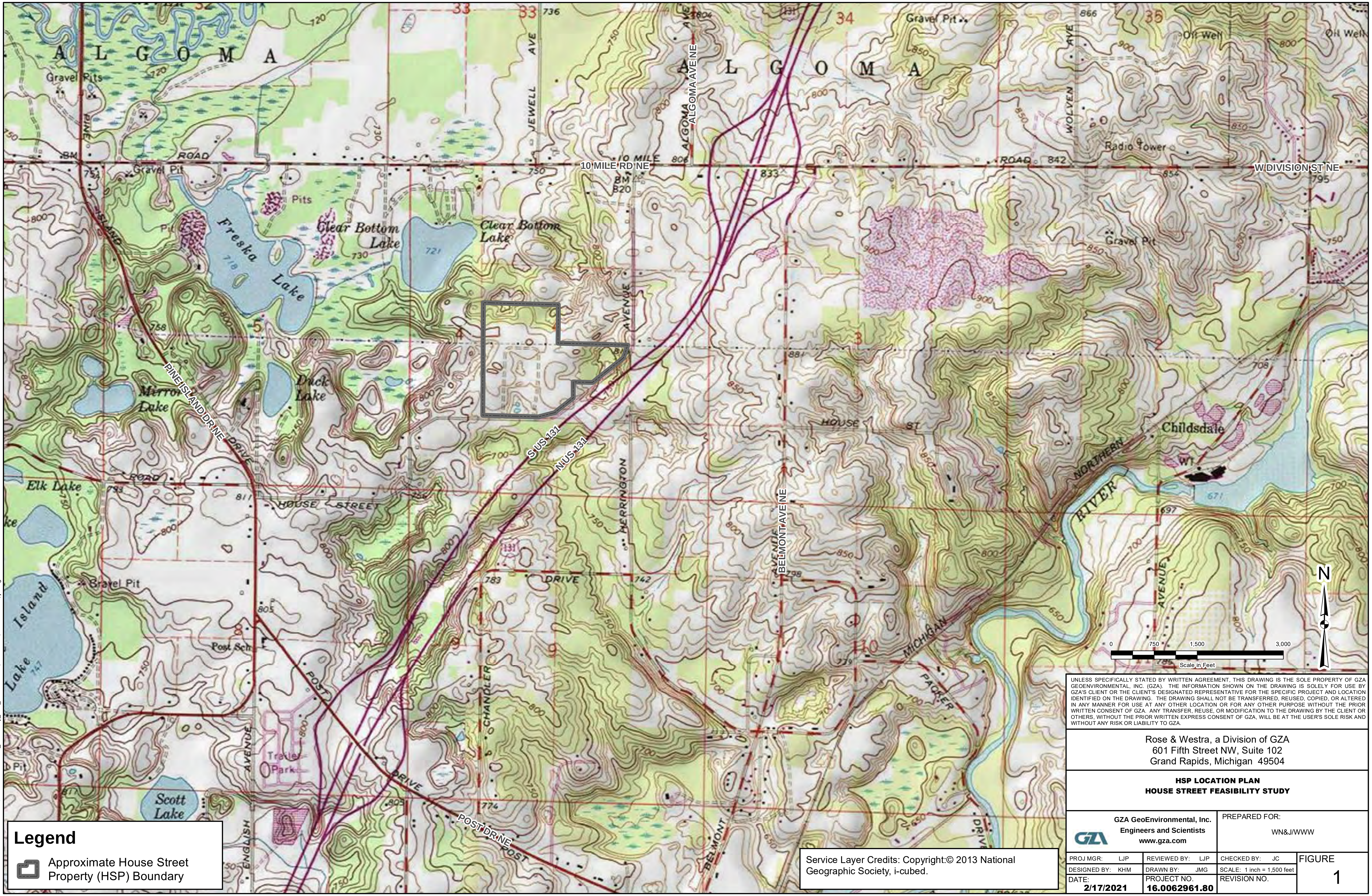
Option 3:	Landfill Cell						
Description:	Excavation of waste materials and soil with waste material and consolidation into a containment cell constructed on-site.						
Performance:	A properly maintained containment cell and cap will effectively eliminate infiltration from ground surface through the primary source. Effectively eliminates approximately 2.6 million gallons of infiltration through 15 acres of waste.						
Reliability	**Implementability**	**Potential Impacts**	**Control of Exposure to Residual Contamination**	**Time Required**	**Estimated Cost for Implementation**	**Institutional Requirements**	**Remedy's Ability to Reduce Toxicity of Mobility of PFAS Compounds**
Lined and capped landfills have greater than 30-year operational history with failures limited to design and/or construction errors. Well established means and methods for construction as well as Quality Control procedures to verify integrity of the low permeable membrane. EPA 2020 indicates PFAS effects on liner and leachate behavior are unknown.	Suitability of subgrade below containment cell currently unknown and may require imported material before placing the synthetic liner. Removal of impacted material from deep hollow at the southern end of the Site may require use of long-stick excavator, clamshell, or installation of temporary support system to limit over excavation. Simultaneous construction and storage/maintenance of waste and impacted material likely to require additional laydown area east of currently delineated waste footprint. Backfilling and compacting deep excavation to limit differential settlement and reduce strain on synthetic liner likely to require specialized heavy equipment. Water collected (from precipitation) while filling the containment cell will require a collection system and treatment/disposal system. Collection and temporary storage on Site with periodic removal and off-site disposal. Dust control during dry, windy periods to limit air borne particulates will require specialized material handling techniques. Stormwater control will need to comply with Part 115 and any Plainfield Township requirements, if applicable. This may require a significant area of the HSP as well as engineering and approval of a high-water contingency.	Clear cutting and grubbing and management of approximately 30 acres of pfas-impacted vegetation and wooded land. Pedestrian and non-construction traffic safety. Access/egress of heavy equipment to/from House Street. Depending upon the suitability of on-site soil, additional off-site material may have to be imported to the site. Relocation and handling of impacted material during containment cell construction will likely be done concurrently requiring more manpower and equipment or longer installation duration. Erosion & sedimentation control and management during construction will be substantial. Vegetation will be removed to create staging areas for clean overburden soil and impacted media which could require off-site disposal. Exposed impacted media will be subject to the elements as it is stockpiled and staged or loaded into the containment cell. Stockpile maintenance (cover and surrounding containment) critical to limit possible run-off into non-impacted areas. Larger laydown and materials staging areas needed directly off House Street and within central part of the Site. Competent (LT Stability) access roads needed to reach northern waste area. Air monitoring during excavation, waste handling, filling and compacting the impacted material within the containment (terminated once material is capped).	Portions of the HSP will remain fenced and restricted from general public	Can begin immediately upon agency approval with construction implementation likely up to 38 months. This does not include design and permitting process. Long term OMM.	Design: $380,000 - $450,000 Construction: $25,000,000 - $28,500,000 Annual OMM: $550,000 - $700,000 (decreasing with time as cap is completed)	Deed restrictions for limitations on soil and groundwater use as well as property zoning and use. Security fencing remaining.	No reduction in toxicity or volume; consolidates waste material and soil with waste material to secure cell with containment effectively eliminating mobility of contaminants in the primary source via infiltration. PFAS compounds remain in secondary source on the HSP; however, a portion of the secondary source would be covered by the containment cell.

Option 4:	Offsite Disposal						
Description:	Excavate waste materials and waste materials mixed with soil as well as overburden and marginal soil using typical earthwork equipment. Permanently dispose of soil in a permitted landfill(s).						
Performance:	Well established performance history. Eliminates infiltration on the Site through waste material (primary source) once removed. Secondary source (PFAS impacted soil below waste materials and above groundwater) remains. Maintenance of grounds not required after vegetation is established.						
Reliability	**Implementability**	**Potential Impacts**	**Control of Exposure to Residual Contamination**	**Time Required**	**Estimated Cost for Implementation**	**Institutional Requirements**	**Remedy's Ability to Reduce Toxicity of Mobility of PFAS Compounds**
Limited by the ability to transfer waste, the ability/willingness of the secure landfill(s) to accept waste, and their ability to control leaching PFAS into groundwater at another location. Well established means and methods for construction.	Standard earthwork means and methods. Removal of impacted material from deep hollow at the southern end of the Site may require use of long-stick excavator, clamshell, or installation of temporary support system to limit over excavation. Backfilling and compacting deep excavation. Water collected (from precipitation) after impacted material has been exposed and during excavation will require a collection system and treatment/disposal system. Collection and temporary storage on Site with periodic removal and off-site disposal. Dust control during dry, windy periods to limit air borne particulates will require specialized material handling techniques.	Clear cutting and grubbing and management of approximately 30 acres of PFAS-impacted vegetation and wooded land. Pedestrian and non-construction traffic safety. Access/egress of heavy equipment to/from House Street. Depending upon the suitability of on-site soil, additional off-site material may have to be imported to the site. Excavation, loading, decontamination of trucks during construction will require continuous traffic through the site. Erosion & sedimentation control and management during construction will likely be limited to the active work areas. Competent (LT Stability) access roads needed to reach northern waste area. Air monitoring during excavation, waste handling, and loading (terminated once material is capped).	Residual contamination (i.e., remaining secondary source) will be covered by clean backfill and not exposed to general visitors of the HSP. Institutional controls would address management of the secondary source soil and groundwater.	Can begin immediately upon agency approval with construction implementation likely up to 40 months (with ideal construction conditions and provided suitable disposal facilities accept the waste stream). This does not include design and permitting process. Long term OMM.	Design: $150,000 - $220,000 Construction: $175,000,000 - $200,000,000 Annual OMM: $40,000 - $60,000	Deed restrictions for limitations on soil and groundwater use as well as property zoning and use.	No reduction in toxicity of material, transfers toxicity off-site. Reduces on-Site mobility after excavation by reduction of PFAS source mass. PFAS compounds remain in secondary source on the HSP.

Option 5:	Pump and Treat						
Description:	installation of groundwater recovery wells on the southern boundary of the HSP adjacent to House Street. The groundwater generated at each well would be routed to a treatment system that would likely include aeration, sanitation, and treatment using a dual-stage Granular Activated Carbon (GAC) carbon system. A significant limitation to the Pump and Treat Option is the logistics of where the then-treated water would be discharged. Based on groundwater flow and the need to ensure the treated water is not immediately reintroduced into the source area or the downgradient plume, two options were identified for the treated water. The first would be routing it to the northeast of the Site toward Clear Bottom Lake where it would be discharged side gradient of the impacted groundwater plume. The second option is deep well injection if a suitable subsurface strata is present below the HSP.						
Performance:	Typically employed to retard continued dispersion of compounds rather than source cleanup. Generally effective over long duration. Performance of pump and treat technology with multiple wells is affected by the heterogeneity of the subsurface and the geochemistry of the groundwater; conditions that may change over time which could require changes to the treatment processes.						
Reliability	**Implementability**	**Potential Impacts**	**Control of Exposure to Residual Contamination**	**Time Required**	**Estimated Cost for Implementation**	**Institutional Requirements**	**Remedy's Ability to Reduce Toxicity of Mobility of PFAS Compounds**
The least reliable option analyzed because mechanical components of the treatment system must be maintained and regularly serviced to operate properly. Recovery wells, instrumentation and pumps, and the GAC may become fouled with time and would require flushing (typically pH adjustment) periodically and/or installation of additional wells/pumps and controls to maintain effective groundwater control.	Relatively easy with standard drilling and earthwork means and methods. Installation of wells on the southern property boundary would require re-working the deep ravine area to create a stable working platform for heavy equipment and the groundwater recovery wellhead components. Dust control will be required during tree and vegetation removal required to install the subgrade piping and treatment system building. Management of drill cuttings is routine. Developing deep wells to remove sediment after installation will require collection and off-site disposal of approximately 400,000 gallons of PFAS-impacted water.	Clear cutting and grubbing of approximately 2.25 acres of wooded land. Relocation of non-impacted soil from other locations on the Site to build up work platform near the deep ravine, drilling and transportation of development water for off-site disposal. May result in the lowering the water table near the HSP. If the treated water is deep well injected, there would be a significant loss of water to the aquifer system. If treated water is discharged to the northwest, toward Clear Bottom Lake, there is potential for flooding of wetlands and real estate near the lake. The volume of pumping required to stagnate the groundwater at the HSP may change the PFAS plume characteristics. Modeling will be needed to evaluate potential changes to the plume to predict if changes to the groundwater flow will expand the PFAS plume.	Portions of HSP will remain fenced and restricted from general public.	Can begin immediately upon agency approval with construction implementation likely up to 12 months (under ideal conditions). This does not include design and permitting process. Long term OMM may be up to 30 years.	Design: $200,000 - $300,000 Construction: $14,000,000 - $16,000,000 Annual OMM: $600,000 - $730,000 (based on the assumption of GAC treatment, additional evaluation needed for deep well injection)	Deed restrictions for limitations on soil and groundwater use as well as property zoning and use. Security fencing remaining.	No reduction in toxicity. PFAS will be transferred to carbon disposal site or deep well (if injected untreated). Will significantly reduce mobility of PFAS Compounds from the HSP.

Option 6:	Phyto-Cap						
Description:	Phytoremediation to control infiltration, maintain existing caps, and deploy impermeable cap on deepest waste in ravine. This may eventually include limited access to trails. This option may be combined with other alternatives such as institutional controls and capping or off-Site disposal of select areas.						
Performance:	Alternative will reduce infiltration through waste by planting species known to increase water uptake. Reduction of waste constituents of concern through phytoextraction and phytoaccumulation. Reduced infiltration of precipitation through waste during growing season. Impact to groundwater quality dependent upon effectiveness of the plants employed and the target compounds. Maintain existing impermeable capped areas, add a new capped area in the ravine, and add additional cover (permeable) to areas where waste is less than 2-feet below current grade.						
Reliability	**Implementability**	**Potential Impacts**	**Control of Exposure to Residual Contamination**	**Time Required**	**Estimated Cost for Implementation**	**Institutional Requirements**	**Remedy's Ability to Reduce Toxicity of Mobility of PFAS Compounds**
Phytoextraction rate greater during the growing season. Concentrations of chemicals known to be in site waste, soil, and below surface water are well below concentrations that inhibit plant growth. Impermeable caps typically used for landfills (proven longevity).	Readily implementable with standard construction equipment. Limited long-term documentation of plant-assisted remediation (phytoremediation) of PFAS. Rework of ravine to place impermeable cap and runoff collection/control may require specialized equipment	Minimal construction safety during limited construction phase. Additional plantings on western and southern boundary of the Site will provide natural view. Remedy encourages increased use of the Site while eliminating residential exposure.	No reduction in toxicity, mobility, or volume of waste materials. Reduction in PFAS mass. However, exposure is controlled by institutional controls and installation of municipal water and filter OMM.	Can begin immediately upon agency approval with construction implementation likely up to 12 months but may be spread over two construction seasons. This does not include design and permitting process.	Design: $400,000 - $500,000 Construction: $6,000,000 - $12,000,000 Annual OMM: $130,000 - $180,000	Deed restrictions for limitations on soil and groundwater use as well as property zoning and use.	Reduction in toxicity related to removal of constituents by phytoextraction and phytoaccumulation. Decreased environmental mobility from capping and increased evapotranspiration.

FIGURES



Legend

Approximate House Street Property (HSP) Boundary

Service Layer Credits: Copyright:© 2013 National Geographic Society, i-cubed.

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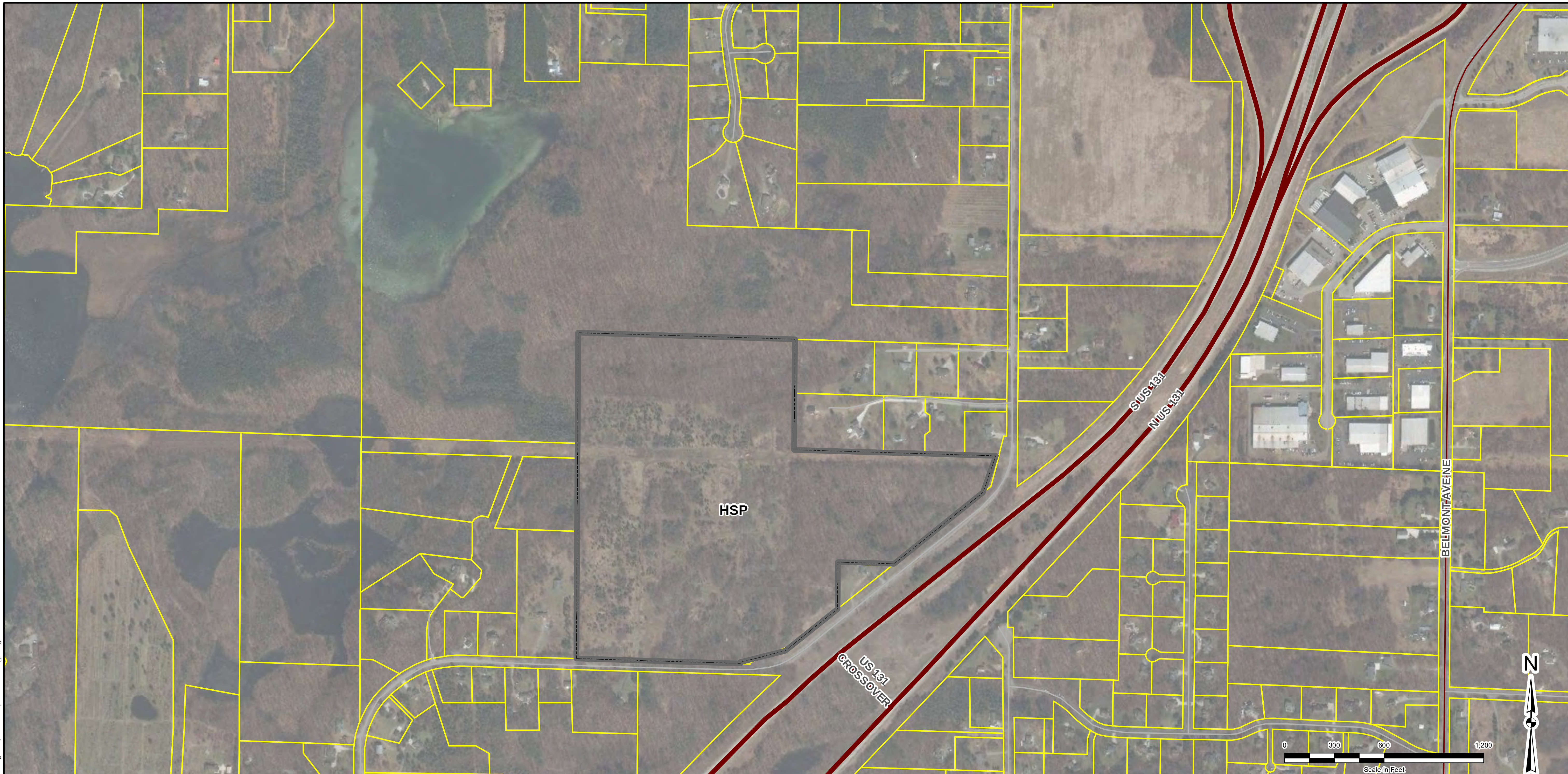
601 Fifth Street NW, Suite 102
Grand Rapids, Michigan 49504

HSP LOCATION PLAN
HOUSE STREET FEASIBILITY STUDY

GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR: WN&J/WWW

PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE 1
DESIGNED BY: KHM	DRAWN BY: JMG	SCALE: 1 inch = 1,500 feet	
DATE: **2/17/2021**	PROJECT NO. **16.0062961.80**	REVISION NO.	



Legend

- Approximate House Street Property (HSP) Boundary
- Parcel Boundary
- Highway
- Primary County
- Other Road

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Parcel boundaries were provided by Kent County.

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HSP AND SURROUNDING AREA
HOUSE STREET FEASIBILITY STUDY

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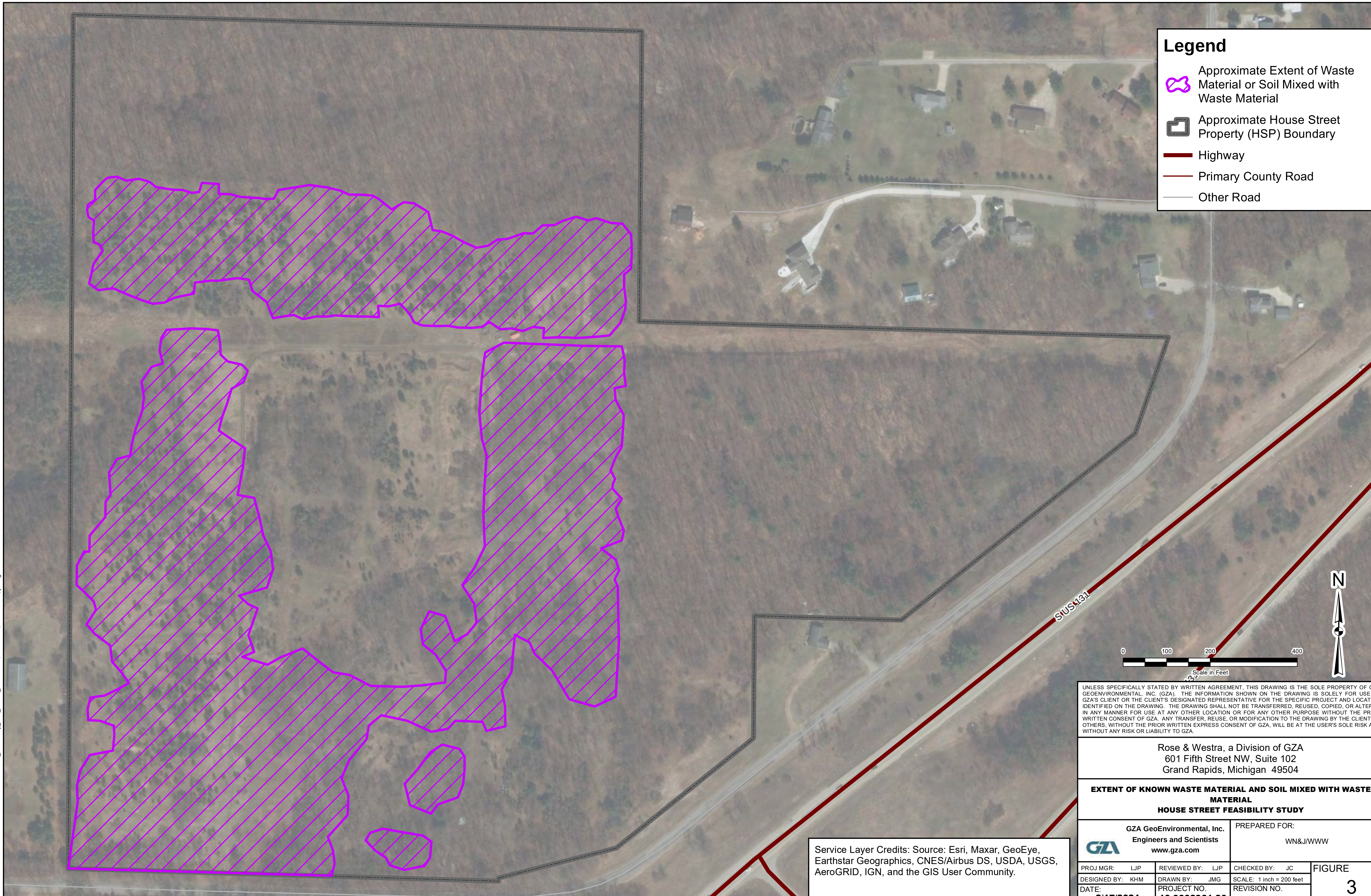
PREPARED FOR: WN&J/WWW

PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE 2
DESIGNED BY: KHM	DRAWN BY: JMG	SCALE: 1 inch = 600 feet	
DATE: 2/17/2021	PROJECT NO. 16.0062961.80	REVISION NO.	



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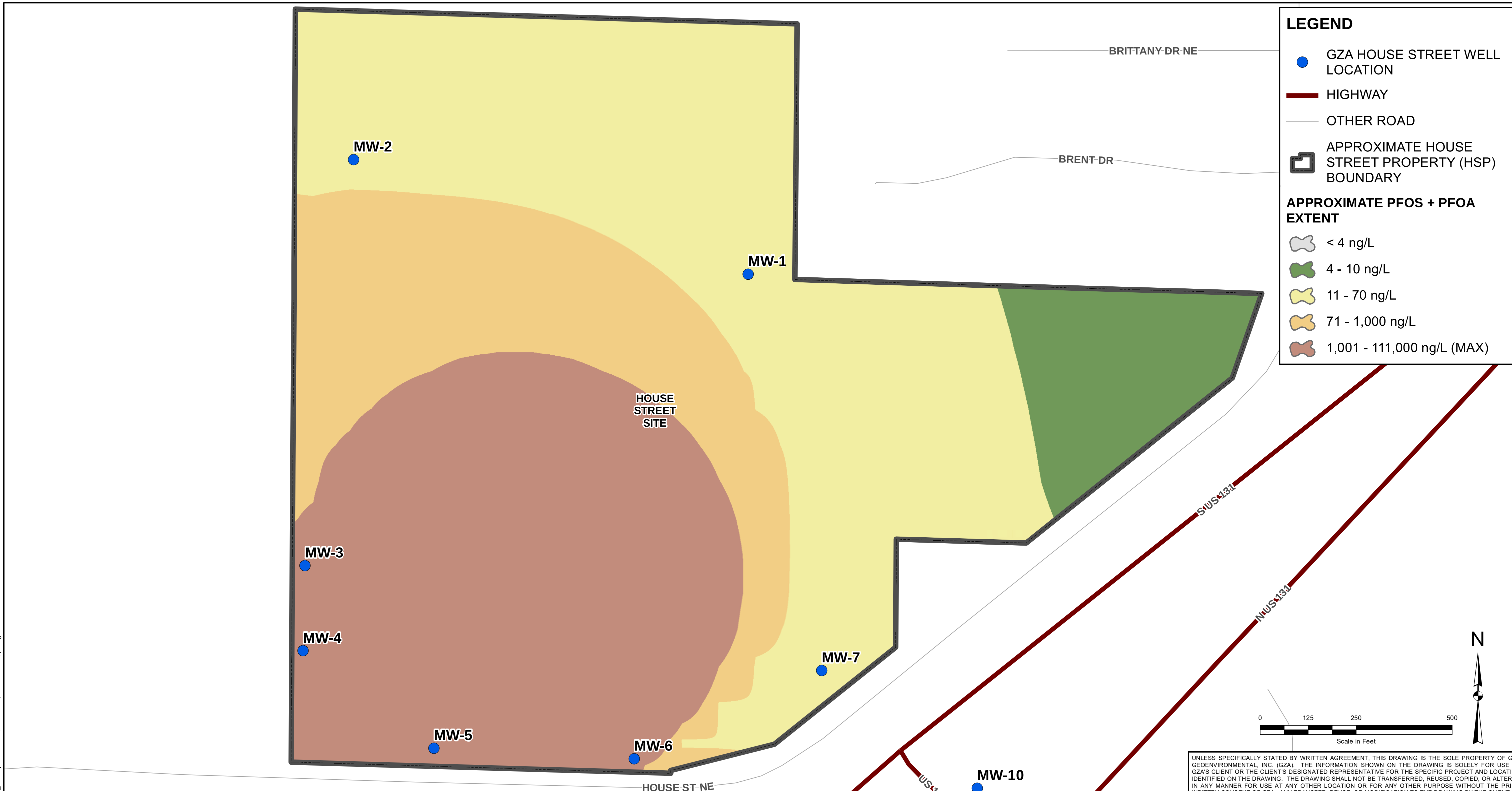
601 Fifth Street NW, Suite 102
Grand Rapids, Michigan 49504

EXTENT OF KNOWN WASTE MATERIAL AND SOIL MIXED WITH WASTE MATERIAL
HOUSE STREET FEASIBILITY STUDY

GZA GeoEnvironmental, Inc. **Engineers and Scientists** **www.gza.com**		PREPARED FOR: WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE 3
DESIGNED BY: KHM	DRAWN BY: JMG	SCALE: 1 inch = 200 feet	
DATE: **2/17/2021**	PROJECT NO. **16.0062961.80**	REVISION NO.	



NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

2. ACRONYMS
- (MAX) = MAXIMUM DETECTED CONCENTRATION IN THE SAMPLES.
- ng/L = NANOGRAM PER LITER
- PFOA = PERFLUORONOCTANOIC ACID
- PFOS = PERFLUOROOCTANE SULFONATE

3. MAXIMUM CONCENTRATION FROM MONITORING AND RESIDENTIAL WELL SAMPLE RESULTS (INCLUDING THE NORTH KENT LANDFILL STUDY AREA) WERE USED TO DEVELOP CONCENTRATION ISOPLETHS.

4. CONCENTRATION ISOPLETHS WERE DEVELOPED USING NATURAL NEIGHBOR INTERPOLATION IN ARCGIS. CONCENTRATIONS WERE NOT EXTRAPOLATED OUTSIDE OF THE AREA OF KNOWN CONCENTRATIONS.

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EXTENT OF KNOWN ON-SITE GROUNDWATER PLUME - PFOS + PFOA
HOUSE STREET FEASIBILITY STUDY

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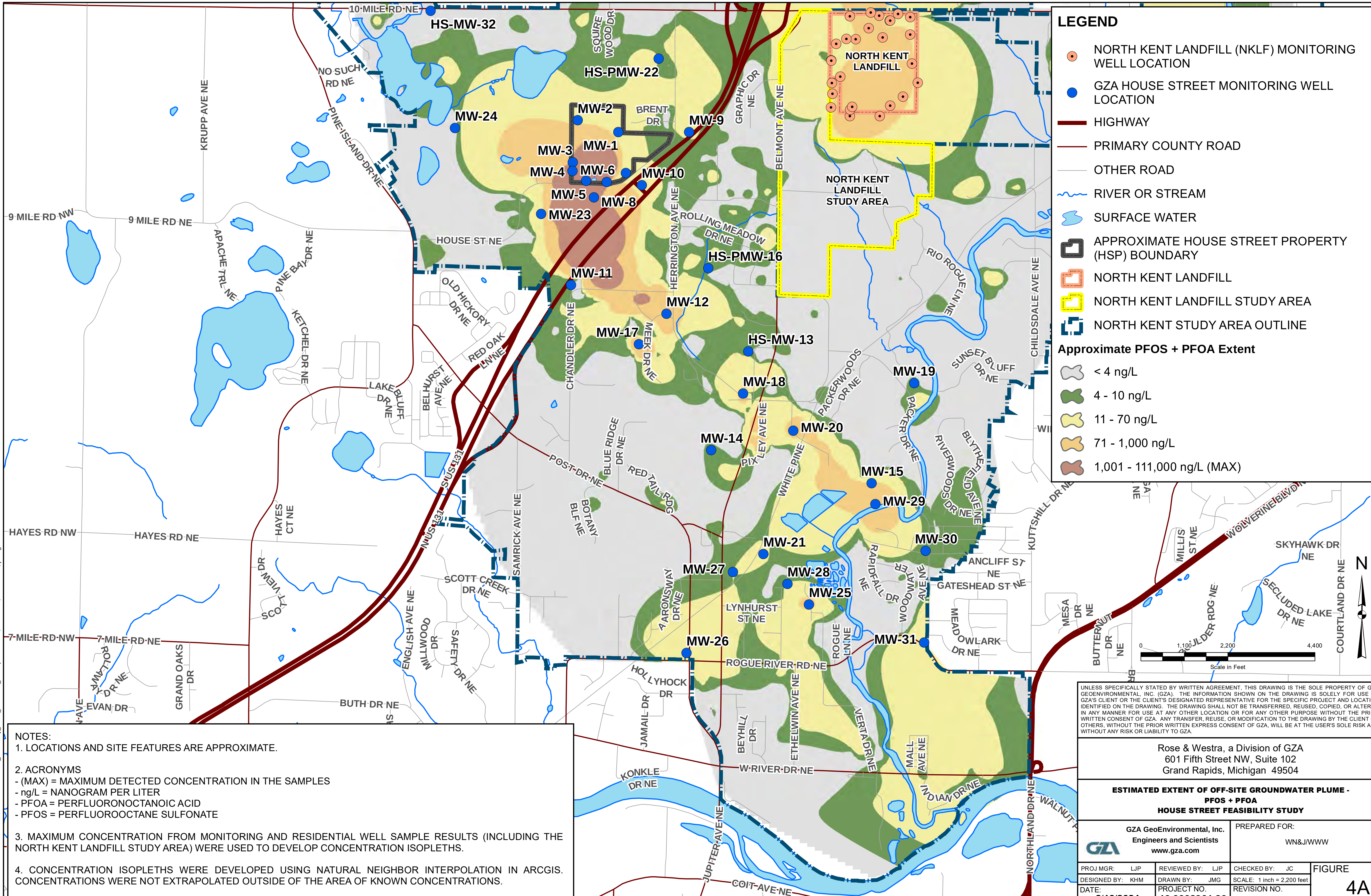
PREPARED FOR: WN&J/WWW

PROJ MGR: LIP	REVIEWED BY: LIP	CHECKED BY: JC	FIGURE 4
DESIGNED BY: KHM	DRAWN BY: ADM	SCALE: 1 inch = 250 feet	
DATE: 2/19/2021	PROJECT NO. 16.0062961.80	REVISION NO.	



LEGEND

- NORTH KENT LANDFILL (NKLF) MONITORING WELL LOCATION
- GZA HOUSE STREET MONITORING WELL LOCATION
- HIGHWAY
- PRIMARY COUNTY ROAD
- OTHER ROAD
- RIVER OR STREAM
- SURFACE WATER
- APPROXIMATE HOUSE STREET PROPERTY (HSP) BOUNDARY
- NORTH KENT LANDFILL
- NORTH KENT LANDFILL STUDY AREA
- NORTH KENT STUDY AREA OUTLINE

Approximate PFOS + PFOA Extent

- < 4 ng/L
- 4 - 10 ng/L
- 11 - 70 ng/L
- 71 - 1,000 ng/L
- 1,001 - 111,000 ng/L (MAX)

NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

2. ACRONYMS
- (MAX) = MAXIMUM DETECTED CONCENTRATION IN THE SAMPLES
- ng/L = NANOGRAM PER LITER
- PFOA = PERFLUORONOCTANOIC ACID
- PFOS = PERFLUOROOCTANE SULFONATE

3. MAXIMUM CONCENTRATION FROM MONITORING AND RESIDENTIAL WELL SAMPLE RESULTS (INCLUDING THE NORTH KENT LANDFILL STUDY AREA) WERE USED TO DEVELOP CONCENTRATION ISOPLETHS.

4. CONCENTRATION ISOPLETHS WERE DEVELOPED USING NATURAL NEIGHBOR INTERPOLATION IN ARCGIS. CONCENTRATIONS WERE NOT EXTRAPOLATED OUTSIDE OF THE AREA OF KNOWN CONCENTRATIONS.

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ESTIMATED EXTENT OF OFF-SITE GROUNDWATER PLUME - PFOS + PFOA
HOUSE STREET FEASIBILITY STUDY

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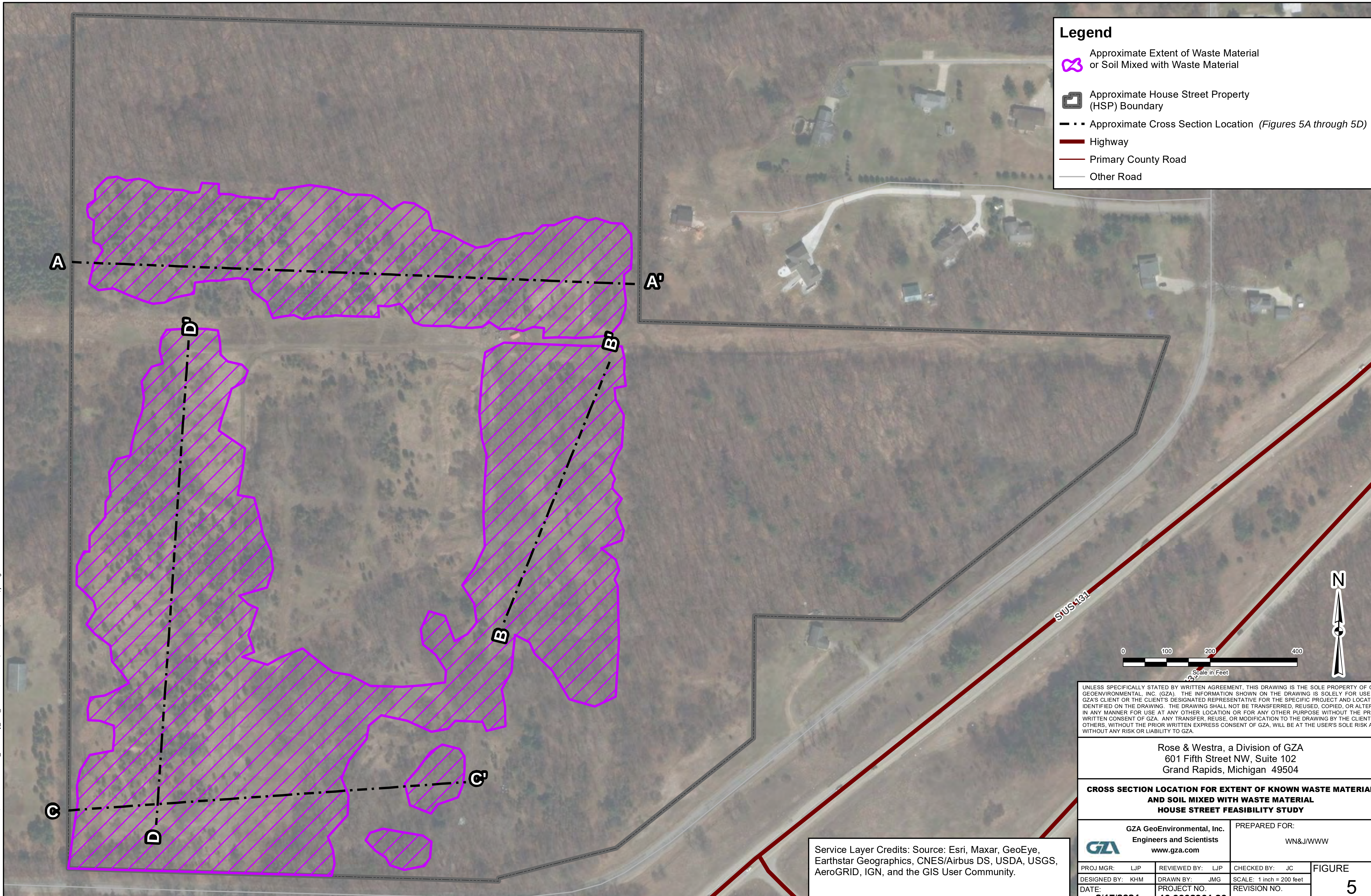
PREPARED FOR: WN&J/WWW

PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE 4A
DESIGNED BY: KHM	DRAWN BY: JMG	SCALE: 1 inch = 2,200 feet	
DATE: 2/19/2021	PROJECT NO. 16.0062961.80	REVISION NO.	



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CROSS SECTION LOCATION FOR EXTENT OF KNOWN WASTE MATERIAL AND SOIL MIXED WITH WASTE MATERIAL
HOUSE STREET FEASIBILITY STUDY

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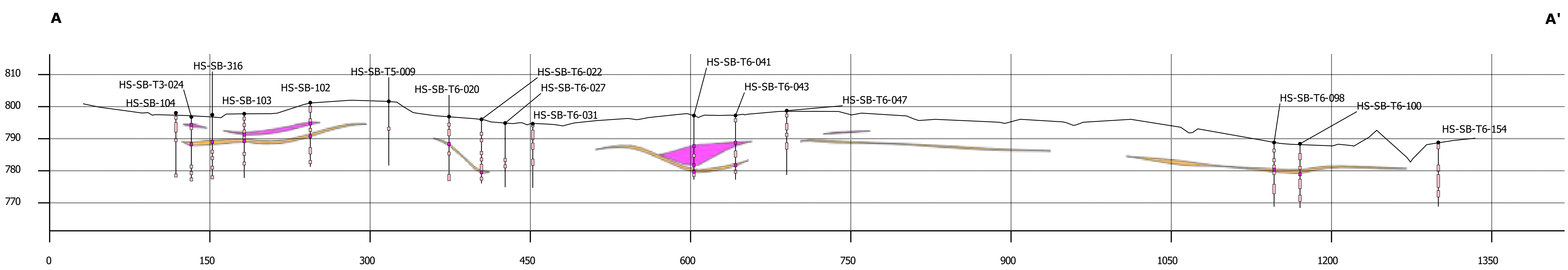
PREPARED FOR: WN&J/WWW

PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE
DESIGNED BY: KHM	DRAWN BY: JMG	SCALE: 1 inch = 200 feet	5
DATE: **2/17/2021**	PROJECT NO. **16.0062961.80**	REVISION NO.	

Figure 5A

Cross Section A - A'

View North



Legend

Observed Soil Conditions

No Waste | Waste

Modeled Waste Material

Estimated Waste Bottom | Waste

Topography

Location

A: 12787541, 588746

A': 12788958, 588694

Scale: 1:1,100

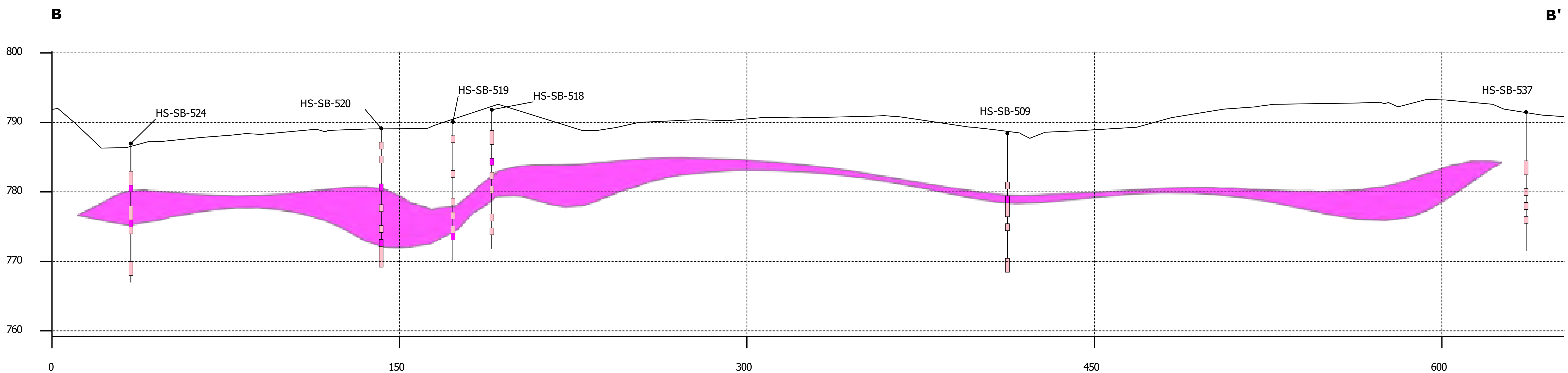
Vertical exaggeration: 3x

0ft 300ft

Figure 5B

Cross Section B - B'

View West



Legend

Observed Soil Conditions

No Waste
Waste

Modeled Waste Material

Waste

Topography

Location

B: 12788604, 587917

B': 12788801, 588539

Scale: 1:520

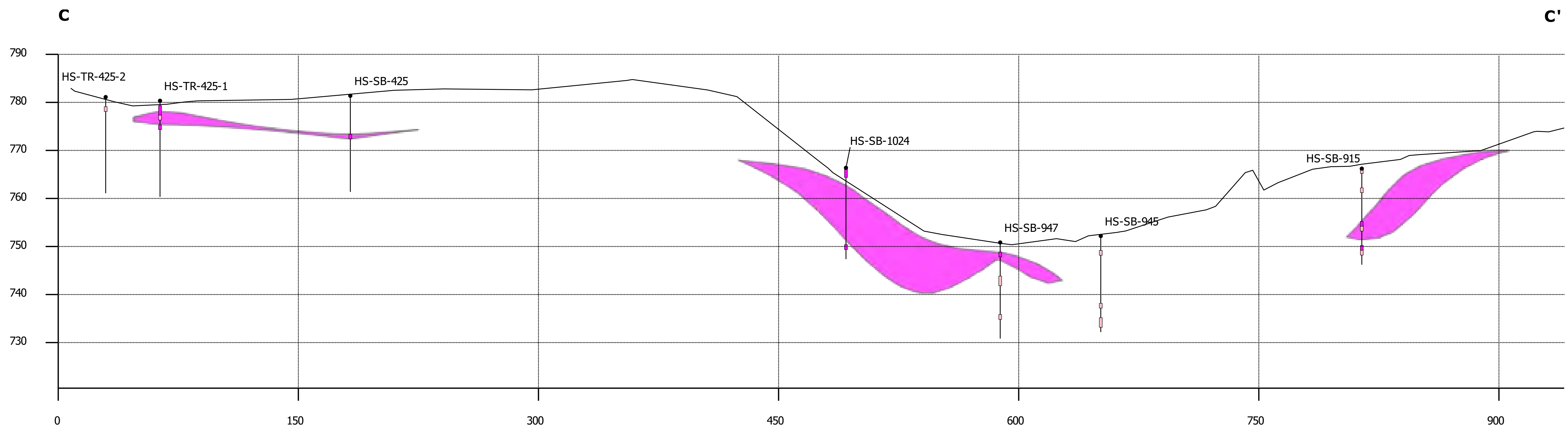
Vertical exaggeration: 3x

0 ft 75 ft

Figure 5C

Cross Section C - C'

View North



Legend

Observed Soil Conditions

No Waste

Waste

Modeled Waste Material

Waste

Topography

Location

C: 12787556, 587496

C': 12788495, 587563

Scale: 1:800

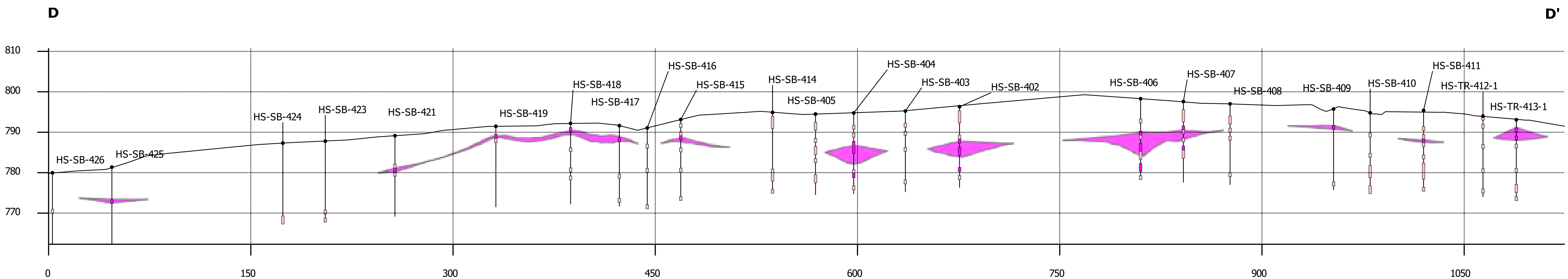
Vertical exaggeration: 3x

0ft 150ft

Figure 5D

Cross Section D - D'

View West



Legend

Observed Soil Conditions

No Waste
Waste

Modeled Waste Material

Waste

Topography

Location

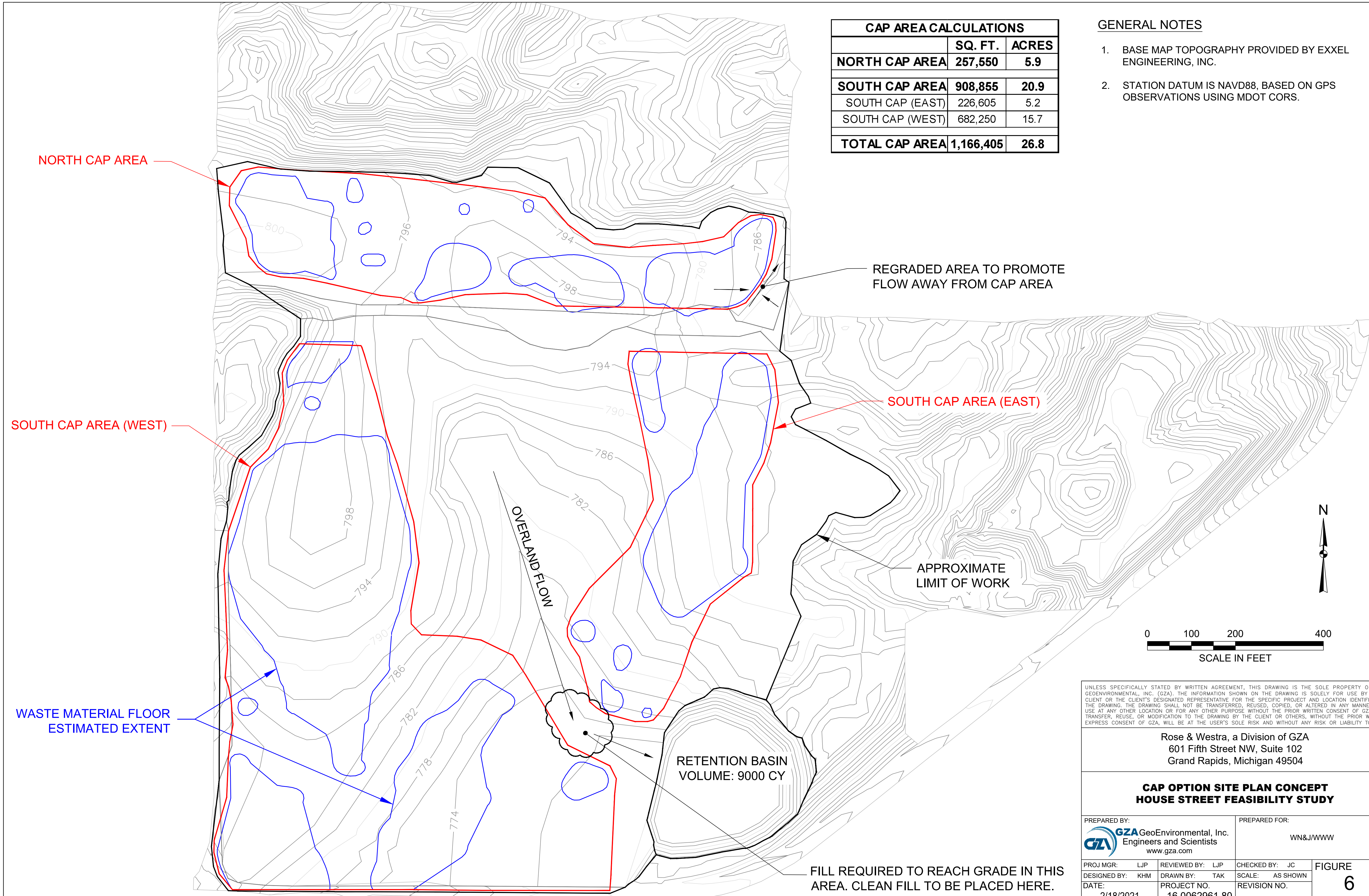
D: 12787727, 587459

D': 12787803, 588581

Scale: 1:850

Vertical exaggeration: 3x

0ft 150ft



CAP AREA CALCULATIONS		
	SQ. FT.	ACRES
NORTH CAP AREA	**257,550**	**5.9**
SOUTH CAP AREA	**908,855**	**20.9**
SOUTH CAP (EAST)	226,605	5.2
SOUTH CAP (WEST)	682,250	15.7
TOTAL CAP AREA	**1,166,405**	**26.8**

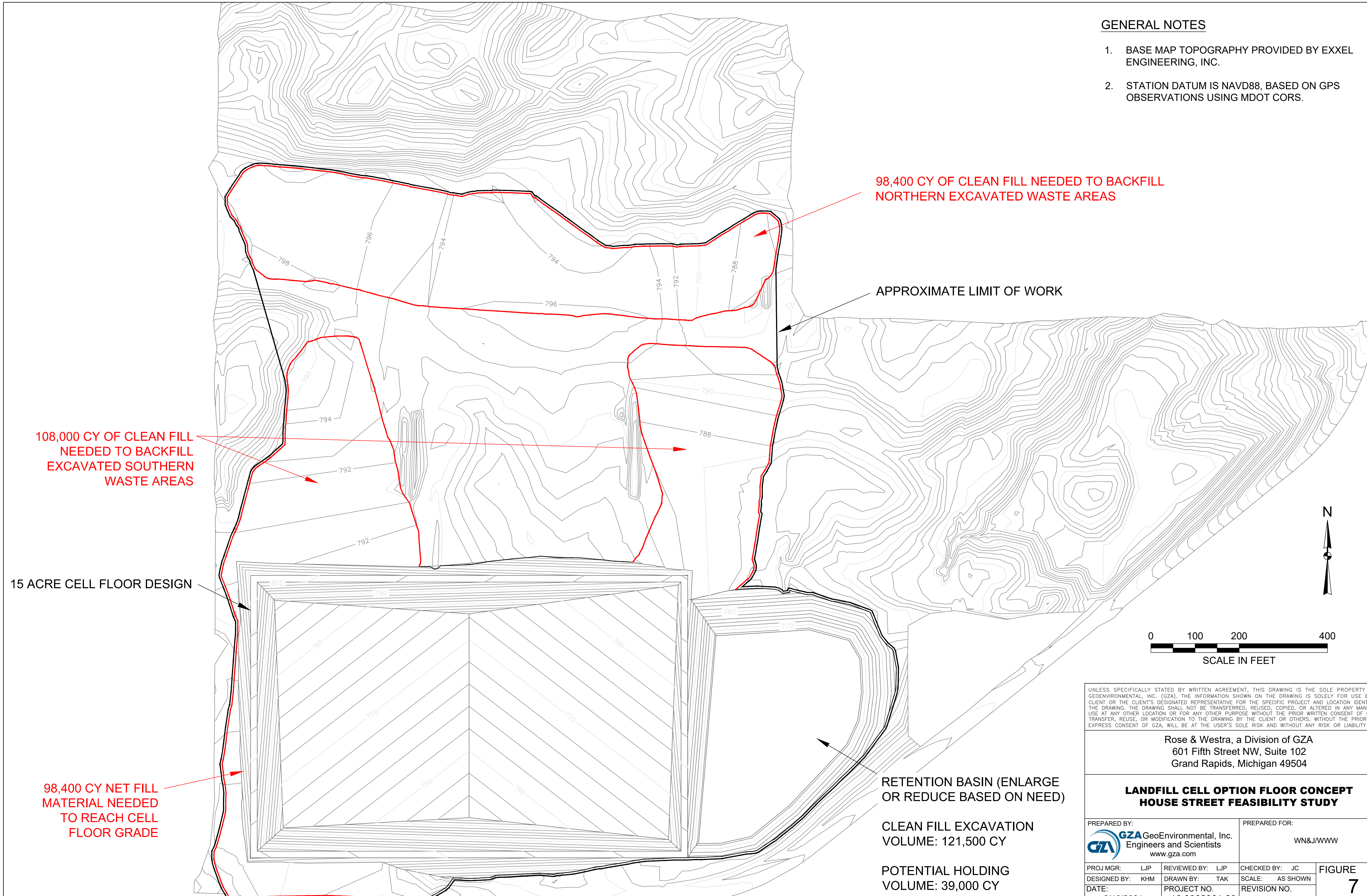
GENERAL NOTES

1. BASE MAP TOPOGRAPHY PROVIDED BY EXXEL ENGINEERING, INC.
2. STATION DATUM IS NAVD88, BASED ON GPS OBSERVATIONS USING MDOT CORS.

Rose & Westra, a Division of GZA
601 Fifth Street NW, Suite 102
Grand Rapids, Michigan 49504

CAP OPTION SITE PLAN CONCEPT
HOUSE STREET FEASIBILITY STUDY

PREPARED BY:		PREPARED FOR:	
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE 6
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: 2/18/2021	PROJECT NO. 16.0062961.80	REVISION NO.	



GENERAL NOTES

1. BASE MAP TOPOGRAPHY PROVIDED BY EXXEL ENGINEERING, INC.
2. STATION DATUM IS NAVD88, BASED ON GPS OBSERVATIONS USING MDOT CORS.

0 100 200 400
SCALE IN FEET

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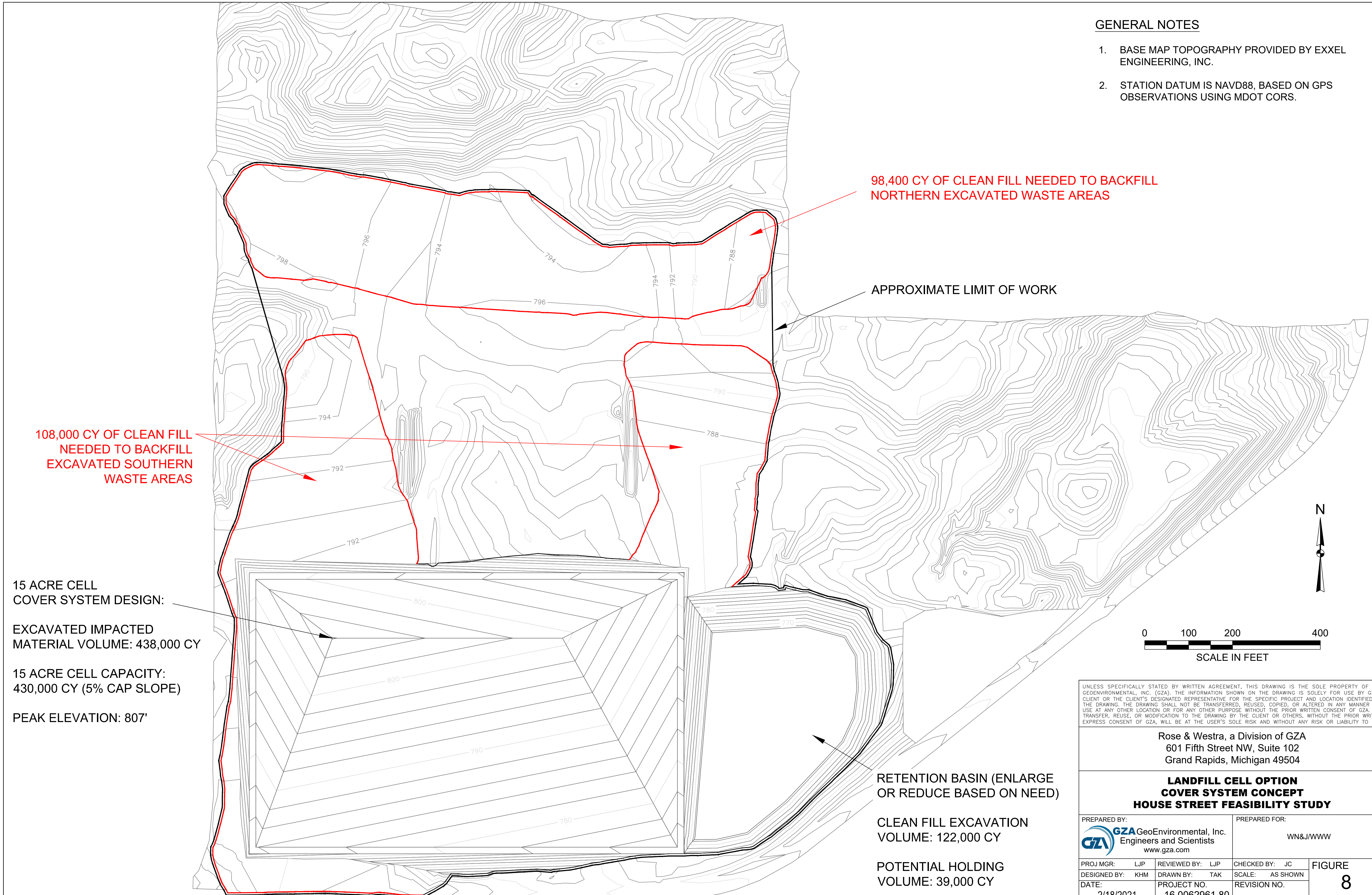
Grand Rapids, Michigan 49504

LANDFILL CELL OPTION FLOOR CONCEPT
HOUSE STREET FEASIBILITY STUDY

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: WN&J/WWW	
PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE 7
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	
DATE: 2/18/2021	PROJECT NO. 16.0062961.80	REVISION NO.	



GENERAL NOTES

1. BASE MAP TOPOGRAPHY PROVIDED BY EXXEL ENGINEERING, INC.
2. STATION DATUM IS NAVD88, BASED ON GPS OBSERVATIONS USING MDOT CORS.

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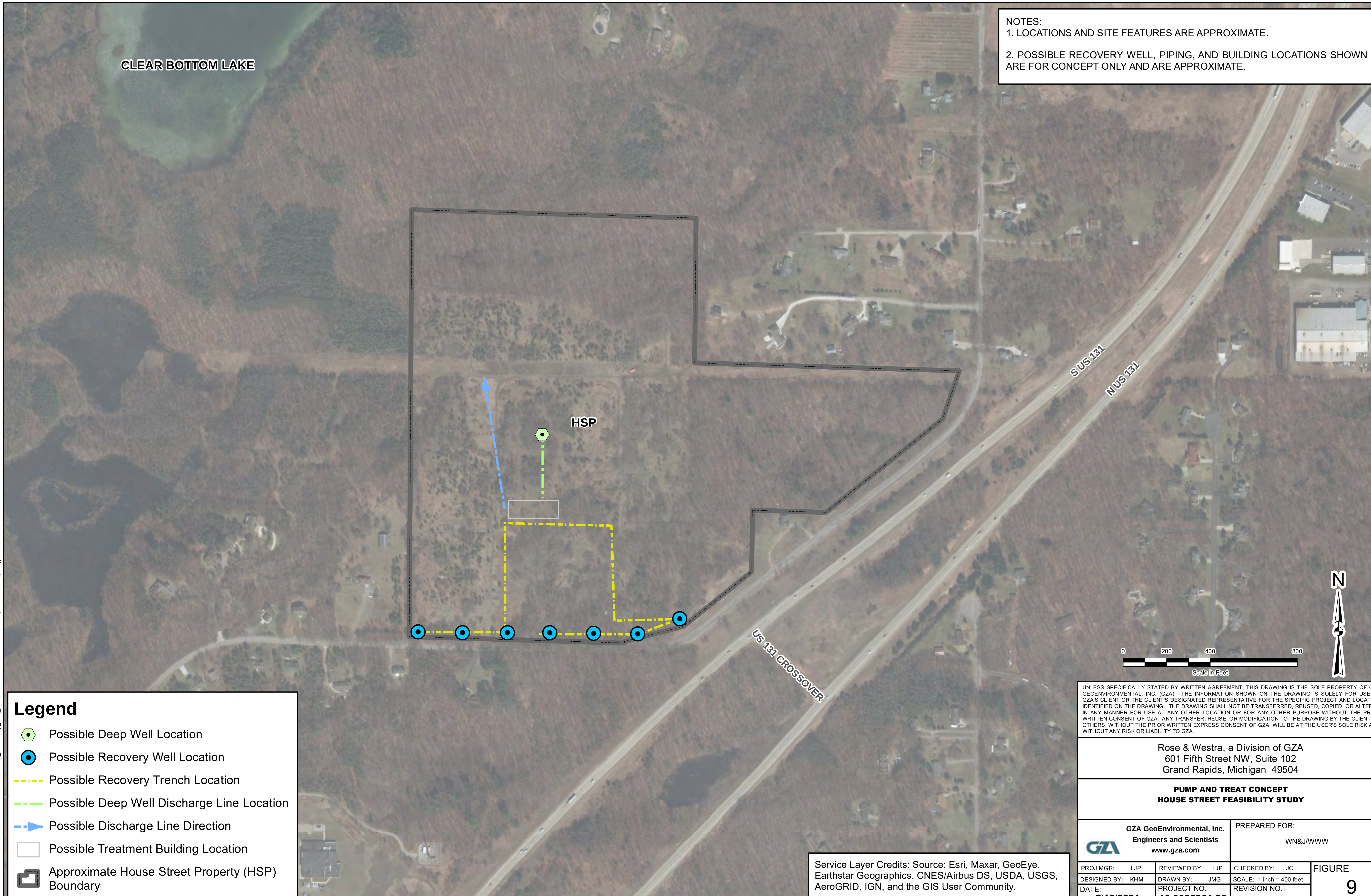
Grand Rapids, Michigan 49504

LANDFILL CELL OPTION
COVER SYSTEM CONCEPT
HOUSE STREET FEASIBILITY STUDY

PREPARED BY:	PREPARED FOR:
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com	WN&J/WWW

PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE
DESIGNED BY: KHM	DRAWN BY: TAK	SCALE: AS SHOWN	8
DATE: 2/18/2021	PROJECT NO. 16.0062961.80	REVISION NO.	



NOTES:
1. LOCATIONS AND SITE FEATURES ARE APPROXIMATE.

2. POSSIBLE RECOVERY WELL, PIPING, AND BUILDING LOCATIONS SHOWN ARE FOR CONCEPT ONLY AND ARE APPROXIMATE.

Legend

- Possible Deep Well Location
- Possible Recovery Well Location
- Possible Recovery Trench Location
- Possible Deep Well Discharge Line Location
- Possible Discharge Line Direction
- Possible Treatment Building Location
- Approximate House Street Property (HSP) Boundary

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

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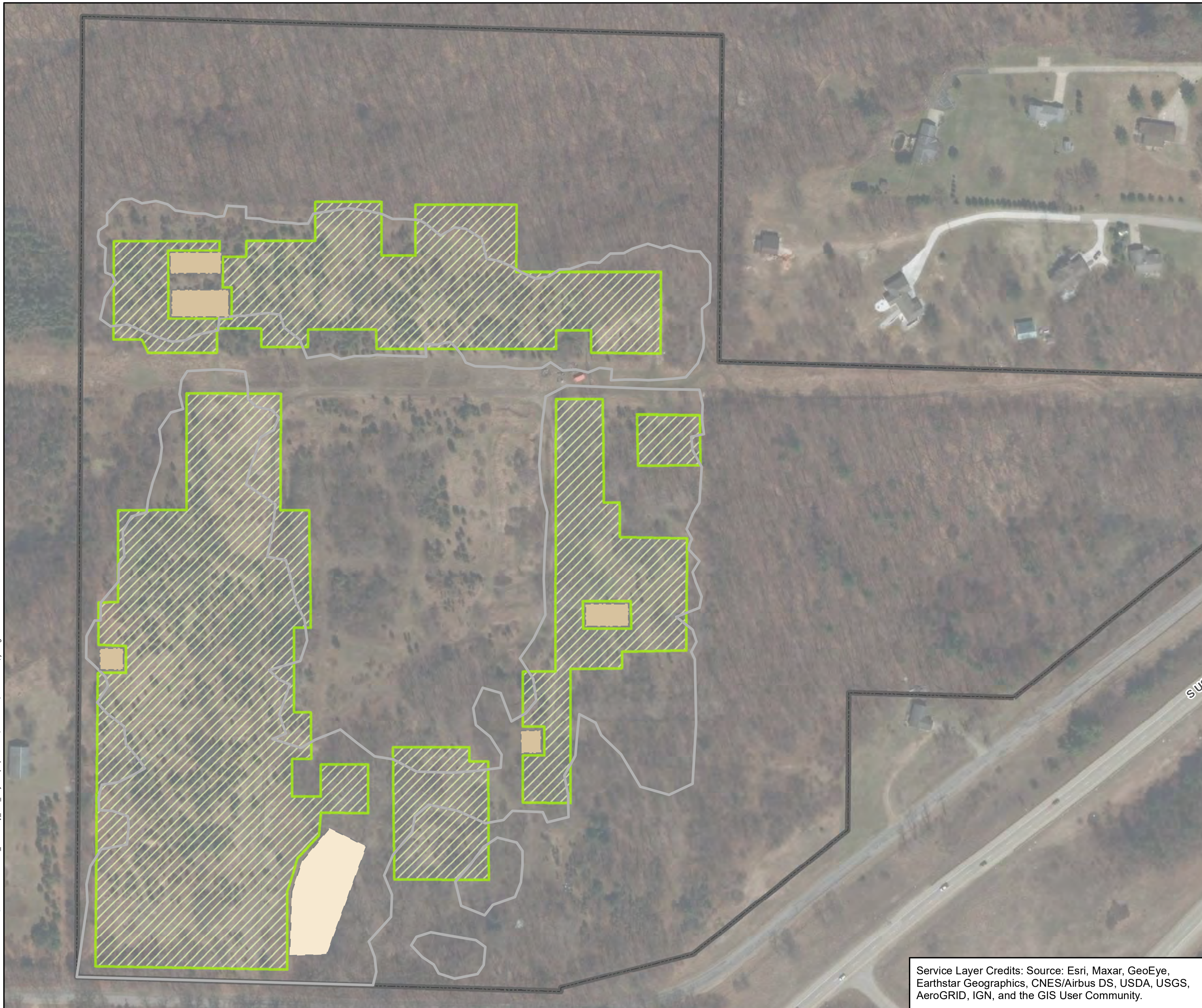
Grand Rapids, Michigan 49504

PUMP AND TREAT CONCEPT
HOUSE STREET FEASIBILITY STUDY

GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR: WN&J/WWW

PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE 9
DESIGNED BY: KHM	DRAWN BY: JMG	SCALE: 1 inch = 400 feet	
DATE: 2/19/2021	PROJECT NO. 16.0062961.80	REVISION NO.	



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Grand Rapids, Michigan 49504

PHYTO-CAP OPTION CONCEPT
HOUSE STREET FEASIBILITY STUDY

GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
WN&J/WWW

PROJ MGR: LJP	REVIEWED BY: LJP	CHECKED BY: JC	FIGURE 10
DESIGNED BY: KHM	DRAWN BY: JMG	SCALE: 1 inch = 200 feet	
DATE: **2/19/2021**	PROJECT NO. **16.0062961.80**	REVISION NO.	

PHYTOREMEDIATION

LANDFILL CAP

GATED ACCESS

Areas of waste material that have existing mature tree growth will be evaluated for possible phytoremediation supplementation. Note, all features are approximate.

HOUSE STREET PROPERTY PHYTO-CAP OPTION RENDERING

HOUSE STREET INVESTIGATION FEASIBILITY STUDY

PREPARED FOR:
WN & J/WWW

0 100 200 400
SCALE IN FEET

PREPARED BY:

ROSE & WESTRA, A DIVISION OF GZA
601 FIFTH STREET NW, SUITE 102
GRAND RAPIDS, MICHIGAN 46504

DATE: 2/16/2021

FIGURE
11

APPENDIX A – R&W/GZA QUALIFICATION DOCUMENTATION

Proactive by Design

GZA SOLID WASTE DESIGN SERVICES
STATEMENT OF QUALIFICATIONS
December 31, 2019

GZA Solid Waste Design Services Qualifications

GZA Experience Overview

GZA has provided environmental investigation, engineering and design services on more than 500 solid waste management facilities nationwide and in several foreign countries. Solid waste management services are provided mainly by our Buffalo, New York and Providence, Rhode Island offices, with technical and field support provided by other offices in the Midwest and Northeast.

We have provided design and construction oversight services for ash containment cell liners and final cover systems at 2 coal-fired electric generating plants in western New York. In addition to our landfill-related work, we have also performed regulatory compliance work (SPCC, SWPPP, BMPs, etc.) and are currently guiding a major energy client through the New York State Brownfield Cleanup Program – showing our breadth of experience for the energy industry.

Our landfill experience covers from the investigation/evaluation phase of a project through to permitting, design, CQA and direct survey data upload for providing construction level layout and final survey certification.

Our landfill work in Rhode Island includes a number of firsts; including the first Brownfields Landfill Redevelopment (Manton Avenue Landfill/Stop & Shop Site in Providence where we used Deep Dynamic Compaction to lower grades and prepare building pads for construction); the largest actively operating landfill and Superfund site (the 330 acre Central Landfill in Johnston, RI), the first voluntary landfill assessment and closure under RIDEM's program (the Jamestown Landfill & Transfer Station in Jamestown) and geotechnical and landfill gas assessment for Rhode Island's first on-landfill solar development (Forbes Street Landfill, E. Providence, RI).

Technical expertise, innovation, and responsiveness are GZA trademarks that have earned us a national reputation as a high-quality firm. Our awareness of, and attention to, the commercial aspects of our clients' business also sets us apart from other environmental engineering firms. Specific to your needs, we have practical and proven landfill cell and closure design, ecological risk and restoration and extensive Superfund experience, and our organization makes that experience readily available. Our success on these projects is, in no small part, due to the strong relationship we have developed with EPA Region 1 and state regulators. GZA has the proven ability to overcome regulatory hurdles having demonstrated hybrid cap equivalency, negotiated two ESD's and one ROD modification at Rhode Island Superfund landfills. We note that the strength of these relations arise from respect for our technical expertise and our understanding of the regulations. We have invested significant time volunteering on numerous RIDEM task forces and our clients have benefited directly from these activities.

Detailed Project Descriptions are attached. A summary of the solid waste/remedial facilities are as follows:

"The GZA team understands National Grid's challenges and objectives, and consistently looks for ways to assist in meeting those objectives in accordance with regulatory requirements."

Elizabeth Greene, National Grid

Project Experience Relevant to Vectren Energy

1. Somerset Operating Company, LLC (fka AES Somerset, LLC), Barker, NY – Provided design and CQA services over the past 12 years for six sub-cell liners, final cover systems and sedimentation basin re-linings. Successfully obtained a Beneficial Use Determination (BUD), through the New York State DEC, to allow using coal ash for cell subgrade construction. Updated site wide SPCC, SWPPP, Spill Prevention Report and BMP. Currently providing design for: developing a final grading plan for balancing cut/fill volumes to provided proper grading to close out 35 acres of open cell area; final cover system including sizing drainage structures; quantifying available soil borrow for low permeability soil barrier.

2. NRG Dunkirk Power, Dunkirk, NY – Design and CQA services for construction of a 5.5-acre ash containment cell. Services also included a borrow source evaluation to determine the existing volume and adequacy of the borrow for use as a low permeability soil barrier.

3. NRG Energy, Huntley Station, Tonawanda, NY – Conducted an embankment stability assessment for a berm separating their settlement pond from the Niagara River. Our findings determined that the existing embankment had a low hazard classification and that no remedial construction was required. Currently providing environmental engineering services for their entry into the NYS Brownfield Cleanup Program.

4. Central Landfill, RI – Large Superfund/NPL landfill with multiple operable units; demonstrated RCRA C cap equivalency with a hybrid cap design; obtained No Action determination for OU2 thru focused human health and ecological risk evaluation.

5. Fresh Kills Landfill, Staten Island, NY – Large CERCLIS landfill closure (Phase 6/7 is 290 acres); challenges included overfilling and waste consolidation, mitigating wetland impacts, limited storm water management options; the landfill being transformed into a park.

6. McKenna Landfill, Orleans County, NY - Superfund landfill, located on the NY Barge Canal system. GZA's scope included capping alternatives evaluation; successful negotiation with numerous agencies including NYSDEC, NYS Canal Corporation and US Army Corps of Engineers.

7. Grant Gear Manufacturing facility, Norwood, MA – Superfund site, waste/soil excavation, consolidation, and capping; effective PRP advocacy in negotiations with US EPA Region 1 and Department of Justice; remedial strategy developed to result in cost-effective closure and to promote site redevelopment.

8. Allied Waste, Niagara Falls Landfill - RCRA Subtitle D Landfill 80-acre expansion involving reclamation of adjacent fill area and waste consolidation; design plans, specifications and procurement assistance; and complex construction phasing and management. Conducted a comprehensive hydrology/hydraulic study of this 370-acre site and provided design for a major re-direction of stormwater flows, incorporating 3 box culverts, and riprap drainage channels. We have provided permitting, design and CQA oversight continuously for over 30 years at this site.

9. Wyman Gordon Facility, N. Grafton, MA – PCB Risk-Based Clean-up (RBC) under EPA Region 1 TSCA. GZA consolidated PCB containing waste soils on-site and created a disposal cell with modified RCRA D cap. Clean-up goal for soil approved by EPA was an average concentration of ≤0.9 mg/kg with a maximum residual (point-by-point) concentration of 18 mg/kg.

10. Coventry Landfill, RI - CERCLIS landfill/State Superfund Site, work with large responsible party group, complex multi-media investigation, negotiated soil-only cap with State regulators, creative closure design allowing offset of closure cost thru a BUD soil program.

GZA Personnel

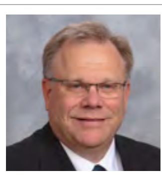
GZA personnel offers the talent, skills, desire, experience, and resources to provide a wide range of solid waste design and construction support services.

Senior members of GZA's Team bring over 80 years of solid waste design experience to benefit Vectren. Specifically, our personnel bring the following benefits:

- Proven successes designing and constructing complex landfill projects, including successfully demonstrating RCRA C cap equivalency using a hybrid cap design;
- In-depth regulatory experience and understanding, and a track record in developing successful working relationships with regulators;
- Pragmatic and cost-effective technical approaches that are flexible enough to address unanticipated changes and issues raised by stakeholders.
- Our proven ability to incorporate sophisticated geotechnical engineering principles into creative and cost saving designs.

Effective management on any project requires committing the right people to meet the technical, schedule, and cost challenges of the project. Effective management also requires clear and concise communication between project personnel, the Client and appropriate regulatory agencies and stakeholders. We believe GZA has the breadth of experience to provide Vectren with the highest level of quality and service to achieve the overall project goals.

Qualifications of key GZA Personnel are summarized below, with their resumes attached.



Bart A. Klettke, P.E. (NY) – Technical Design Lead. Mr. Klettke is a Principal with the firm and has over 35 years of professional experience. Klettke attained his Bachelor of Science Degree in Civil Engineering from Valparaiso University. He serves as the Solid Waste Technical Practice Lead for the entire company. He has permitted, designed, managed the construction of landfill liners and closures for many solid waste management facilities. He is experienced in performing and supervising landfill liner and closure designs, site civil designs, geotechnical investigations/designs, and CQA monitoring programs. His project experiences, highlighted on his resume, demonstrates the depth of his successes associated with solid waste facility liner design and closure engineering. His experience is illustrated in the Project Descriptions for the AES Somerset, NRG Energy, McKenna, Allied Waste and western New York landfill projects. As a Principal in the firm, he has the authority to implement the resources needed and oversee project execution to meet those needs and goals in a responsive and cost-efficient manner.

Senior members of GZA's Team bring over 80 years of solid waste design experience to benefit Vectren.

Edward Summerly, PG (RI). Edward Summerly, is a Principal with the firm and a registered Professional Geologist. He holds a Bachelor of Science Degree in Geology from the University of Rhode Island and a certification in Geological Field Studies from the University of Texas. Mr. Summerly has over 30 years of experience in the environmental engineering field. He has served as technical lead on numerous large multidisciplinary projects within the solid waste industry including the Central Landfill, Fresh Kills Landfill and Coventry Landfill projects. Ed's experience includes EPA Superfund studies and remediation, landfill permitting, and geohydrologic studies, site investigations, regulatory compliance, and environmental testing at more than 30 solid waste facilities in New England, New York and the Midwest. Ed has a broad environmental background, extensive landfill engineering experience, and landfill gas design experience along with his proven management capabilities. As a Principal and Sr. Vice President in the firm, he has the authority to implement the resources need by the GZA Project Team and oversee project execution to meet those needs and goals in a responsive and cost-efficient manner.

Todd Greene, PE (RI) - Project Manager - Design Services. Mr. Greene is a Sr. Technical Consultant with GZA and has 23 years of design experience on civil, landfill and environmental engineering projects. Specific project experience includes hydrology, storm water management, site grading, landfill baseliner design and landfill construction oversight, landfill capping design and cap construction oversight, and landfill gas collection system design. Notably and as presented on the Project Descriptions, Todd served as Project Manager and lead designer on the Fresh Kills Landfill, Central Landfill and Coventry Landfill closure projects.

Ted Klettke – Project Engineer/Designer. Ted Klettke has extensive landfill design and construction oversight experience. His designs incorporate 3-dimensional surface models for direct data upload for machine-control grading and survey certification. He is proficient in Sketchup Pro 3-Dimensional Modeling to portray easily understandable visual models of site and design features such as groundwater contours, buildings, subsurface features, and aerial topography for landfill-related designs. He has produced 3-Dimensional Virtual Walkthrough Videos of several work sites for presentations to clients, contractors and regulators.

"GZA has always been a pleasure to work with. Their knowledge, expertise and attitude are second to none and GZA delivers a quality product."

Ed Hughes, Massachusetts Department of Conservation and Recreation

Michael Kress – Assistant Project Manager. Mr. Kress has over 12 years of professional experience including geotechnical engineering, construction management, contracting, project budgeting and scheduling, oversight of MGP and brownfield remediation, development of storm water management plans and construction specifications. Michael has extensive field experience in geotechnical subsurface investigations, solid waste management facility design, construction, management, and construction quality assurance monitoring. His responsibilities have included management of subsurface exploration programs, monitoring well design and observation and logging of soil and rock samples. His AutoCAD skills have been utilized in the design and layout of landfill systems, details and Site plans.

References

Edward Segali Superintendent *Fresh Kills Landfill Project*	Tully Construction Co. 127-50 Northern Boulevard Flushing, NY 11368	718.446.7000
Claude Cote, Esq. Director of Regulatory Compliance and Safety *(Kahuku Wind Energy Clean-up Project)*	Sun Edison 179 Lincoln Street/Suite 500 Boston, MA 02111	207-480-0499
Michael Gray Public Works Director *(Jamestown Landfill Closure Project)*	Town of Jamestown 93 Narragansett Ave Jamestown, RI 02835	401.423.7225
Mark Zimmerman Operations Manager *(AES Somerset Ash Containment Facility)*	Somerset Operating Co. 7725 Lake Road Barker, NY 14012	716.696.2463

Ralph Larimore Environmental Manager *Allied Waste Niagara Falls Landfill*	Republic Services 5600 Niagara Falls Blvd. Niagara Falls, NY 14304	716.371.4222
George Streit Operations Manager *(NRG Huntley and Dunkirk Facilities)*	NRG Energy, Inc. 106 Point Drive North Dunkirk, NY 14150	716.200.2797
Brian Card Director of Engineering and Operations *(Central Landfill Project)*	RIRRC 65 Shun Pike Johnston, RI 02835	401.942.1430

Proactive by Design

PROJECT DESCRIPTIONS

GZA Solid Waste Statement of Qualifications:
December 30, 2019

Project Highlights

- **Design/Contractor Bid Solicitation**
- **Relined Active Retention Basins**
- **Construction Quality Assurance**
- **Engineering Budget: $240K; Construction Budget: $5.1 Million**

AES Somerset LLC Solid Waste Disposal Area II, Phases C & D Landfill Liner & Relining of Retention Basins

BARKER, NY

GZA provided engineering design and construction quality assurance (CQA) monitoring services for construction of a 14-acre landfill cell and relining of two active retention basins for this 675 megawatt, coal-fired electric generating station on the south shore of Lake Ontario in upstate New York.

GZA modified the existing engineering reports, drawings, technical specifications and QA/QC Plan to replace the original design geosynthetic clay liner (GCL) with an HDPE geomembrane in accordance with newly imposed regulatory requirements. We performed a slope stability analysis to demonstrate that the revised design was stable.

The design for relining the 2 retention basins required removal of existing pond sediments and relining the base and side slopes with 12 inches of low permeability soil and an HDPE geomembrane. The pond configurations were altered to maximize capacity and modifications were made to the pond inlet channels and outlet structures. We developed a dewatering plan to allow bypass of stormwater inflow during basin relining.

GZA developed construction-level drawings, technical specifications and a construction QA/QC plan to sufficiently define the proposed work in soliciting contractor proposals. Drawing development included establishing a 3-D computer model of the landfill layers for direct data transfer to the contractor and certifying surveyor. The 3 lowest contractor bids were within 3% of GZA's engineer's estimate for this $5.1 million project.

GZA provided CQA monitoring during the landfill subgrade and liner construction. The CQA program included density test monitoring and collecting undisturbed tube samples of the compacted clay liner. Monitoring of the geomembrane installation required detailed construction documentation including assigning destructive sample tests, observation of non-destructive tests and placement of overlying materials.

GZA coordinated between the Owner, earthwork and geosynthetics contractors, project surveyor and the regulator on a tight project schedule to complete the project within budget. GZA reviewed contractor submittals and prepared a construction certification report documenting the landfill cell construction.

GZA was retained in 2008 by AES Somerset to provide design and CQA monitoring services for construction of SWDA II, Phases E & F East (10 acres) in 2008 and 2010. GZA prepared construction-level drawings, technical specifications and a construction QA/QC plan to solicit contractor proposals.

Project Highlights

- Design/Contractor Bid Solicitation
- Construction Quality Assurance
- Prepared Beneficial Use Determination (BUD) Application for waste materials

AES Somerset LLC Solid Waste Disposal Area II, Phases E & E East Landfill Liner

BARKER, NEW YORK

GZA provided engineering design and construction quality assurance (CQA) monitoring services for construction of a 10-acre landfill cell for this 675 megawatt, coal-fired electric generating station on the south shore of Lake Ontario in upstate New York.

GZA developed construction-level drawings, technical specifications and a construction QA/QC plan to sufficiently define the proposed work in soliciting contractor proposals. Drawing development included establishing a 3-D computer model of the landfill layers for direct data transfer to the contractor and certifying surveyor.

GZA provided CQA monitoring during the landfill subgrade and liner construction over a two year period. The CQA program included performing density testing of the subgrade and clay liner materials. Bulk samples of these materials were collected and tested for physical parameters and compared to established specifications. Undisturbed Shelby tube samples were collected from the compacted clay liner to asses permeability properties. Monitoring of the geomembrane installation required detailed construction documentation including assigning destructive sample tests, observation of non-destructive tests and placement of overlying materials.

GZA coordinated between the Owner, earthwork and geosynthetics contractors, project surveyor and the regulator on a tight project schedule to complete the project within budget. GZA reviewed contractor submittals and prepared a construction certification report documenting the landfill cell construction.

GZA prepared an application for Beneficial Use Determination (BUD) to use a coal by-product (bottom ash) to be used as subgrade material to build the foundation of the landfill. The application was submitted to and subsequently approved by the NYSDEC. The use of this waste material in future cell construction will benefit the client by reducing the cost of fill soils purchased and imported from off-site sources.

NRG Dunkirk Power, LLC
Solid Waste Management Facility, Cell B2
POMFRET, NEW YORK

GZA provided engineering design and construction quality assurance (CQA) monitoring services for construction of a 5.5-acre landfill cell for ash waste generated from the Dunkirk coal-fired electric generating station on the southern shore of Lake Erie in upstate New York.

GZA generated engineering reports, drawings, technical specifications and QA/QC Plan for construction of a landfill liner consisting of low permeability soil and HDPE geomembrane liner in accordance with newly imposed regulatory requirements. We also performed a slope stability analysis to demonstrate that the proposed design was stable.

The general design included preparation of subgrade soil and placement of required thickness of subbase soils within the Cell B2 foot print. A minimum two feet of secondary low permeability soil followed by one foot of primary low permeability soil and HDPE geomembrane liner and associated geocomposite and granular drainage layers. Soils used for Subbase and low permeability soils were mined from a NRG borrow pit located north of Van Buren Road, north of the Site. These borrow soils were determined to be suitable for their respected usage in the proposed landfill cell B2 as part of a borrow source evaluation completed by GZA. This evaluation included completion of over 20 test pits and several soil tests for sieve, moisture/density and low permability analysis. Our evaluation identified the borrow area had a sufficient volume of soil for use as Subbase and low permeability soils needed to be processed prior to placement and included increasing moisture and screened soil to less than 1-inch.

GZA also designed a double contained HDPE leachate forcemain to replace the existing system for the soil waste management facility. This new larger volume forcemain consists of an approximate 1,800 linear feet of piping to the connected between two existing manholes at the Site for eventual discharge into the facilities sedimentation ponds.

GZA developed construction-level drawings, technical specifications and a construction QA/QC plan to sufficiently define the proposed work in soliciting contractor proposals. Drawing development included establishing a 3-D computer model of the landfill layers for direct data transfer to the contractor and certifying surveyor.

GZA provided CQA monitoring during the landfill cell and leachate forcemain construction. The CQA program included density test monitoring and collecting undisturbed tube samples of the compacted clay liner. Monitoring of the geomembrane installation required detailed construction documentation including assigning destructive sample tests, observation of non-destructive tests and placement of overlying materials. GZA also observed and documented the construction and testing of leachate collection pipies and associated manholes and the construction of the leachate forcemain pipe.

Project Highlights

- Borrow Source Evaluation
- 3-D Landfill Cell Design with Leachate Forcemain
- Construction QA Monitoring

GZA coordinated between the Owner, earthwork and geosynthetics contractors, project surveyor and the regulator on a tight project schedule to complete the project within budget. GZA reviewed contractor submittals and prepared a construction certification report documenting the landfill cell construction.

Project Highlights

- Subsurface Soil Borings
- Embankment Evaluation
- Utilization of PCSTABL (version 6) Slope Stability Program

NRG- Huntley Power, LLC
Embankment Stability Assessment
TONAWANDA, NEW YORK

GZA was engaged by NRG to drill three (3) test borings to observe subsurface conditions and provide an embankment stability assessment of the facilities embankment which is situated between an on-Site ash settlement pond and the Niagara River and is located in the southern portion of the NRG Huntley Power Plant. An existing discharge pipe is present within this embankment that allows surface water to drain from the settling pond to the Niagara River. GZA completed the following scope of services for this project:

- Retained the services of our drilling subcontractor to complete three test borings at the Site for collection and classification of soil samples. Two borings were done in the embankment area on each side of the existing discharge pipe and one test boring was done in an area of presumed undisturbed soils located south of the settlement pond and discharge pipe. Ground water measurements were also made from within the drilling augers at the completion of each test boring.

- Selected overburden soil samples were tested by GZA's geotechnical laboratory for moisture content and grain size analysis (i.e., sieve and hydrometer tests). Additionally, one Shelby tube sample was collected from a layer of fine grained soils (located below the embankment and associated settlement pond) and was submitted to our soils laboratory for consolidated undrained triaxial testing and unit weight determination.

- Ground surface elevations in the area of the embankment area were measured by our subcontracted land surveyor. The ground surface elevations and locations of the three test borings were recorded, as well as, existing embankment features including rip-rap location, the shoreline of the Niagara River the settlement pond water level, and discharge pipe inverts, among others. These locations were tied into an existing Site benchmark that was provided by NRG for our use with plan and cross-section figures.

- The evaluation included an assessment of the embankment stability via the slope stability analysis program PCSTABL (Version 6) assuming circular and block failures and calculations for infinite slope analysis. The program and calculations were completed with internal friction angles and cohesion values obtained from lab test results and published values for similar materials to provide an assessment of the existing conditions at the Site.

- GZA prepared an evaluation report that summarized the findings of the completed subsurface explorations, laboratory testing program, and embankment evaluation. Our findings determined that the existing embankment would have a hazard classification of low to remote and that a more detailed stability analysis was not warranted at this time.

PROJECT PROFILE

Central Landfill- Rhode Island Resource Recovery Corporation

Johnston, Rhode Island

GZA's success on RIRRC projects at the Central Landfill is the result of a highly motivated GZA Team, technically challenging objectives and high client expectations. GZA has enjoyed a 30-year history with the Rhode Island Resource Recovery Corporation (RIRRC) as their environmental and engineering consultant. During this contract, we have undertaken more than 300 tasks, many of which are ongoing. Our services have included: general regulatory compliance consulting, monitoring and reporting of surface water (RIPDES program), groundwater (RIDEM Solid Waste Program and EPA Superfund Program), soil gas/landfill gas, radon and waste water (IWDP/DMR Program); Phase I/II Environmental Site Assessment and property acquisition support; public relations assistance; solid waste facility permitting; wetlands permitting and reconstruction; SWPPP, SPCC and BMP plan development and training; air emission permitting, monitoring, and GHG reporting; geohydrologic studies; UST/AST management and closure; ecological/habitat studies; construction support and certification to name a few.

While too numerous to list, the highlights of several are presented below.

Superfund Remedial Investigations (OU1 and OU2)
GZA has completed two remedial investigations at the facility for RIRRC under State and Federal guidelines for Superfund studies. The first, Operable Unit 1, evaluated the nature and extend of solid and hazardous waste within the source area – a 121-acre unlined landfill that operated from 1955 to 1993. The second study, Operable Unit 2, evaluated the extent of offsite contaminant migration via surface water and groundwater flow, landfill gas migration and air-borne contamination.

Project Highlights

- Provided full range of environmental engineering and regulatory compliance support services for 2,000-4,000 ton/day facility
- Landfill planning, design, permitting and expansion construction support
- Oversaw closure of 121-acre RCRA C Superfund Landfill and 33-acre RCRA D Landfill
- Designed, installed and operate two groundwater pump & treatment systems for contaminants in bedrock
- Sampling and analysis of surface water, groundwater, soil, soil gas, landfill gas and waste and evaluation of regulatory compliance
- GZA has enjoyed a 30 year history with the Rhode Island Resources Recovery Corporation as their environmental consultant
- In implementing studies and developing appropriate solutions, GZA worked actively and successfully with RIRRC, Town officials, EPA, RIDEM and local Citizens group.
- To date, GZA has logged more than two million records of chemical testing data into our database system on behalf of the RIRRC.

Central Landfill- Rhode Island Resource Recovery Corporation
Johnston, Rhode Island

Our work included:

- Surficial and borehole geophysical analysis;
- Shallow and Deep monitoring well installations;
- Groundwater, surface water, soil, sediment, air, landfill gas and waste sampling and analysis;
- Aquatic toxicity testing;
- Human health and ecological risk assessment following State and Federal guidance;
- Data evaluation, management and reporting;
- Participation in public workshops, public meetings and hearings.

Our work products, technical opinion and recommendations have consistently been accepted by the USEPA, RIDEM and the Army Corp of Engineers (ACOE).

Environmental Compliance and Monitoring
This category includes a wide variety of related and unrelated environmental tasks. Most tasks are required by RIDEM regulations, EPA Superfund or Clean Air Act mandates, or local requirements (e.g., Cranston Sewer Authority, Town of Johnston) Our services have included:

- Sampling, Testing and Reporting for the Storm Water Discharge (RIPDES)
- Sampling, Testing and Reporting of Groundwater conditions as required by RIDEM Solid Waste Regulations and EPA Superfund Requirements
- Sampling, Monitoring and Reporting of Surface Landfill Gas Emissions
- Air Emissions Permitting and Annual Inventory Reporting
- Alternative Cover Materials Testing and Evaluation
- Waste Water Monitoring and Reporting (IWDP/DMRs)
- Wetland Delineation and Permitting
- Emergency Response Actions
- Regulatory Meetings and Presentations
- Property Transaction Site Assessments

We use the Equis System by EarthSoft, a sophisticated chemical and geological information database with GIS capabilities through ArcView, to manage, analyze and report on compliance monitoring programs. To date, GZA has logged more than two million records of chemical testing data into our database system on behalf of the RIRRC.

Landfill Closures
As part of our Superfund work for RIRRC, GZA conducted feasibility studies to evaluate innovative waste capping and groundwater migration control methods. Our work formed the basis for the closure of the 121 acre unlined Phase I Landfill. GZA also acted as RIRRC's technical representative on the Phase I RCRA C cap design and installation project overseeing this multi-year/multi-million dollar project which was competed in 2006.

GZA designed the RCRA D caps for both the Phase II and III Landfill (33-acres in all). The capping systems used for these projects are suitable for active solid waste landfills (i.e., RCRA D) or hazardous waste landfill (i.e., RCRA C). They incorporate a synthetic membrane liner, low permeability soils, and sophisticated geotextile drainage systems to promote stability and prevent erosion.

Groundwater Containment System
GZA conducted state of the art bedrock fracture flow modeling using Fracman/MAFIC code to assess containment migration in waste, overburden and bedrock. This model was accepted by both EPA and RIDEM and then used by GZA to design an efficient groundwater containment pump and treatment system as part of the Superfund remedial actions. The system consists of an air operated groundwater extraction pump, an equilization tank and defoaming system, a shallow tray air stripper and 2,100 feet long double-wall conveyance piping system. GZA installed and operates the system, on behalf of RIRRC, which has removed and treated more than 6,000,000 gallons of highly contaminated groundwater.

Permitting, Design, and Construction Management of the Relocation of Cedar Swamp Brook and Associated Wetlands for Landfill Expansion
Cedar Swamp Brook was an existing waterway and associated wetland corridor located along the southerly toe of the existing 200 acre landfill. In order to expand the landfill, the relocation of approximately 7,500-feet of the existing brook channel was undertaken by the RIRRC, in two phases, to make way for a new 44-acre lined landfill (Phase

Central Landfill- Rhode Island Resource Recovery Corporation

Johnston, RI

IV) and a new 33-acre landfill (Phase V). The stage 1 permitting process had taken a serious time setback and was into its sixth year when GZA was brought on-board. Approval for the stage 1 brook relocation was obtained within three months of GZA's project involvement. GZA was then retained for the entire design and permitting process for the second stage of relocation which was completed in only 2.5 years. GZA also provided procurement services, construction oversight and management for both stages of relocation. This project involved significant habitat assessment and hydrologic modeling; stream channel relocation via bedrock blasting and removal; and installation of compensatory riparian wetlands.

Contracting Agency (Client)
Rhode Island Resource
Recovery Corporation
65 Shun Pike, Johnston, RI
Mr. Michael O'Connell
Executive Director
(401) 942-1430

Date of Project:
1984 – on-going

Consulting Fees:
$5+ million

Project Team Members:
GZA GeoEnvironmental, Inc.

Principals-in-Charge:
Edward A. Summerly, P.G.

Project Managers:
Igor Runge, PhD, P.H.
Todd R. Greene, P.E.
Richard A. Carlone, P.E.
Anthony Urbano, P.E.

Freshkills Landfill, Sections 6 and 7 Design/ Build Services

Staten Island, NY

Project Highlights

- Provided complete design including construction drawings for 285-acre Landfill Cap and Landfill Gas Collection and Central Alarm
- Provided value engineering services with project savings of approximately $5,000,000
- Overall Closure design and Phase 1 constructon drawings completed in 3 months
- Value engineering and re-design of proposed landfill gas collection system resulted in superior gas collection and significantly reduced emissions

GZA was retained by Tully Construction Co. to complete all engineering design task associated with the a 285-acre landfill in closure at the New York City Department of Sanitation's (DSNY's) Fresh Kills Landfill, Section 6/7 located on Staten Island, New York.

The Fresh Kills Landfill facility is owned and operated by DSNY. The Section 6/7 landfill closure project was contracted by DSNY as a construction design/build project. The closure permit documents were prepared by Malcolm Pirnie, Inc for the DSNY. The permit documents were utilized for the design/build contract documents. GZA's responsibilities were to review the permit documents and develop construction plans and details, which met the intent of the permit and complied with the New York State Department of Environmental Conservation's (NYSDEC's) landfill closure regulations, Part 360. The final construction documents were reviewed and approved by both the DSNY and NYSDEC prior to commencing with construction activities. GZA worked directly with DSNY on all closure design components and addressed NYDOS design comments as required to expedite the approval process to start construction activities.

Subsequent to the overall closure design, GZA provided value engineering services for Tully and prepared engineering calculations and design modifications to DSNY for review and approval. GZA's value engineering services included alternate geocomposite drainage layer design, develop construction sequencing plans to manage stormwater runoff during construction, landfill gas conveyance modifications to reduce head loss, promote condensate drainage, minimize system maintenance requirements, and grading modifications to reduce general fill and embankment fill quantities. These modifications streamlined the construction process and schedule, saved DSNY millions of dollars on geocomposite drainage net cost, soil material cost, increase landfill gas recovery rates and provided a better end product for our client and DSNY.

Freshkills Landfill, Sections 6 and 7
Design/ Build Services

Staten Island, NY

GZA prepared intial working drawings for the overall landfill closure design and prepared subsequent temporary working drawings, final working drawings and construction as-builts for each phase of the construction. The landfill closure was divided into five (5) phases with intial working drawings and Phase 1 temporary working drawings prepared in the winter and spring of 2006. Phase 1 construction was intiated in the spring of 2007 and Phase 5 construction was completed in Fall of 2011. GZA submitted the final construction as-built plan package to Tully and DSNY in the Spring of 2012. The overall landfill cap design incorporated future end use components as provided by DSNY, for a recreational park and future roadway expansions associated with Yukon Avenue.

GZA provided full time project Quality Control (QC) and landfill gas system construction support during Phase 1 of construction. GZA's QC engineer monitored construction and reviewed constructed portions of the landfill cap for compliance with the construction drawings and project specifications. GZA's QC engineer reviewed all material testing data associated with the project, which included analysis (both structural characteristics and environmental), geomembrane testing and pipe pressure testing. The QC engineer review construction as-builts as it pertained to the design intent and compliance with Part 360 and provided all QC data to DSNY for construction certification.

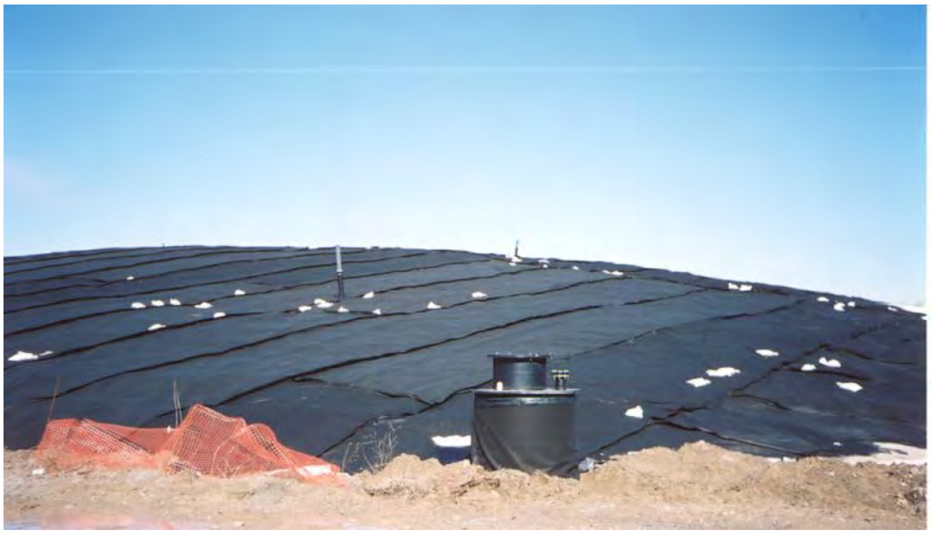
Throughout the construction process GZA attended DSNY's weekly construction meetings as requested by Tully and or DSNY to interact with DSNY and ensure the landfill cap construction is completed per GZA's construction drawings and details, address any field modifications to the design to ensure the construction process progressed efficiently and in a timely manner without interruptions.

GZA's engineering design tasks included all aspects of landfill closure design including the following:

- Geotechnical and slope stability analysis;
- Geosynthetic and geomembrane design:
- Developing subgrade and finish grading plans;
- Stormwater management and conveyance (hydrologic and hydraulic design);
- Swale and downchute layout and design;
- Landfill gas collection and control systems; including custom wellhead and vault designs;
- Material quantity estimates;
- Construction drawings;
- Approval of Contractor Shop Drawings;
- Provide recommendations for construction sequencing;
- Field Construction Oversight and Construction Certification;
- On-site QC testing including pneumatic pressure testing; confirmation of pipe pitches via as-built survey;
- Provided construction recommendations for piping and vault installations and critical connections to existing header pipes and flaring systems;
- Provided construction sequencing recommendations for landfill gas header switch overs and temporary header placement to maintain active gas collection during construction activities;
- Direction of remedial measure needed to meet the design intent; and
- Project documentation.
- Worked closely with the gas system operator and developed detailed system switchover procedures to allow the continued operation of the existing systems during construction and a seamless transfer to the new systems components upon their completion.

McKenna Landfill Closure

Orleans County, NY



Project Highlights

- Successful coordination and negotiation with numerous agencies including NYSDEC, NYS Canal Corporation and US Army Corps of Engineers
- Pre-design investigations allowed better determination of material quantities for remedial design
- Use of geosynthetic components reduces quantities of soil materials needed, shortened construction schedule and lessened remedial construction costs

The McKenna Landfill was listed on the New York State Registry of Inactive Hazardous Waste Sites as a Class 2 site. It is approximately 1800 feet long by 500 feet wide and consists of about 20-acres. The New York State (NYS) Barge Canal adjoins one side of the landfill. A proposed remedial action plan and "Record of Decision" were issued by the New York State Department of Environmental Conservation (NYSDEC). GZA GeoEnvironmental was retained to provide remedial design and observe, test and document remedial construction. Prior to remedial design, GZA collected additional site data through a site reconnaissance, land surveying, test pit and test boring explorations, installation of groundwater monitoring wells, landfill gas survey, wetland delineation and leachate collection/analysis.

Perimeter Clay Cutoff Wall

Our remedial design incorporated a plan to recover existing cover and fill soils for reuse. The closure design included a perimeter barrier wall system consisting of both a compacted clay wall and an 1800 lf soil-bentonite slurry wall, a geosynthetic landfill gas/leachate collection blanket, a perimeter leachate collection system, a gas venting system and a soil/geosynthetic composite final cover system. Additional analysis was done to evaluate the impacts of seasonal draining of the adjacent NYS Barge Canal on the soil-bentonite barrier wall and leachate collection system. We also made an evaluation of various final cover systems with comparative costs. In addition to remedial design, a surface water management plan, a post-closure maintenance and monitoring plan, and an environmental monitoring plan were prepared.

Following remedial design and its approval by the various agencies, GZA prepared construction contract drawings for competitive bidding. We remained involved during the bidding process through participation in the pre-bid meeting, prepared meeting minutes and contract addendum, and analyzed the bids received.

McKenna Landfill Closure

Orleans County, NY

During remedial construction, GZA provided construction administration, engineering and construction quality assurance/quality control observation and testing. This work involved soil laboratory testing (including permeability and direct shear), field testing for compaction and geomembrane seam strength, and observation of the work done for comparison to project specifications. A construction certification report was prepared and submitted to NYSDEC. Our report was approved and the Site is currently in post-closure monitoring.

Grant Gear PCB Superfund Site

Norwood, MA

Project Highlights

- Excavation, consolidation, and capping
- Effective PRP advocacy in negotiations with US EPA Region 1 and Department of Justice
- Remedial strategy developed to result in cost-effective closure and to promote site redevelopment
- Brownfields Redevelopment
- Building demolition, stream diversion, sediment and soil consolidation and capping

In two distinct efforts, GZA has assisted the Potentially Responsible Parties (PRPs) with evaluation of site conditions and remedial response actions at the Norwood PCB Superfund site in Norwood, Massachusetts. In 1984, GZA assisted Grant Gear Realty Trust, a PRP that had previously operated a capacitor manufacturing business on the property, with an assessment of site conditions to evaluate the potential for off-site migration of PCBs by air and surface water transport. Using a combination of low-cost, PCB-screening techniques developed by GZA for this project and EPA-approved analytical methods, PCBs were measured in soils and sediment. Based on GZA's exposure assessment, the State of Massachusetts implemented immediate remedial measures at the site, which included installation of a temporary cap of geotextile and crushed stone over selected contaminated areas. Later, a U.S. EPA contractor prepared the RI/FS, which formed the basis of the Record of Decision (ROD).

In 1995, GZA's multi-disciplinary team of engineers and scientists was retained by three of the Potentially Responsible Parties for this Superfund Site to re-evaluate the costly, over-designed 1989 ROD. GZA developed equally protective, yet much more economical and conducive to redevelopment, remedial alternatives for the site cleanup that led to EPA's reconsideration of the ROD for the site and the amendment of the remedial plans for contaminated groundwater, soil, sediments and the on-site facility.

This work, which focused on both evaluation of site-related risks and selection of feasible remedial alternatives, was performed in response to the technical and financial impracticability of U.S. EPA's remedy specified in the 1989 ROD. U.S. EPA's initial remedy included groundwater extraction and treatment; on-site solvent extraction of PCB-contaminated soils and sediments from the adjacent Meadow Brook; and, the decontamination of machinery and surfaces in the on-site building to

Grant Gear PCB Superfund Site
Norwood, MA

remove PCBs. However, due to the high cost and difficulties with implementing the ROD as well as the initially selected remedial strategy's interference with site redevelopment, EPA considered changing the remedial strategy for site soils. GZA's work in this phase of the project included:

- Participation in negotiations with EPA and DEP regarding the remediation of this Site.
- The development of human health and ecological risk-based cleanup levels.
- The development of a defensible Maximum Acceptable Sediment Concentration (MASC) for PCBs in the sediments of a stream adjacent to this CERCLA site. The MASC was based on bioconcentration/ bioaccumulation modeling of PCBs through the food chain using raccoons as receptor organisms.
- The delineation of soil and sediment cleanup areas using risk-based target levels.
- An assessment of the need to maintain the already installed EPA groundwater extraction and treatment system.
- The development of cost-effective remedial options that would promote site reuse, including soil consolidation and capping, source removal, building demolition and long-term groundwater monitoring.
- An evaluation of feasible remedial options using CERCLA alternative evaluation criteria.
- The preparation of a detailed analysis comparing the benefits of our strategy to those of EPA's strategy.
- The development of cost estimates for the remedial strategies evaluated during the analysis.

The site remedy proposed by GZA included: extensive consolidation of contaminated soils and sediment followed by installation and maintenance of a multilayer asphalt and geotextile soil cap; removal of sludge from the building's drainage system and in-place closure; demolition of the building (containing asbestos, lead paint and PCB contamination) and capping of the building slab; and, source control coupled with long-term monitoring of contaminated site groundwater. GZA's proposed remedial strategy, which was accepted by EPA in an amended ROD, was a protective, highly implementable option, which cost-effectively promoted redevelopment of the property. This re-evaluation of the proposed CERCLA cleanup, coupled with a proactive legal strategy, resulted in substantial cost savings to the PRPs, as well as quicker attainment of site closure.

Throughout the negotiations with EPA, the PRP's utilized GZA's cost estimates for the remedial alternatives in their decision making process. They also used these estimates to seek cost recoveries under their insurance policies. GZA's willingness to perform the remediation on a fixed price basis for our cost estimate facilitated resolution of the dispute with EPA and convinced the PRP's to take the lead in performing the remediation.

GZA was subsequently contracted by the PRP's to implement the remedy to regulatory sign off on a negotiated fixed price basis. GZA prepared plans, specifications, and work plans for building demolition within one month of issuance of the Consent Agreement. We completed the building demolition by the end of 1996 within four months of Contract award, meeting one of EPA's goals. GZA developed innovative methods for managing demolition debris onsite by incorporating it into the overall cap design, which substantially lowered the project costs.

GZA then prepared the plans, specifications and work plans for the remaining work, which was conducted during 1997 and 1998. This work included:

- Diversion of the stream, utilizing pumps with a combined capacity of 18 mgd;
- Removal of the stream sediments in the "dry" using standard earthwork equipment;
- Consolidation of material onsite;
- Assessment of excavation limits utilizing field screening immunoassay techniques; and
- Capping of the contaminated material including sediments with a geotextile and 6 inches of asphalt.

In addition to the remediation, the Site has been redeveloped

Grant Gear PCB Superfund Site

Norwood, MA

as a retail facility. GZA was contracted to perform certain aspects of the redevelopment including installation of subsurface utilities and of the storm water management system to limit potential future exposure to site contaminants and development of site-grading and building plans that meet both remedial and redevelopment objectives. In addition we designed a vapor barrier to protect building occupants from potential vapor intrusion.

Following redevelopment as a retail center in 2008, the Site was delisted from the NPL in 2011.

Allied Waste Niagara Falls Landfill, LLC
Sanitary Landfill VIII- Subareas A through F
Niagara Falls, NY

GZA performed a State Environmental Quality Review Act (SEQRA) permit application for an 84-acre landfill expansion. The proposed expansion involved remediation/removal of long-existing industrial fill to allow landfilling operations to continue for another 15 to 20 years. Excavation of a former on-site hazardous waste treatment facility with disposal off-site at a permitted hazardous waste facility is one of the benefits of the project. The landfill expansion effectively transformed this industrial "Brownfield" into an aesthetically pleasing "Green Space". These positive aspects of the project allowed Allied to procure the expansion permit with little to no public opposition.

Our design required removal of about 2.2 million cubic yards of waste lime from the landfill expansion footprint and disposal of the waste back into the constructed cells. About 1 million cubic yards of lime was left in-place with the landfill cells partially constructed over the lime. The design called for the surface of the lime to be graded at a steep slope (about 6 to 10 percent) to account for consolidation upon filling.

The landfill design met 6 NYCRR Part 360 regulations having a double-composite liner system consisting of primary and secondary (drainage geocomposite) leachate collection systems and two low permeability barriers covered with HDPE geomembranes.

GZA prepared contract bid documents to solicit and evaluate contractor proposals for construction of the first two Subareas A & B, in 2006. The bid documents quantified different on-site fill types for excavation and removal or use as subgrade construction material. Disposal of excavated waste into Allied's active cell occurred concurrent with regular landfill disposal activities. Costs for constructing Subarea A and the west part of Subarea B, completed in 2006-2009, came under budgeted costs and the project was completed on schedule.

Project Highlights

- Active facility, receives approximately 2,500 tons of waste per year
- SEQRA Permit Application – 84 Acre Landfill
- Large Volume Management of Existing Industrial Fill
- Design/Contractor Bid Solicitation
- Construction Quality Assurance Oversight

Contracting Agency (Client)-Allied Waste Niagara Falls Landfill Division of Republic Services

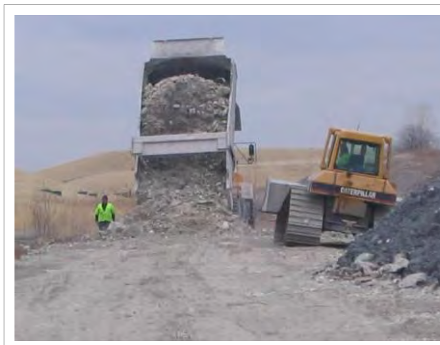
Mr. David Grenier, Division Manager,-(716) 285-3344

Date of Project: 2005 – on-going

Consulting Fee: $5,000,000

Project Team Firms:-GZA GeoEnvironmental, Inc.

Project Personnel-Bart A. Klettke (PIC), P.E., John Beninati, Ted Klettke, Dan Wulf



Allied Waste Niagara Falls Landfill, LLC
Sanitary Landfill VIII, Subareas A through F

Niagara Falls, NY

GZA performed construction quality assurance (CQA) monitoring and soils and geosynthetics laboratory testing in our Buffalo and Hopkinton, Massachusetts labs. GZA directed investigations and assigned analytical lab testing of suspected contaminated soils, including known areas having polychlorinated biphenyl (PCB) contamination. Based on these investigations, GZA directed remedial excavation and off-site disposal of the contaminated soils into a permitted hazardous waste facility. GZA prepared a final construction certification report for approval by NYSDEC.

Subsequent development of the east portion of Subarea B (7 acres) and Subarea C (18 acres) occurred on an accelerated schedule in the years 2010, 2011 and will continue thru 2012 to facilitate managing the large amounts of waste required to be excavated and placed in the newly built landfill cells. To date (Jan. 2012), over 1 million tons of waste have been relocated to facilitate new cell construction.

Wyman-Gordon – West PCB Area

North Grafton, MA

The Wyman-Gordon facility is a large aerospace forging facility with multiple OHM sources and releases that occurred from the 1940s through the 1970s. Investigation and remediation of historic contaminant releases are being managed under the Massachusetts Contingency Plan (MCP) and the federal Resource Conservation and Recovery Act (RCRA) Corrective Action Program. The West PCB Area is a historic dumping area for industrial and laboratory refuse, forge operation by-products, and building refuse and asphalt rubble from various construction projects. The historic dump was located partially on Wyman-Gordon property and partially on an electrical power transmission corridor owned by the regional power distribution company. During the site investigation field work several empty and crushed barrels, other refuse, and black fill material were observed deposited on the edge of a wetland area. Subsequent analytical results for this area reported concentrations of PCB Aroclor 1254 as high as 1,832 mg/kg in wetland soil, and as high as 32,500 mg/kg in the upland soil/fill material. The West PCB Area also contains historic disposal pits for industrial by-products including acid waste neutralization sludge, descaling salt cake/salt sludge, and aluminum dross.

The West PCB Area remediation is being implemented under the MCP, RCRA, and as a Risk-Based Clean-up (RBC) under the federal Toxic Substances Control Act (TSCA; 40 CFR 761.61(c)). GZA secured final approvals from the US Environmental Protection Agency (USEPA) for the RBC under TSCA in October, 2014. Based on GZA's human health and environmental risk assessments for the site EPA approved clean-up goals of:

- A total PCB concentration ≤ 3.4 mg/kg for wetland soil, on a point-by-point basis.
- And average total PCB concentration of ≤0.9 mg/kg within the top three feet of upland soil within the excavation area.
- A maximum residual total PCB concentration of ≤18 mg/kg in upland soil on a point-by-point basis.

Project Highlights

- PCB Risk-Based Clean-up under TSCA
- USEPA approved risk-based goals range from:
- Average of 0.9 mg/kg in surficial soil
- 18 mg/kg not to exceed
- 3+ acres of upland remediated
- 0.9 acres wetland remediated
- 7,795 tons of >100 mg/kg PCB soil shipped to hazardous waste landfill via on-site rail siding
- 5,143 yds3 of ≤100 mg/kg PCB soil consolidated beneath on-site low permeability cap
- Non-friable asbestos management and disposal effectively integrated with PCB remediation

Wyman Gordon – West PCB Area

North Grafton, MA

By agreement with the property owner of the electrical power transmission corridor, the clean-up goal for upland and wetland soil on the transmission corridor was <1 mg/kg on a point-by-point basis.

GZA also secured several other permits and authorizations related to wetland protection, dewatering and water treatment and discharge, and erosion control.

The remediation program consisted of excavation of PCB contaminated soil to reach the clean-up goals, and restoration of the disturbed upland and wetland areas. PCB contaminated soil with concentrations >100 mg/kg PCBs were trucked to a rail-road siding located on a different area of the 200 acre Site, and transport by rail to the Wayne Disposal Inc. (WDI) facility in Belleville, Michigan which is licensed to accept RCRA and TSCA wastes. Excavated soil with ≤100 mg/kg PCBs were consolidated on-site and covered with an engineered low permeability cap.

The approved plan included confirmatory sampling of the excavated sub-grade and sidewalls on a 25-foot grid. The ultimate depth and extent of the excavation was based on the results of iterative confirmatory sampling rounds to show that the clean-up goals had been met.

Other aspects of the project included:

- Excavation took place under 345kV transmission lines and distribution poles. The utility approved a geotechnical pole stability analyses prepared by GZA to define a "stability cone" around each pole to define how close and deep to each pole the excavation could advance without temporary shoring of the pole structures.
- Construction of an asphalt decontamination pad and water collection sump where heavy equipment and trucks could be de-contaminated using Metal X/Pipe X detergent when moving from higher to lower contaminated portions of the site, or when moving off-site.
- Dewatering wetland excavation areas, and on-site treatment and discharge of approximately 3 million gallons of dewatering and decontamination water under a NPDES Remedial General Permit.
- Establishment of a clean-travel way and loading area to avoid decontamination of earth moving/rock trucks being used to transport PCB contaminated soil approximately 1-mile to a rail siding located on the east side of the WG facility.
- Establishment of a containment and loading area at the on-site rail siding where PCB contaminated soils could be dumped without contaminating tires of the off-loading truck, and to facilitate containment and daily clean-up of the loading area to avoid release of contaminated particulates to the surrounding area.
- Broken pieces of corrugated, cementitious, asbestos-containing building materials ("transite") were observed in the PCB contaminated fill early in the remediation project. GZA developed and gained approval for an asbestos management and monitoring plan that allowed the project to move forward with minimal disruption and added expense.
- The regulatory agencies approved the use of a low permeability cap for consolidated PCB contaminated soils which was also designed to cover the historic sub-surface disposal pits to minimize contact between hazardous materials in the pits and infiltrating storm water.

GZA performed construction over sight, and acted as the general contractor for the remediation work. The following work accomplished:

- Approximately 7,795 tons of PCB-contaminated soils with concentrations >100 mg/kg PCBs were excavated and transported by rail to the WDI facility.
- Approximately 5,143 cubic yards of soils with concentrations ≤100 mg/kg PCBs were excavated and consolidated on-Site beneath the low permeability cap.
- The one acre low permeability cap has been completed and stabilized.
- Approximately 2.1 acres of upland (not including the cap area) have been restored and stabilized.
- Approximately one acre of vegetated wetland has been restored and stabilized.

As of the end of the 2015 construction season the West PCB remediation field work was largely completed. A small area with PCBs >100 mg/kg was discovered in an unexpected location based on confirmatory sampling results. In addition, soill with PCB concentrations above the ≤1 mg/kg clean-up goal was left within the "stability cone" adjacent to the some of the powerline poles. WG and the land owner are in discussions regarding the disposition of those soils. We expect the remediation to be completed in 2016.

PROJECT PROFILE

Former Coventry Landfill
Site Investigation, Remedial Action Work Plan and Landfill Closure

Coventry, Rhode Island

GZA was selected through a quality-based competitive process by the Coventry Landfill Performing Parties Group (CLPPG) for environmental engineering services needed to evaluate and close the town landfill. The inactive landfill is included on the RI Department of Environmental Management's (RIDEM's) State Solid Waste Facilities/Landfill list and "State Sites" inventory. It is also inventoried on the USEPA's CERCLIS list (list of potential Superfund sites). As such, the Coventry Landfill is subject to numerous regulatory programs, most notably RIDEM's Solid Waste and Site Remediation Programs.

The approximately 27-acre Site is owned by the Town of Coventry, Rhode Island. The Town operated landfill accepted municipal waste and lesser amounts of commercial/industrial waste, including drum cleaning and reclamation liquids, for land-disposal between approximately 1945 and 1975.

GZA's investigation was conducted in accordance with a ***Site Investigation Work Plan***. The investigation involved the collection, screening and laboratory testing of soil, groundwater, landfill gas and soil vapor samples. In addition, GZA performed a soil vapor survey of the down-gradient neighborhood, a soil vapor extraction pilot study and a groundwater remediation pilot study. The studies found:

- The lateral The lateral extent of buried waste exceeded the previously defined waste disposal area by several acres;
- Although the existing landfill cover materials met the required minimum thickness of 2-feet, the existing site grading and storm water management systems were inadequate to prevent ponding and soil erosion;
- Groundwater quality was impacted both on-Site and off-Site in the downgradient area;
- A contaminant hot spots was identified within the waste cell;
- The SVE pilot study and landfill gas survey show the need to control methane within the waste cell to prevent off-Site migration.

Project Highlights

- Investigations and cleanup under RIDEM's Closure Policy for Inactive and Abandoned Solid Waste Landfills
- CERCLIS/State listed property
- Closure requirements address both Site Remediation & Solid Waste regulatory programs
- Off-Site contaminant migration driving groundwater remediation and vapor intrusion evaluation
- In developing our work scope, evaluating our findings and developing remedial alternatives, GZA worked actively and successfully with the CLPPG members
- A portable landfill gas flare will be installed beneficially reuse landfill methane to destroy VOCs extracted by the SVE system
- Closure will use 300,000 cubic yards of impacted soil for shaping and grading, significantly reducing landfill closure costs

Former Coventry Landfill
Site Investigation, Remedial Action Work Plan and Landfill Closure

At the conclusion of the investigative phase, GZA completed a Remedial Action Work Plan (RAWP). The RAWP was prepared to address the applicable requirements of RIDEM's Remediation Regulations, as well as their Solid Waste Regulations and Closure Policy for Inactive or Abandoned Solid Waste Landfills. The recommended and approved alternative for closure of the landfill consists of the following actions which incorporated a combination of remedial measures to address the requirements of applicable regulatory programs:

- Increase the thickness of the soil cap so that all areas of the Site that received municipal solid wastes are provided with the equivalent of a soil cap thickness of not less than two feet.
- Use approximately 300,000 cubic yards of lightly impacted controlled fill materials under a beneficial use determination (BUD) to shape the subgrade in order to establish proper design grades prior to installation of a new final clean soil cap.
- Re-graded the Site, as necessary, to meet a minimum drainage slope of 3% and maxim stable slope (i.e., 3:1) to control erosion, reduce infiltration and manage stormwater drainage.
- Installation of a soil vapor extraction system (SVE) as part of the landfill closure to address aromatic and chlorinated VOCs within the Hot Spot waste and reduce methane levels within and around the waste cell.
- Develop a revised post-closure groundwater and soil gas monitoring program.
- Modify the Site's groundwater classification to GB to be consistent with RIDEM's Rules and Regulations for Groundwater Quality.
- Protect the long-term effectiveness of the remedy by establishing an Environmental Land Use Restriction for the property.
- Assist the Town of Coventry in drafting and enacting a Groundwater Ordinance, which prohibits the use of groundwater down-gradient of the landfill as a potable water supply.

The RAWP was accepted by RIDEM and GZA developed detailed construction plans and specification for the remediation and closure. In addition to the regulatory requirement of the landfill closure scope, the Town wanted to evaluate the Site for future solar energy development. GZA is actively involved in a number of renewable energy projects involving solar power installed on landfills and our diverse technical expertise allows us to support our client's endeavors from concept through completion.

In the spring of 2014, GZA was selected by the CLPPG as the Construction Oversight/Consulting Engineer, which included construction supervision/oversight and consulting services from pre-Construction planning through completion of the Construction and post-Construction operation, maintenance, and monitoring of the SVE system. The objective of this phase of the project was to provide the Group with construction administration, contractor/construction oversight, project documentation and regulatory reporting to ensure the project is constructed in accordance with the RIDEM approved RAWP, Order of Approval and the corresponding construction specifications prepared by GZA. Our construction oversight services will provide sufficient field documentation, and construction quality assurance (CQA) to allow GZA to certify, as Engineer-of-Record, that the as-built cap and SVE systems comply with the contract documents, thus allowing the Group to obtain a Letter of Compliance and Certificate of Landfill Closure from RIDEM and removal of the Site from EPA's CERCLIS list.

Construction of the SVE system began in October of 2014 and was completed in January 2015. The landfill grading and shaping with BUD material and landfill closure began in November of 2014 and is anticipated to be completed in 2018. GZA provides ongoing BUD program oversight, engineering services and environmental compliance monitoring on the project.

Contracting Agency (Client)
Coventry Landfill Preforming Parties Group, 4801 Courthouse Street, Suite 300Williamsburg, VA

Mr. David Graham, Esq. Landfill Group Representative- (757) 259-3855

Date of Project: April 2008 – on-going
Consulting Fee: $975,500

Project Team Firms: GZA GeoEnvironmental, Inc.
Project Personnel: Edward A. Summerly, P.G. (PIC), Todd R. Greene, P.E., Mark Dalpe, Rick Carlone, P.E., Erik Beloff, Nichole Murawski

Proactive by Design

RESUMES OF KEY STAFF

GZA Solid Waste Statement of Qualifications for:
Vectren Energy

RESUME

Bart A. Klettke, P.E.

Principal/District Office Manager

Summary of Experience

Mr. Klettke has over 30 years of professional experience. He has permitted, designed and managed the construction of solid waste management facilities including coal ash containment cells, and site civil projects. He is experienced in performing and supervising CQA monitoring programs, civil site plans, and geotechnical investigations. As the Principal in Charge and Operations Manager of the Buffalo, New York office, Mr. Klettke is responsible for contracting, project budgeting, scheduling of office and field staff activities, and conducting a profitable operation.

Relevant Project Experience

Principal, Sanitary Landfill Area VIII, Allied Waste Niagara Falls Landfill, Niagara Falls, New York. Designed a 90-acre solid waste management facility including developing permit drawings and writing a design rationale report. Design required management of on-site miscellaneous fill soils to minimize relocation of soils and maximize available air space. Currently administering QA/QC monitoring program for on-going construction of landfill cells.

Principal, Sanitary Landfills V & VIII Final Closure Design, Allied Waste Niagara Falls Landfill, Niagara Falls, New York. Designed a final cover system for a 125-acre sanitary landfill having a combination soil cover and geosynthetics system. The soil cover system is required in areas having limited truck and heavy equipment traffic access at the bottom of the landfill cell, which greatly restricted placing cover soils over an alternative geosynthetic cover system. Additional design features included incorporating passive gas vent risers tied into the gas vent layer, rip-rap downchutes in interior swale areas, rip-rap drainage swales and extension of leachate clean-out access pipes.

Principal, Solid Waste Disposal Area II, Phases C - H, AES Somerset, LLC, Barker, New York. Designed a 34-acre ash monofill waste management facility and re-lining of 2 retention basins. Procured a Beneficial Use Determination (BUD) from NYSDEC to allow use of coal bottom ash for cell liner subgrade. Prepared contract documents and developed ACAD 3-dimensional surface models for construction layout of multiple layered landfill liner. Administered QA/QC programs, overseeing a field engineer and 1 to 2 technicians.

Associate Principal, NRG Dunkirk Power, Ash Landfill Cell B-2 Expansion, Pomfret, New York. Provided Principal review of the design of a 5.5-acre solid waste management cell expansion at an existing ash landfill. Prepared permit and contract documents and developed ACAD 3-dimensional surface models for construction layout of multiple layered landfill liner. Interfaced with contractor's construction manager and certifying land surveyor for construction layout including proper tie-in to existing containment cells. Quantified available variable borrow soils based upon test pit explorations and topography of borrow area.

Education

B.S., 1984, Civil Engineering,
Valparaiso University, Indiana

Registrations & Certificates

Professional Engineer – 1992
New York, #069423

Affiliations

- Member - American Society of Civil Engineers
- Member – Engineering Society of Buffalo
- Member - New York State Association for Solid Waste Management
- Member – New York State Society of Professional Engineers

Areas of Specialization

- Solid Waste Design
- Civil Site Design
- Geotechnical Engineering
- Construction Administration

Bart A. Klettke, P.E.

Principal/District Officer Manager

Project Manager, Landfill Remediation Project, Town of Hamburg, New York. Overall design responsibility for remedial closure of this solid waste management facility. Developed work plan to consolidate waste and re-grade existing landfill, and provide surface water drainage.

Project Manager, Chaffee Landfill, Waste Management of North America, Sardinia, New York. Performed design modifications for the containment berms, site access roads and surface drainage structures for this solid waste management facility. Design modifications saved client 70,000 cubic yards of earth fill. Calculated survey control for construction layout. Calculated earthwork and air-space volumes, using computer surface modeling program.

Project Manager, McKenna Landfill Remedial Closure, Waste Management of North America, Albion, New York. Developed construction drawings for remedial closure of this solid waste management facility. Calculated earthwork and construction material volumes using computer surface modeling program. Provided design interpretation, reviewed contractor submittals, reviewed payment quantities, and addressed concerns and questions by contractor. Monitored geosynthetic installations.

Project Manager, Sanitary Landfill Area V, Subarea B, BFI Waste Systems of North America, Niagara Falls, New York. Designed a 13-acre solid waste management facility including developing construction drawings, and writing technical specifications and QA/QC plan. Construction drawings were developed as 3-dimensional ACAD files to allow direct data extraction for survey layout. Calculated earthwork and material volumes, using computer surface modeling program. Coordinated with client and project surveyor in obtaining pre-construction survey data for design of this project in highly sensitive environment.

Senior Project Manager, Alltift Landfill & Ramco Steel Site, Buffalo, New York. Developed an extensive Quality Assurance/Quality Control Plan and Health & Safety Plan for the project Contractor for landfill remediation work done at this site. Managed the project budget, assigned soils and geosynthetics laboratory testing, and supervised engineering technicians in administering these plans.

Project Engineer, Sanitary Landfill Area V, Subarea A, BFI Waste Systems of North America, Niagara Falls, New York. Designed a 22-acre solid waste management facility. Developed permit drawings and QA/QC plan for approval by NYSDEC. Developed construction drawings and technical specifications. Calculated cut and fill volumes, using computer surface modeling program. Estimated construction costs to assist client in determining viability of project. During construction, managed the field activities and coordinated the contractor's earthwork efforts. Made recommendations for acceptance of subgrade and fill placement in sensitive existing fill soils. Supervised four technicians in implementing QA/QC plan. Provided design interpretation, reviewed contractor submittals, reviewed payment quantities, and addressed concerns and questions by client and NYSDEC. Wrote formal construction observation report for NYSDEC approval.

Project Engineer, Sanitary Landfill Area VI, Subareas A through D, Closure Construction, BFI Waste Systems of North America, Niagara Falls, New York. Designed closure plans, including surface water management structures, for this 45-acre solid waste management facility. Developed construction drawings, technical specifications and QA/QC plan. Managed the contractor's earthwork activity and acted as the Owner's construction manager. Supervised two to three technicians in implementing QA/QC plan. Provided contract administration, design interpretation, reviewed contractor submittals and addressed concerns and questions by client and NYSDEC.

Project Engineer, Mohawk Valley Sanitary Landfill Expansion, Waste Management of New York, Frankfort, New York. Coordinated subsurface exploration in evaluating hydrogeological conditions of a proposed landfill expansion. Work included monitoring of test boring activities, installation of multi-level groundwater monitoring wells, groundwater screening and sampling, and field permeability testing. Evaluated permeability test data and coordinated soils laboratory testing. Assisted in preparation of technical reports. All work done in accordance with New York State Department of Environmental Conservation 6 NYCRR Part 360 regulations.

Project Engineer, Ellery Sanitary Landfill, Jamestown, New York. Designed a final cover system for a 12-acre landfill cell. Design included multiple double containment leachate transfer systems, access road and surface drainage structures. Wrote technical specifications, QA/QC plan, contract documents for competitive bids; and calculated material quantities and construction costs.

RESUME

Edward A. Summerly, P.G.

Principal

Education

B.S., 1985, Geology,
University of Rhode Island
Geological Field Methods, 1984, University of Texas at El Paso

Registrations & Certificates

Professional Geologist – 1994, Kentucky, # 1871

Affiliations

- Environmental Business Council, RI Chapter Board Member
- Solid Waste Association of North America, Landfill Gas Technical Division Member
- Association of Ground Water Scientists and Engineers
- Rhode Island Society of Environmental Professionals

Areas of Specialization

- CERCLA/RCRA/State
- Site Investigations
- Feasibility Studies
- Site Remediation
- Solid Waste & Landfill Gas

Specialized Training

- 2001, Queens University, Hydrogeology of Fractured Rock
- 1999, PSMJ Resources, Advanced Project Management Training Course
- 1997, ASTM, Risk Based Corrective Action (RBCA) Decision Making Training Course
- 1996, OSHA, Confined Space Entry Training Certification
- 1995, GSC, Contaminant Fate and Groundwater Transport Modeling Course
- 1995, EPA, Human Health Risk Assessment Guidance for Superfund Course

Summary of Experience

Mr. Summerly is a Principal and Registered Professional Geologist. He serves as manager and technical lead on multi-disciplinary studies and design projects focusing on Solid Waste Management Facilities, landfill gas control and reuse, and contaminated sites requiring assessment of environmental contamination (soil, groundwater, surface water, air), human health and ecological risk management and hazardous waste remediation. His responsibilities include: technical direction, contract management, project planning, budget control, and quality assurance. Mr. Summerly has been involved with site investigations (soil, groundwater, surface water, air), environmental compliance issues, permitting, and testing at more than 30 solid waste management facilities in the northeast. He has managed several Superfund, RCRA Corrective Action and State lead studies involving remedial investigation (waste identification, groundwater, surface water and geologic characterization) groundwater contaminant migration evaluation, human health and ecological risk assessment/risk management, and public relations. Mr. Summerly has supervised and participated in the preparation and implementation of Superfund, RCRA, and State Remedial Investigation/Feasibility Studies, QAPPs, and subsequent site clean-up and Remedial Actions.

Mr. Summerly's more than 30 years of experience includes participation in RIDEM's regulatory Task Force for the redevelopment of Rhode Island's Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases and he is GZA's Technical Practice Leader for Solid Waste Services.

Solid Waste Management Facility Experience Includes :

Central Landfill, Johnston, RI
Fresh Kills Landfill, Staton Is, NY
Jamestown Landfill, Jamestown, RI
Richmond Landfill, Richmond, RI
Manton Avenue Landfill, Providence, RI
Rose Hill Landfill, South Kingstown, RI
Macera Landfill, Johnston, RI
Home Town Properties Landfill, Exeter, RI
Global Waste Recycling, Coventry, RI
Materials Recycling Facility, Johnston, RI
Plainfield Pike Recycling Facility, Johnston, RI
Tuckers Industrial Dump, Johnston, RI
Coventry Landfill, Coventry, RI
Cumberland Landfill, Cumberland, RI
Canton Landfill Solar Facility, Canton, MA
A Street Landfill Solar Facility, Johnston, RI
Kingston Landfill, Kingston, MA
Rocky Hill Landfill, East Greenwich, RI
Plainfield Landfill, Plainfield, MA
Oak Bluff Landfill, Martha's Vineyard, MA
Edgartown Landfill, Martha's Vineyard, MA
Vineyard Haven Landfill, Martha's Vineyard, MA
Tisburry Landfill, Martha's Vineyard, MA
Gay Head Landfill, Martha's Vineyard, MA
SeMass/American Ref-Fuel, West Wareham, MA
Rocky Point Landfill, Warwick, RI
Barrington Landfills 1 and 2, Barrington, RI
MOA Landfill, Atlanta, MI
Violia ES Landfill, Zion, IL
Charlestown Landfill, Charlestown, RI
Ravenbrook Landfill Solar Facility, Carver, MA
Forbes St. Landfill Solar Facility, E. Prov,, RI

Relevant Project Experience

Principal, Central Landfill Superfund Site RI/FS and RD/RA, Johnston, Rhode Island. This EPA mandated study involved evaluation of environmental conditions (air, soil, bedrock, groundwater, surface water, and sediment) at New England's largest solid waste management facility, which is also an EPA Superfund Site. Project elements included development and implementation of work plans for subsurface explorations,

Edward A. Summerly, P.G.

Principal

multi-media environmental sampling and analysis, geophysical studies and groundwater transport evaluation. The project culminated in the closure of the 121 acre Operable Unit 1 Landfill with a modified RCRA Subtitle C Cap, installation of a groundwater pump and treatment system in an identified Hot Spot and a finding of No Action Required for the Operable Unit 2 off-site area.

Principal, Fresh Kills Landfill Closure, Staten Island, NY. Mr. Summerly serves as technical lead for landfill gas collection and control on this multi-year design-build landfill closure project. This project involves closing and capping a 300 acre cell of the former Fresh Kills Landfill working as the design engineer for the construction contractor. Key elements of GZA's services are design of all closure elements including: the RCRA D synthetic membrane cap, stormwater control structures, landfill gas collection and conveyance systems, and roadways. Mr. Summerly's responsibilities also include coordination of operation of the new landfill gas collection and control systems, and integration of the new and existing gas systems with the DSNY's gas system operator who produces pipeline quality natural gas from the recovered methane for resale.

Principal, Coventry Landfill Assessment, Closure Design and Construction QA/QC, Coventry, RI. Mr. Summerly directed GZA's work on this CIRCLIS and State List landfill site which, to date, has consisted of extensive environmental investigations both on and off-site, landfill cap and closure design, remedial action planning, groundwater and landfill gas migration assessment, and meetings with State regulators. The closure design incorporates the use of 300,000 cubic yards of impacted soil from off-site sources under a Beneficial Use Determination (BUD) regulatory approval, the revenue from which will significantly reduce Site closure costs. The proposed future use of the facility is as a utility-scale solar energy farm. Final landfill closure grading and cap design integrates the needs of the solar farm to put this otherwise fallow land back into productive use.

Principal, Central Landfill Phase VI Landfill Design and Permitting, Johnston, Rhode Island. Mr. Summerly serves as contract manager and technical specialist on this 153 acre landfill expansion design and permitting project. Work to date has involved: conducting a pre-design geohydrologic investigation of the site, design of a double-composite synthetic baseliner system using HDPE, as well as a geocomposite clay liner and dual composite drainage nets to gain additional air space, leachate collection system design, operational and post-closure landfill gas collection and control system designs for regulatory compliance, gas mining for beneficial reuse, and preparation of landfill license application documents for regulatory approval.

Principal, Central Landfill Environmental Engineering General Services Contract, Johnston, Rhode Island. Mr. Summerly serves as contract manager and technical specialist on this multi-year task order contract. Work to date has involved the completion of more than 65 individual jobs/tasks with budgets ranging from $400 to $750,000 including portions of two broad based remedial investigations and feasibility studies. Other work performed under this contract has drawn upon more than 20 distinct environmental services areas such as: landfill permitting, air quality evaluation and permitting, landfill gas control, BUD soil/waste evaluation, emergency response, hazardous waste disposal, regulatory compliance auditing and monitoring, environmental monitoring, dredging, geotechnical soils testing and blast monitoring, technical support for public meetings and presentations, and environmental data interpretation and reporting.

Associate Principal, Rose Hill Landfill Superfund Site. Mr. Summerly directed GZA's work on this project which consisted of evaluating the results of a Remedial Investigation and Feasibility Study that was conducted by the EPA, for the Potentially Responsible Parties (PRP Group). The purpose of our work was to ensure that the regulatory agencies had selected the most cost-effective remedy (capping and landfill gas control) that was protective of human health and the environment. Our recommendations lead to additional field studies (completed by GZA), to better assess groundwater migration, landfill mining options, and landfill gas control. As a result of our work, the EPA and RIDEM changed the selected remedy to a more protective and cost-effective approach.

Principal, Jamestown Landfill Assessment and Closure. Mr. Summerly directed GZA's work which consisted of the completion of a site investigation work plan, site investigation, underground injection control closure, remedial action work plan preparation, landfill capping and closure design, landfill gas migration assessment, landfill capping and closure engineering oversight, site redevelopment as a Department of Public Works facility and quarterly environmental compliance monitoring of groundwater and

Edward A. Summerly, P.G.

Principal

soil gas. GZA assisted the Town in obtaining and/or evaluating off-site soils from a variety of sources which resulted in a significant reduction in landfill closure costs. This project has also included public relations work including public meetings, presentations, and participation in a citizen's advisory committee.

Principal, Barrington Landfills 1 and 2 Assessment and Closure. Mr. Summerly directed GZA's work which consisted of the completion of a multi-media site investigation, landfill gas migration assessment, survey and boundary determination, landfill capping and closure design and construction oversight. Our closure design incorporated the redevelopment of the Site as a recreational facility including two soccer fields, walking paths and paved parking.

Principal, A. Macera Landfill Assessment and Closure, Johnston, Rhode Island. Mr. Summerly directed GZA's work which consisted of the completion of a site investigation work plan, site investigation, landfill gas migration assessment, remedial action work plan preparation, landfill capping and closure design, and site redevelopment as an industrial park. As part of this closure design GZA worked with the Client and RIDEM to reduce the closed landfill footprint by 40%, and reuse excavated waste and soils in the capping project under a BUD approval. The Site reuse plan incorporates on-landfill bus parking for the Town of Johnston and passive recreation, and the recovered land has been developed into an industrial park.

Principal, Tucker's Industrial Dump Assessment and Closure Design, Johnston, Rhode Island. Mr. Summerly directed GZA's work which consisted of the completion of a site investigation work plan, site investigation, landfill gas migration assessment and control design, remedial action work plan preparation, landfill capping and closure design, and site reuse as a residential development. A significant component of this work included delineating a chlorinated solvent groundwater contaminant plume and associated vapor plume migrating from the dump below a proposed residential development.

Principal, Richmond Landfill. Mr. Summerly directs a team of environmental professionals conducting ongoing quarterly compliance monitoring of groundwater at this closed landfill and CERCLIS site. Work consists of Low Flow groundwater sampling, chemical analysis, statistical data evaluation, perimeter landfill gas monitoring for migration control, and reporting to the RIDEM's Office of Waste Management.

RESUME

Todd R. Greene, P.E.

Senior Project Manager/Senior Engineer

Education

B.S., 1996, Civil Engineering, Norwich University

Registrations & Certificates

Professional Engineer – 2008, Rhode Island, 8567

Areas of Specialization

- Civil Engineering
- Landfill Engineering and Construction
- Construction Management & Oversight
- Stormwater Management & Design
- Hydrologic and Hydraulic Analysis
- Environmental Engineering
- Soil and Groundwater Remediation
- Groundwater Hydrology
- Solid and Hazardous Waste Disposal
- Wastewater Treatment – OWTS Design
- Topographic Survey

Summary of Experience

Mr. Greene's has 15 years of experience primarily on civil, landfill and environmental engineering projects. Specific project experience includes hydrology, stormwater management, site grading, structural steel design and analysis, landfill baseliner design and landfill construction oversight, landfill capping design and cap construction oversight, landfill gas collection system design, trouble shooting small industrial wastewater pretreatment facilities, construction layout and surveying utilizing GPS, geohydrological studies, industrial wastewater permitting, site remediation (pump and treat, bioremediation and soil vapor extraction with air sparging) and various air, water and soil sampling techniques.

Relevant Project Experience

Landfill Engineering Projects

Project Manager / Project Engineer, Fresh Kills Landfill Closure, Staten Island, New York. Mr. Greene serves as project manager and lead designer to develop construction drawings and details for Section 6/7 of the Fresh Kills Landfill located in Staten Island New York. The landfill closure design included, grading, geosynthetic design, storm water conveyance and management, maintenance road layout and design, erosion control design and specification, gas collection and conveyance design. This project involves closing 285 acre cell of the former Fresh Kills Landfill under a five phase construction sequence and schedule, working as the design engineer for the construction contractor, Tully Construction. Key elements of GZA's services are design of all closure elements and preparing construction drawing submittals as follows: Initial Working Drawings and details for the 285 acre closure and Temporary and Final Working Construction drawings for each specific construction phase. Mr. Greene work directly for Tully Construction and interact and communicated with the New York Department of Sanitation (DSNY) and DSNY's engineering consult to address and incorporate site and design considerations into the project. As part of the Temporary Working Drawing submittals value engineering was conducted for the geosynthetic layering, geosynthetic drainage details, gas system and earthwork activities.

Project Manager, Central Landfill, Johnston, Rhode Island. Providing multiple general and daily engineering services for the Rhode Island Resource Recovery Corp. at the Central Landfill Facility in Johnston, RI; services include environmental, site civil, solid waste and landfill engineering services for the following tasks:

- Review and oversight of the implementation of the erosion control and sediment monitoring;
- Trash and construction material volume estimates;
- Develop grading plans;
- Property acquisition evaluations;
- Landfill planning;
- Landfill settlement and filling monitoring;
- Review, evaluate and prepare RFP / RFQ packages;
- Waste Compaction evaluation;

Todd R. Greene, P.E.

Senior Project Manager/Senior Engineer

- Construction layout;
- Construction oversight of horizontal methane extraction lines;
- Construction as-built surveys;
- Utility installation construction oversight;
- Haul road design and layout;
- Perform Topographic surveys;
- Drafting / design utilizing Autodesk Civil design series;
- GPS trouble shooting; and
- Facility design modifications and trouble shooting.

Project Manager / Project Engineer, Central Landfill, Johnston, Rhode Island. Performed multiple design and layout modifications to the tipping facility; projects included construction as-built and layout for the relocation of the tarping racks and bollards located on the northern and eastern side of the facility, performed a structural analysis to determine if the existing trash shoot areas could support the operation of knuckle booms, designed an alternative trash shoot curtain to minimize air-born litter, designed alternative trash pit covers and push wall protection plates and performed several field evaluations on the facility.

Project Manager / Project Engineer, Central Landfill, Johnston, Rhode Island. Phase V 110 Acre landfill design modification and construction drawing preparation. Project include incorporating alternative geo composites to increase landfill air space and reduce construction cost and time to the base cell area and utilizing the existing OU-1 cap construction materials for the secondary containment system to minimize construction cost of the Phase V piggy back area.

Project Manager / Project Engineer, Central Landfill, Johnston, Rhode Island. Phase II / III RCRA 30 acre capping project. Project included construction oversight of the cap subgrade and overall cap construction. In addition the project required grading and bench design modifications to minimize slope cuts and constructability issues. The project also required GPS file modification to create grid and triangulation files compatible to the corporations Gradestar GPS software and the implementation of leachate controls to dewater the caps anchor trench to expose the existing baseliner system.

Project Manager / Project Engineer, Central Landfill Phase VI Landfill Design and Permitting, Johnston, Rhode Island. Phase VI landfill expansion permit application submittal and performed associated calculations and designs corresponding with the landfill gas collection system, leachate collection and conveyance systems, base cell subgrade design and developed permitting drawings and prepared the overall landfill cell permitting submittal for RIDEM review and comment.

Project Manager, Town of Barrington Landfills 1 & 2 Site Investigation (SIR), Barrington, Rhode Island. Mr. Greene provided the Town with engineering services to conduct a site investigation at the former Barrington landfill. The site investigation included, waste delineation and characterization, characterization of cover materials, groundwater sampling and monitoring, evaluate groundwater flow direction, soil gas monitoring and proposed site redevelopment alternatives and preparation of the SIR for submittal with to RIDEM. Once the SIR was approved, GZA prepared a Remedial Action Work Plan, which has subsequently been approved by the Department. GZA services included construction drawings and specifications and full time construction oversight.

Project Manager, Town of Barrington Landfill 1 & 2 Closure Design & Construction Oversight, Barrington, Rhode Island. Mr. Greene was the project manager and certifying engineer for the closure and landfill capping of Barrington's landfills 1 & 2. The landfills were approximately 9 acres divided by a town roadway. The closure required the preparation of a Remedial Action Work Plan for review and approval by the Rhode Island Department of Environmental Managements (RIDEM). In addition Mr. Greene prepared construction drawings, details and specifications and contractor bid packages and assisted the town in contractor selection. Mr. Greene was responsible for all construction administration & management of the project through construction on behalf of the Town of Barrington. Full time construction oversight and landfill closure certification was also conducted and prepared, respectively. Value engineering was performed to obtain regulatory approval of reducing the minimum cap slope requirement from 3 to 5 percent to 1 percent, which will with beneficial re- use of the properties as recreational sports fields.

Project Manager, Town of Jamestown Landfill Closure, Jamestown, Rhode Island. Mr. Greene provided engineering services to close and cap the former town landfill. As part of the landfill closure, design plans were developed to site the Town's Department of Public Works Facility (DPW) on the landfill. Design and permitting services included the landfill closure, site grading, stormwater management, waste management plan, ELUR, water supply and sewer / ISDS design, wetlands permitting and development of a remedial action work plan. The project included providing the Town with engineering cost estimates and closure and site redevelopment

Todd R. Greene, P.E.

Senior Project Manager/Senior Engineer

alternatives. This project required a close working relationship with RIDEM's Department of Waste Management.

Project Manager, Hartford Landfill, Connecticut Resource Recovery Corporation (CRRA), Hartford, Connecticut. Mr. Green performed an operational and site audit on the Hartford landfill. The landfill operates in two separate areas: The Bulky Waste Cell and The Ash Landfill, which receives ash from CRRA's Mid Connecticut Project trash to energy plant. Engineering services include an overall evaluation of the landfill including site staff and management, filling sequencing, filling procedures, available equipment, stormwater management, daily cover practices, site erosion and sediment controls, leachate breakouts, methane extraction, overall site maintenance and long term planning. The results of the evaluation was summarized and presented to CRRA for their use to modify the landfill operation to function more efficiently and potentially extend the overall life of the landfill.

Project Manager, Hi-Lo Landfill Redevelopment, Johnston, Rhode Island. GZA's provided third party engineering review of proposed environmental remediation and closure activities associated with the Hi-Lo landfill property. In addition, we reviewed the Pocasset River flood plain maps and information as delineated by FEMA and identified potential re-development issues for the property as they pertain to the current flood plain delineation. GZA prepared an M-1 Form to request for Letter of Map Revisions based on Fill (LOMR-F) to submit to FEMA and prepared a wetland edge verification request to RIDEM.

Project Reviewer / Technical Specialist, Former Coventry Landfill, Coventry, Rhode Island. Project involved the design remedial actions and a final closure system for the former Coventry Landfill located on Arnold Road in Coventry, Rhode Island. The landfill was subject to two RIDEM regulatory programs; the Solid Waste Program (due to the former use of the properties as solid waste disposal facility) and the Site Remediation Program, and the RIDEM policy memorandum entitled "Closure Policy for Inactive or Abandoned Solid Waste Landfills". GZA develop a Remedial Action Work Plan (RAWP) and Landfill Closure Design consisting of a soil vapor extraction system, 24-inch thick soil cap and associated stormwater management system, designed in accordance with the *Rhode Island Stormwater Design and Installation Standards Manual Dated: December 2010.* The landfill closure and associated remedial activities include a Beneficial Use Determination to import slightly contaminated soils to the site to prepare the landfill cap subgrade and a Construction Stormwater Pollution Prevention Plan (SWPPP).

Project Manager, Providence & Worcester Railroad (P&W) / JM Mills Landfill / Peterson & Puritan Super Fund Site, Mendon Road to Martin Street Rail Siding. GZA provided engineering and environmental consulting services to assist P&W in obtaining RIDEM and EPA approvals to construct a new 8000 foot long railroad siding within the OU-2 area associated with the Peterson & Puritan Super Fund Site and associated JM Mills Landfill. The proposed rail side is located adjacent to the eastern edge of the JM Mills Landfill Site. GZA prepared a Field Investigation Work Plan (FIWP) for submittal to EPA and RIDEM to perform a series of test pits along the eastern perimeter of the JM Mills Landfill to delineate the extent of the buried waste within P&W's ROW and or adjacent to, the area of the proposed rail siding. Following EPA and RIDEMs approval of the FIWP, GZA conducted the test pitting program and obtained field data to delineate the extent of buried waste adjacent to the proposed rail siding. The result of the test pitting program was utilized to assess if construction of the proposed rail siding may be completed without requiring the removal of significant amounts of buried waste material and to identify construction techniques and details that would be compatible with available alternatives for a RCRA C landfill closure. Based on GZA's evaluation, EPA accepted the proposed rail siding concept and the rail siding is currently under construction.

Project Manager, Former Rocky Hill Fair Grounds Landfill Closure, East Greenwich, Rhode Island. GZA designed and prepared a corresponding remedial action work plan, which received RIDEM approval to construct a landfill cap and implementation of an Environmental Land Use Restriction (ELUR). The approved remedial action complied with the RIDEM policy memorandum entitled "Closure Policy for Inactive or Abandoned Solid Waste Landfills". The landfill closure consists of consolidating the landfill to a 0.4 acre area within the interior limits of the existing utility easement constructing a 24-inch thick engineered soil cap consisting of 6-inches of loam, 18-inches of gravel borrow (vegetative support) and an underlying high visibility permeable geotextile warning barrier. GZA prepared construction drawings, specifications and construction bid documents to solicit contractor bids to construct the proposed landfill cap. In addition GZA provided construction administration, management and field oversight services during construction. Following the completion of construction activities, a Remedial Action Closure Report was prepared in accordance with RIDEMs Remediation Regulations and Solid Waste Resubmitted to RIDEM for review and approval.

GZA RESUME

Theodore A. Klettke

Project Engineer

Summary of Experience

Mr. Klettke's experience includes both environmental and geotechnical engineering projects. He utilizes AutoCad skills to develop 3-dimensional design and layout of landfill liner and final cover systems. Other responsibilities include: Supervising landfill CQA programs and providing survey design interpretation for construction contractors and certifying surveyors, surveying, soil and groundwater site investigations, geotechnical investigations, observation and logging of subsurface explorations, and sampling of soil, groundwater, surface water, sediment, and air.

Education

B.S., 2011, Mechanical Engineering, Valparaiso University

Areas of Specialization

- CQA/CQC Monitoring and Testing
- 3-Dimensional AutoCad Landfill Design
- 3-Dimensional Sketchup Modeling
- Surface Volume Calculation
- Geosynthetics QA/QC
- Photo Documentation
- Surveying
- Geotechnical Investigations

Relevant Project Experience

Sanitary Landfill VIII, Subarea E, Allied/BFI Waste Systems of North America, Inc., Design, Niagara Falls, New York. Designed a 13-acre solid waste management facility including development of construction drawings developed as 3-dimensional ACAD files for construction layout and survey certification. Calculated earthwork and material volumes for developing accurate bid quantities. Developed 3-dimensional Sketchup Pro model and virtual tour video of a complex multi-faceted leachate cleanout and drainage pipe system, storm-water improvements, excavation cut surface, and fill grade surfaces.

Hydrogeologic and Geomembrane System Assessment of the State Licensed Disposal Area (SDA) of the Western New York Nuclear Services Center (WNYNSC), West Valley, New York. Developed 3-dimensional Sketchup Pro model and virtual tour video of groundwater in comparison to site features. Created groundwater database within excel to populate graphs and 3-dimensional model as current groundwater levels are added. Converted data to Geographic and State Planar North American Datum of 1983 (NAD83) & North American Vertical Datum of 1988 (NAVD).

NRG Dunkirk Power LLC Landfill Closure Assessment, Dunkirk, New York. Designed multiple final grading options for closure of an operational 11-acre landfill cell. Calculated earthwork and material volumes within a computer surface modeling program.

Sanitary Landfill VIII, Subarea B East, Allied/BFI Waste Systems of North America, Inc., Subgrade and Primary and Secondary Liner Construction, Niagara Falls, New York. Observed/documented daily field activities and implemented construction quality assurance (CQA) testing and documentation. Recorded observations/measurements during installation of subgrade soils, low permeability soils, high density polyethylene geomembrane (HDPE) and geocomposite material including: In-place nuclear density measurements, thin wall Shelby tube permeability sampling, placement and seam orientation for conformance with permit requirements; destructive testing of HDPE liner materials; non-destructive testing of HDPE liner materials in accordance with applicable operation/construction permits. Coordinated with contractors the job progress/schedule, tracking of quantities as well as any quality control issues. Recorded geosynthetic panel placement, seam locations, destructive sample locations and patch locations. Observed and recorded non-destructive geosynthetics liner testing.

Theodore A. Klettke

Project Engineer

Sanitary Landfill VIII, Subarea C, Allied/BFI Waste Systems of North America, Inc., Subgrade and Liner Construction CQA, Niagara Falls, New York. Performed air monitoring during the excavation of industrial fill from the landfill footprint. The work included screening the excavated fill with a photo-ionization detector (PID), 4-gas meter, and sampling the upwind and downwind air for dust particulates. Observed/documented daily field activities and implemented construction quality assurance (CQA) testing and documentation. Recorded observations/measurements during installation of subgrade soils, low permeability soils including: In-place nuclear density measurements, thin wall Shelby tube permeability sampling. Monitored, tested, sampled and documented the construction of a test pad to qualify proposed soil borrow for use as low permeability soil.

Sanitary Landfill VIII, Subarea D Permit Design, Allied Waste Niagara Falls Landfill, Niagara Falls, New York. Designed a 17-acre landfill liner system using 3-D ACAD for permit-level drawings. Developed excavation grades in area of extensive existing industrial fill, top of subgrade and landfill liner grades, and containment berm cross-sections. Determined optimal design grades to minimize relocation of existing fill and maximize airspace, and calculated excavation volumes from design work.

312 Maple Street, Village of Endicott, New York. Monitored installation of a groundwater monitoring well system. The work included the decommissioning and installation of monitoring wells to assess groundwater in top-of-clay, top-of-rock and bedrock zones. Sampled and logged overburden fill, natural soils and bedrock. Documented well installation and well development. Surveying was performed to find the elevation and location of the newly installed monitoring wells. Ground water sampling was performed at several wells around the site.

Solid Waste Disposal Area II, Cells C & D, AES Somerset. LLC Subgrade and Liner Construction, Somerset, New York. Observed/documented daily field activities and implemented construction quality assurance (CQA) during completion of two sub-areas totaling 14.5 acres. Recorded observations/measurements during installation of subgrade soils, low permeability soils, high density polyethylene (HDPE) geomembrane and geocomposite material including: In-place nuclear density measurements, thin wall Shelby tube permeability sampling, placement and seam orientation for conformance with permit requirements; destructive testing of HDPE liner materials; non-destructive testing of HDPE liner materials in accordance with applicable operation/construction permits. Coordinated with contractors regarding job progress/schedule, tracking of quantities as well as quality control issues. Recorded geosynthetic panel placement, seam locations, destructive sample locations and patch locations. Observed and recorded non-destructive geosynthetics liner testing and completed daily field progress reports.

Solid Waste Disposal Area II Cells G & H East, AES Somerset. LLC Design, Somerset, New York. Designed a 10-acre solid waste management facility including developing construction drawings developed as 3-dimensional ACAD files for construction layout. Calculated earthwork and material volumes, using a computer surface modeling program.

Enbridge Pipeline, Erosion Control Monitoring, Buffalo New York. Created AutoCad maps for each excavation site along the pipeline where the pipeline integrity was evaluated. Wrote weekly & monthly reports for active or completed dig evaluation sites & developed and updated on a daily basis, a project status sheet for past, current and future dig evaluation sites.

Buffalo State College Underground Utilities Improvement Project, Buffalo, New York. Performed pre-construction documentation of existing conditions for underground utility installations being done on the Buffalo State College campus. Work consisted of photographing & recording video of nearby buildings, sidewalks, and other structures to show their condition before work was done by the contractor. Photographs were logged in a photo page Microsoft Word document and the videos were compiled and edited within Windows Movie Maker. The photograph and video locations were plotted on a map of the campus area.

Signore Brownfield Clean-up Program Supplemental Remedial Investigation, Ellicottville, New York. Soil vapor intrusion samples were taken of the air space beneath basements of houses surrounding the Signore site. Work consisted of drilling a hole through the concrete floor of the basement and sampling the vapors below the sub-slab of the house. Air samples were also taken from the basement ambient air and the outdoor ambient air. Air samples were then sent to a lab for analysis.

Army Reserve Underground Storage Tanks & Fire Main Investigation. Surveyed temporary and permanent groundwater wells to find the elevation of each well based on a known benchmark.

Theodore A. Klettke

Project Engineer

AUTOCAD
Mr. Klettke has experience in AutoCAD design. His work consists of developing 3-dimensional surface models for developing grading plans, providing survey layout data, and calculating earthwork and landfill airspace volumes. He has been involved in the design of several solid waste management facilities in western New York.

SKETCHUP PRO 3-D DIMENSIONAL MODELING
Mr. Klettke is proficient in Sketchup Pro 3-Dimensional Modeling. His work consists of developing 3-dimensional models of site features such as groundwater contours, buildings, subsurface features, and aerial photography layered atop TIN surfaces. He has produced 3-Dimensional Virtual Walkthrough Videos of several work sites.

SURVEYING
Mr. Klettke has surveying experience working at Klettke Land Surveyors P.C. during his high school and college years. His work consisted of operating a survey total station, data collector, & level instruments. He determined if residences were within the Federal Emergency Management Administration (FEMA) flood elevation boundaries by noting and recording elevation measurements. He also drafted and prepared maps based on data collected from field notes.

Professional Experience

OSHA 40-Hour HAZWOPER Training

Certified Operator of Nuclear moisture/Density Gauge (Troxler Electronics, Inc.)

Contractor Safety Orientation at GM – Lockport Complex

NSC CPR Course

NSC First Aid Course

Michael Kress

Assistant Project Manager

Education

B.S., 2004, Civil Engineering, State University of New York at Buffalo
A.A.S., 1990, Civil Engineering Technology, Erie Community College, North Campus

Professional Development

- Passed Fundamental of Engineering Exam (EIT), October 2004
- OSHA 40 Hour Health & Safety Training Course – 29 CFR 1910.120
- NYSDEC Stormwater Management Training
- HAZWOPER Certification
- Troxler Nuclear Density Trained

Areas of Specialization

- Geotechnical Investigation
- Construction Management and CQA
- Stormwater Analysis and Design
- AutoCAD, MathCAD
- Landfill Design
- Soil and Rock Classification
- Geosynthetic QA/QC
- Stormwater Management Plans

Summary of Experience

Mr. Kress has over 12 years of professional experience including geotechnical engineering, construction management, contracting, project budgeting and scheduling, oversight of MGP and brownfield remediation, development of storm water management plans and construction specifications. Michael has extensive field experience in geotechnical subsurface investigations, solid waste management facility design, construction, management, construction quality assurance monitoring and in-place nuclear density testing. His responsibilities have included management of subsurface exploration programs, monitoring well design and observation and logging of soil and rock samples. His AutoCad skills have been utilized in the design and layout of landfill systems, details and Site plans.

Relevant Project Experience

Former Gloucester Gas Light Company MGP Facility, Gloucester, Massachusetts. Lead Field Engineer for remediation implementation involving timber pier and granite seawall demolition, mechanical and suction dredging, by divers, of 30,000 cubic yards of impacted sediment, excavation and disposal of upland impacted soils, capping in-situ materials, DNAPL collection systems, marine armor mattress installation, mechanically stabilized earth walls, re-construction of seawalls and pier systems and Site restoration.

Former Supertane Coal Tar Site, Charles Town, West Virginia. Design of soil management and impermeable cap containment structures above consolidated coal tar wastes. Design of Stormwater conveyance and containment structures, block retaining walls with associated stability analysis and site restoration. Development of Plans, Specifications and Bid Documents.

22 Cooper Street Former Coal Tar Site, Waltham, Massachusetts. Performed on-site construction oversight of field work involving, impacted material excavation and disposal and in-situ stabilization via mixing.

Former Manufactured Gas Plant (MGP) Remedial Action, Vineland, New Jersey. Assisted in development of Remedial Action Work Plans and specifications for work associated with remedial efforts at a former manufactured gas plant. Performed on-site construction oversight throughout the duration of the field work involving, sheetpile earth support, vibration and optical survey monitoring, utility relocation, impacted material excavation, groundwater management and site restoration.

Solid Waste Disposal Area II, Cells C through H, AES Somerset. L.L.C. Subgrade and Liner Construction, Somerset, New York. Developed a Beneficial Use Determination (BUD) application submitted to the NYSDEC to use a waste coal by-product as fill material in landfill subgrade construction. Observed/documented daily field activities and implemented construction quality assurance (CQA) during completion of six sub-areas totaling 40 acres. Recorded observations/measurements during installation of subgrade soils, low permeability soils, high density polyethylene geomembrane (HDPE) and geocomposite materials including: In-place nuclear density measurements, thin wall Shelby tube permeability sampling, placement and seam orientation for

Michael Kress

Assistant Project Manager

conformance with permit requirements; destructive and non-destructive testing of HDPE liner materials in accordance with applicable operation/construction permits.

Sanitary Landfill VIII, Subarea A, Allied/BFI Waste Systems of North America, Inc., Subgrade, Liner and Cap Construction, Niagara Falls, New York. Oversight and documentation of daily field activities and implemented construction quality assurance (CQA) during the installation of HDPE and linear low density polyethylene geomembrane (LLDPE), geocomposite and geosynthetic clay liner (GCL) materials including: placement and seam orientation for conformance with permit requirements; destructive and non-destructive testing of liner materials in accordance with applicable permits; recorded observations/measurements; coordinated daily installation activities with surveyor to: record location of each panel, seam location, destructive sample locations, patch locations, and tracking of quantities. Completed daily field progress reports and addressed project issues and concerns with the regulatory agency (NYSDEC) and the client.

Fresh Kills Landfill, Section 6/7 Sanitary Landfill Final Cover, New York City Department of Transportation, Staten Island, New York. Performed stormwater analysis, design of Swales, Culverts, Gabion Downchutes, Piping and Detention Basins for final closure and capping. Utilized AutoCad, FlowMaster, Win TR55, and other design programs to check/size capacity of the structures mentioned above. Performed slope stability analysis for liner components as well as overall stability. Supplied the Survey team with control points for layout of above mentioned features.

McWilliams Forge, Sanitary Sewer Re-alignment, Rockaway, New Jersey. Project oversight and quality control manager for sanitary and process wastewater system modifications with oversight and documentation of sub-contractor construction/demolition activities, scheduling progress and tracking changed conditions. When required, construction alternatives were evaluated and presented to the Site owner and sub-contractor when unforeseen conditions were identified or encountered.

First Winds Wind Farm, Buffalo, New York. Field engineer for investigation of an 8-tower wind farm expansion. Field staff responsible for oversight of the subsurface explorations, electroresistivity testing and laboratory testing; assisted in foundation and road analysis; and preparation of the geotechnical report.

Solid Waste Disposal Projects Summary

Project Name/Location	***Client***	***Remedial Investigations/ Feasibility Studies***	***Hydrogeological Investigation/ Environmental Monitoring***	***Permitting Services***	***Design Services***	***Landfill Closure/Remediation***	***Construction Administration/ Support and/or CQA***
Massachusetts							
Foxboro State Hospital Landfill Foxboro, Massachusetts	DCAMM	■			■	■	■
Lakeville State Hospital Lakeville, Massachusetts	New England Development	■	■	■	■		
E. Bridgewater Landfill East Bridgewater, Massachusetts	Browning-Ferris Industries	■		■			
Fall River Landfill Fall River, Massachusetts	Republic Services/BFI			■	■		■
Chicopee Landfill Chicopee, Massachusetts	Browning-Ferris Industries		■	■	■		■
Haverhill Ash Landfill Haverhill, Massachusetts	Ogden Industries				■		■
Hunt Road Landfill Amesbury, Massachusetts	Waste Management of North America				■		■
Millbury Ash Landfill Millbury, Massachusetts	Wheelabrator, Inc.				■		■
Plainville Landfill Plainville, Massachusetts	Laidlaw Waste Systems	■					
Canton Landfill Canton, Massachusetts	Gemma Renewable Power, LLC			■	■		■
Ravenbrook Landfill Carver, Massachusetts	Ravenbrook, Inc.		■	■	■		■
Shrewsbury Ash Landfill Shrewsbury, Massachusetts	Wheelabrator, Inc.				■		■
North Meadow Road Landfill Medfield, Massachusetts	Town of Medfield		■	■	■	■	■
Battis Road Landfill Merrimac, Massachusetts	Town of Merrimac	■	■	■	■	■	■
Martone Landfill Barre, Massachusetts	United Waste Systems	■	■	■	■	■	■
Hudson-Stow Landfill Hudson, Massachusetts	United Waste Systems	■	■	■	■	■	■
Kmito Landfill Randolph, Massachusetts	Browning-Ferris Industries	■	■	■	■	■	■
Fitchburg Landfill Fitchburg, MA	United Waste/ USA Waste/ Waste Management	■	■	■	■	■	■
Ashby Landfill Ashby, MA	Town of Ashby, MA	■		■		■	■

Project Name/Location	*Client*	*Remedial Investigations/ Feasibility Studies*	*Hydrogeological Investigation/ Environmental Monitoring*	*Permitting Services*	*Design Services*	*Landfill Closure/Remediation*	*Construction Administration/ Support and/or CQA*
Granby Landfill Granby, MA	United Waste/ USA Waste/ Waste Management						
Indian Road Landfill Dudley, MA	Town of Dudley, MA						
Certainteed Shingle Landfill Walpole, MA	Certainteed Corporation Walpole, MA						
Rhode Island							
Central Landfill Johnston, Rhode Island	Rhode Island Resource Recovery Corporation						
Jamestown Landfill Jamestown, Rhode Island	Town of JamestownJamestown, Rhode Island						
Manton Avenue Landfill Providence, Rhode Island	Stop & Shop Company						
A. Macera Landfill Johnston, Rhode Island	Rhode Island Resource Recovery Corporation						
Richmond Landfill Richmond, Rhode Island	Town of RichmondRichmond, Rhode Island						
Rose Hill Landfill South Kingston, Rhode Island	Town of South Kingston and Narragansett, Rhode Island						
Woonsocket Landfill Woonsocket, Rhode Island	RI Department of TransportationProvidence, Rhode Island						
Former Forbes Street Landfill East Providence, Rhode Island	City of East Providence, RIEast Providence, RI						
Middletown Town Landfill Middletown, Rhode Island	Town of MiddletownMiddletown, Rhode Island						
Cranston Sanitary Landfill Cranston, Rhode Island	Messina Upright Company, LLPCranston, Rhode Island						
Barrington Landfills 1 & 2 Barrington, Rhode Island	Town of BarringtonBarrington, Rhode Island						
Tuckers Industrial Dump Johnston, Rhode Island	DAC Corporation						
Rock Point Landfill Narragansett, Rhode Island	Toll Brothers Corporation/RIDEM						
Coventry Landfill Coventry, Rhode Island	Town of Coventry/PRP Group Coventry, Rhode Island						

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Rocky Hill Fair Grounds Landfill East Greenwich, Rhode Island	New England Institute of Technology Warwick, Rhode Island	■	■	■	■	■	■
Charlestown Landfill Charlestown, Rhode Island	Town of Charlestown Charlestown, Rhode Island		■				
Connecticut							
Bristol Landfill Bristol, Connecticut	Town of Bristol			■	■		
DePaulo Drive RCRA Closure Southington, Connecticut	Town of Southington		■	■	■		■
Yaworski Lagoon Superfund Canterbury, Connecticut	Pervel Industries				■		■
Vermont							
Waste USA Landfill Coventry, Vermont	Resicon, Inc.				■		
New Hampshire							
Auburn Road Landfill Londonderry, New Hampshire	Town of Londonderry		■	■		■	
Brookline Municipal Landfill Brookline, New Hampshire	Town of Brookline		■				
Charlestown Landfill Charlestown, New Hampshire	Hoyle, Tanner & Associates		■			■	
Consumat Sanco Landfill Bethlehem, New Hampshire	Consumat Sanco, Inc.		■	■		■	■
Demolition Debris Landfill Nashua, New Hampshire	RDG, Inc.		■	■		■	■
Dover Municipal Landfill Superfund Site Dover, New Hampshire	Wehran Engineer		■				
Exeter Landfill Exeter, New Hampshire	Town of Exeter			■		■	■
Franklin Ashfill Franklin, New Hampshire	Craig Musselman Associates		■				■
Franklin Sanitary Landfill Franklin, New Hampshire	City of FranklinHoyle, Tanner & Associates		■	■		■	■
Fremont Landfill Fremont, New Hampshire	Town of Fremont		■			■	

Solid Waste Disposal Projects Summary

Project Name/Location	*Client*	*Remedial Investigations/ Feasibility Studies*	*Hydrogeological Investigation/ Environmental Monitoring*	*Permitting Services*	*Design Services*	*Landfill Closure/Remediation*	*Construction Administration/ Support and/or CQA*
Gilson Road Superfund Site Nashua, New Hampshire	State of New Hampshire		■	■		■	■
Hudson Municipal Landfill Hudson, New Hampshire	Town of Hudson		■	■		■	■
Industrial Casting Sand Landfill Mt. Vernon, New Hampshire	Hitchner Manufacturing, Inc.		■	■	■		
Laconia Disposal Gardens Laconia, New Hampshire	City of Laconia		■	■		■	■
Merrimack Landfill Merrimack, New Hampshire	Kimball-Chase, Inc.		■				
New Boston Municipal Landfill New Boston, New Hampshire	Town of New Boston		■	■		■	■
PSNH Ashfill Bow, New Hampshire	Public Service Co. of New Hampshire			■	■		
Roketenetz Landfill Pelham, New Hampshire	Stanley Roketenetz		■	■	■		■
Somersworth Landfill Somerworth, New Hampshire	Wehran Engineering		■				
Souhegan Regional Landfill Amherst, New Hampshire	Souhegan Regional Landfill DistrictAmherst, New Hampshire		■	■	■		■
Turnkey Landfill I, II and III Rochester, New Hampshire	Waste Management of New Hampshire		■	■	■		■
Turnkey Landfill of Danbury Danbury, New Hampshire	Turnkey Landfill of Danbury, Inc.		■	■	■		■
Unity Landfill Unity, New Hampshire	Town of Unity		■				
Washington Landfill Washington, New Hampshire	Town of Washington		■				
Windham Landfill Windham, New Hampshire	Town of Windham		■				
Four Hills Landfill Nashua, New Hampshire	City of Nashua			■			
Lebanon Landfill Lebanon, New Hampshire	Town of Lebanon			■			
Maine							
Candidate Site, Special Waste Landfill Buxton, Maine	Town of Buxton		■	■			

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City of Lewiston Landfill, Phase II Landfill Expansion Lewiston, Maine	City of Lewiston		■	■	■		■
Crossroads Landfill, Asbestos Landfill Closure Norridgewock, Maine	Waste Management Disposal Services of Maine, Inc.			■		■	■
Crossroads Landfill, Phase 3C Expansion Norridgewock, Maine	Waste Management Disposal Services of Maine, Inc.			■	■	■	■
Crossroads Landfill, Phase 10 Expansion Norridgewock, Maine	Waste Management Disposal Services of Maine, Inc.			■	■	■	■
Crossroads Landfill, Phase 1-6 Closure Plan Norridgewock, Maine	Waste Management Disposal Services of Maine, Inc.			■		■	
Crossroads Landfill, Phase 9, 11 & 12 Expansion Norridgewock, Maine	Waste Management Disposal Services of Maine, Inc.	■		■	■		
Crossroads Landfill, Phase 5 Construction Norridgewock, Maine	Waste Management Disposal Services of Maine, Inc.						■
Crossroads Landfill, Phase 7 Expansion/Closure Norridgewock, Maine	Waste Management Disposal Services of Maine, Inc.			■	■	■	■
Defense Fuel Supply Point Landfill Casco Bay Facility	U.S. Department of Defense Defense Logistics Agency		■		■	■	
Demolition Debris Landfill Scarborough, Maine	Attorneys for Present Property Owner		■				
Kiln Dust and Clinker Landfills Thomaston, Maine	Dragon Products Company		■				
Old Buxton Landfill Buxton, Maine	Maine Department of Environmental Protection		■				
Paris Utility District Sludge Landfill (AC Lawrence Disposal Site) Paris, Maine	Paris Utility District, Maine Department of Environmental Protection		■	■		■	■
Portsmouth Naval Shipyard, Solid Waste Planning/Transfer Station Permitting	U.S. Navy			■			
Rushton St. (Municipal) Landfill Sanford, Maine	Maine Department of Environmental Protection		■				

Project Name/Location	*Client*	*Remedial Investigations/ Feasibility Studies*	*Hydrogeological Investigation/ Environmental Monitoring*	*Permitting Services*	*Design Services*	*Landfill Closure/Remediation*	*Construction Administration/ Support and/or CQA*
Town of Fairfield Landfill Fairfield, Maine	Maine Department of Environmental Protection		■				
Town of Gorham Landfill Gorham, Maine	Maine Department of Environmental Protection		■				
Town of Hollis Landfill Hollis, Maine	Town of Hollis			■	■	■	■
Town of Lebanon Landfill Lebanon, Maine	Town of Lebanon		■	■		■	
Town of Norway Landfill Norway, Maine	Maine Department of Environmental Protection		■				
Town of Pittsfield Landfill Pittsfield, Maine	Town of Pittsfield		■				
Town of Vinalhaven Landfill Vinalhaven, Maine	Town of Vinalhaven		■	■			
U.S. Navy Landfill Redington Township, Maine	U.S. Navy		■	■		■	■
Wood Waste and Ash Landfills E. Wilton, Strong & Mattawamkeag, Maine	Confidential Client		■				
Midwestern States							
Evergreen Landfill Toledo, Ohio	Waste Management of North America			■	■		■
Pine Tree Acres, Inc. Lenox Township, Michigan	Town of Lenox Township		■	■	■		
Seymour Road Landfill Montrose Township, Michigan	Pollard Disposal		■				■
South Macomb Sites 9 and 9A Macomb Township, Michigan	South Macomb Disposal Authority			■	■		
MOA Landfill Atlanta, Michigan	MOA Solid Waste Management Authority		■	■	■	■	■
New York							
Freshkills Landfill Section 6/7 Staten Island, New York	Tully Construction Co., Inc.			■	■	■	■
Love Canal ICF Niagara Falls, New York	NYSDEC		■		■		■
Mohawk Valley Sanitary Landfill Frankfort, New York	Waste Management of North America		■				

Project Name/Location	*Client*	*Remedial Investigations/ Feasibility Studies*	*Hydrogeological Investigation/ Environmental Monitoring*	*Permitting Services*	*Design Services*	*Landfill Closure/Remediation*	*Construction Administration/ Support and/or CQA*
Monroe-Livingston Landfill Scottsville, New York	Waste Management of North America						■
Niagara County Refuse Disposal Landfill Lockport, New York	Niagara County Refuse Disposal District		■	■			■
Niagara Landfill Niagara, New York	Browning-Ferris Industries		■	■	■		■
Sanitary Landfill VI Niagara, New York	Browning-Ferris Industries		■	■	■		■
Sanitary Landfill VII Niagara, New York	CECOS International		■	■	■		
Sanitary Landfills I, II, III and IV Niagara, New York	Browning-Ferris Industries		■	■	■		■
Secure Chemical Management Facility No. 4 Niagara Falls, New York	CECOS International		■				■
Secure Chemical Management Facility No. 5 Niagara Falls, New York	CECOS International		■				■
New York Department Sanitation Fresh Kills Landfill Staten Island, New York	Tully Construction				■	■	■
Fountain Avenue Landfill Brooklyn, New York	FGG/Cashman				■		■
Sanitary Landfill V, Subareas A-C Niagara Fall, New York	Allied Niagara Fall Landfill			■	■	■	■
Sanitary Landfill VIII, Subareas A-D Niagara Fall, New York	Allied Niagara Fall Landfill			■	■	■	■
Pennsylvania							
Pelegrene Landfill Coral, Pennsylvania	USA Waste Services, Inc.			■	■		
Washington, DC							
Uline Arena Transfer Station Washington, DC	USA Waste Services, Inc.				■		
New Jersey							
Keegan Landfill Kearney, New Jersey	Creamer Sanzari—Joint Venture					■	■

Project Name/Location	Client	Remedial Investigations/ Feasibility Studies	Hydrogeological Investigation/ Environmental Monitoring	Permitting Services	Design Services	Landfill Closure/Remediation	Construction Administration/ Support and/or CQA
Bergen County Residual Ash Landfill North Arlington, New Jersey	Bergen County Utilities Authority			■	■		
Koppers Ash Landfill Kearney, New Jersey	Koppers Industries		■		■		
Salem County Utilities Authority	Salem County Utilities Authority		■	■	■		
Mississippi							
Clearview Landfill Lake, Mississippi	Chambers Waste Systems of Mississippi, Inc., Scott County, Mississippi	■	■	■	■	■	■
Jackson Transfer Station Jackson, Mississippi	USA Waste Services, Inc.				■		
Central Landfill Pearl River, Mississippi	TransAmerica			■	■		
MidSouth Landfill Hinds County, Mississippi	USA Waste Services, Inc.				■		
Florida							
C&D Landfill Central Florida	Sanifill, Inc.Norcross, Georgia						
Berman Road Landfill Okeechobee, Florida	Chambers Waste Systems of Florida, Inc., Okeechobee, Florida	■	■	■	■		■
Transfer Station Miami, Florida	Confidential Client			■			
Tennessee							
Quail Hollow Landfill Tullahoma, Tennessee	USA Waste Services, Inc.	■		■	■	■	■
Nashville Transfer Station Nashville, Tennessee	Sanifill of Tennessee, Inc.	■		■	■		
Cedar Ridge Landfill Lewisburg, Tennessee	Sanifill of Tennessee, Inc.			■	■	■	■
Georgia							
Athens Clark County Clark County, Georgia	M.R. Chasman & Associates				■		
Lawrenceville Transfer Station Lawrenceville, Georgia	USA Waste Services, Inc.			■	■		
Pine Bluff Landfill Ballground, Georgia	USA Waste Services						■

Project Name/Location	*Client*	*Remedial Investigations/ Feasibility Studies*	*Hydrogeological Investigation/ Environmental Monitoring*	*Permitting Services*	*Design Services*	*Landfill Closure/Remediation*	*Construction Administration/ Support and/or CQA*
Oakdale Road Landfill Smyrna, Georgia	USA Waste Services, Inc.			■	■	■	
R&B Landfill Banks County, Georgia	USA Waste Services, Inc.	■	■	■	■		■
Paulding County Transfer Station Hiram, Georgia	USA Waste Services, Inc.				■		
RTS Landfill Hall County, Georgia	USA Waste Services, Inc.			■	■		
Speedway Landfill Winder, Georgia	USA Waste Services, Inc.	■					
Forrest Park Transfer Station Georgia	USA Waste Services, Inc.			■	■		
South Carolina							
Solid Waste Transfer Station Fairfield County, South Carolina	USA Waste Services, Inc.			■	■		
Oak Ridge Landfill Dorchester, South Carolina	USA Waste Services, Inc.						■
Screaming Eagle Landfill Elgin, South Carolina	USA Waste Services, Inc.						■
Twin Oaks Transfer Station York County, South Carolina	USA Waste Services, Inc.				■		
North Carolina							
Anson County Landfill Anson County, North Carolina	Chambers Development		■	■	■		
Solid Waste Transfer Station Charlotte, North Carolina	Chambers Waste Systems of North Carolina			■	■		■
Virginia							
Maplewood Recycling and Disposal Facility Amelia County, Virginia	Chambers of Virginia			■	■		
Big Bethel Landfill Disposal Facility Hampton, Virginia	USA Waste of Virginia			■	■		
Maryland							
King George Landfill King George County, Maryland	USA Waste Services, Inc.			■	■		
Calvert County Transfer Station Calvert County, Maryland	USA Waste Services, Inc.			■	■		

Project Name/Location	***Client***	***Remedial Investigations/ Feasibility Studies***	***Hydrogeological Investigation/ Environmental Monitoring***	***Permitting Services***	***Design Services***	***Landfill Closure/Remediation***	***Construction Administration/ Support and/or CQA***
Calvert County Landfill Calvert County, Maryland	USA Waste Services, Inc.						
Honeygo Landfill Jessup, Maryland	USA Waste Services, Inc.						
Puerto Rico							
CDS Frog Landfill Humacao, Puerto Rico	USA Waste Services, Inc. Casquas, Puerto Rico						