NEW YORK STATE | Department of Environmental Conservation

KATHY HOCHUL
Governor

AMANDA LEFTON
Acting Commissioner

April 1, 2025

Huntley Power LLC
George Streit
3500 River Road
Tonawanda, New York 14150

Dear George Streit:

Huntley Power South Parcel, #C915337
Tonawanda (T), Erie County
Arsenic Fixation Study Report

The New York State Department of Environmental Conservation (NYSDEC) has received the *Arsenic Fixation Bench Study Results* [February 2025], as prepared by GZA GeoEnvironmental of New York on behalf of Huntley Power, LLC for the subject line site. Based on our review we have the following comments for your reference:

1) <u>Section 1.3, Groundwater Standard</u>: while NYSDEC understands that the calculated groundwater protection standard is a requirement of the federal coal combustion residual regulations, it should be noted that NYSDEC will evaluate the effectiveness of any groundwater remedy based on the Class GA Ambient Water Quality Standards;

2) <u>Section 3.2, Last Sentence</u>: this sentence seems to contradict conversations between NYSDEC and Huntley Power, LLC where unsaturated materials have been identified as the material that leaches the most arsenic to the groundwater system. Clarification of these statements should be made if this report is revised;

3) <u>Section 3.3, Product Abbreviation</u>: it is not clear what treatment product is represented by “FS” as it is not defined earlier in this section;

4) <u>Section 4.0, Fourth Bullet</u>: based on this bullet it may be pertinent to evaluate means of inducing aerobic conditions in the groundwater to remove arsenic from groundwater if in-situ treatments are reconsidered; and

5) <u>Section 4.0, Fifth Bullet</u>: it is not clear if the site groundwater used in the leachate tests already had arsenic present in it, and if so what effect this had on the leaching test results and evaluation.

Given previous discussions with Huntley Power, LLC it is understood that an arsenic fixation remedy may not be feasible due to changes in the federal coal combustion residual regulations.

As such, NYSDEC does not require a revised document addressing the above comments, unless arsenic fixation is determined to be a possible remedial option under the federal regulations. If you wish to discuss this matter in more detail feel free to contact me at 716-851-7220 or benjamin.mcpherson@dec.ny.gov.

Sincerely,

DN: cn=Benjamin McPherson, o=NYSDEC, ou=DER, email=benjamin.mcpherson@dec.ny.gov, c=US
Date: 2025.04.01 12:06:47 -04'00'

Benjamin McPherson, P.E.
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ARSENIC FIXATION BENCH STUDY RESULTS

Huntley Power South Parcel
Tonawanda, New York
NYSDEC BCP Site Number C915337

February 17, 2025
File No. 21.0056855.20

PREPARED FOR:
HUNTLEY POWER LLC

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VIA EMAIL

February 17, 2025
File No. 21.0056855.20

Mr. Benjamin McPherson
New York State Department of Environmental Conservation
Division of Environmental Remediation
700 Delaware Avenue
Buffalo, New York 14209
email: benjamin.mcpherson@dec.ny.gov

Re: Arsenic Fixation Bench Study Results
Huntley Power South Parcel
Brownfield Cleanup Program (BCP) Site Number C915337
Town of Tonawanda, New York (Site)

Mr. McPherson:

GZA GeoEnvironmental of New York (GZA), on behalf of our client, Huntley Power LLC (Huntley), prepared this report describing the results of a preliminary arsenic fixation bench study. The study was conducted to evaluate potential remedial alternatives to fixate arsenic in fill at the above referenced BCP Site. GZA prepared this report in response to NYSDEC's request for data and summary thereof presented at a meeting on June 7, 2024.

We trust this report meets your present needs. If you need additional information, please call Thomas Bohlen at (716) 844-7050.

Sincerely,

GZA GEOENVIRONMENTAL OF NEW YORK

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Michael Sommer (Huntley Power LLC)
George Streit (Huntley Power LLC)

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ACRONYMS

BCP	Brownfield Cleanup Program
bgs	below ground surface
CCR	Coal Combustion Residuals
Class GA	Groundwater criteria
DEC	New York State Department of Environmental Conservation
DER	Division of Environmental Remediation
EPA	Environmental Protection Agency
GPS	Groundwater Protection Standard
GZA	GZA GeoEnvironmental of New York
NYSDEC	New York State Department of Environmental Conservation
ppb	Parts Per Billion
ppm	Parts Per Million
RI	Remedial Investigation
RIR	Remedial Investigation Report
sq ft	Square feet

1.0 INTRODUCTION

GZA GeoEnvironmental of New York (GZA), on behalf of our client, Huntley Power LLC (Huntley), prepared this report describing the results of a preliminary arsenic fixation bench study. The study was conducted to evaluate potential remedial alternatives to fixate arsenic in fill (coal combustion residuals (CCR)) at the Huntley Power South Parcel, Brownfield Cleanup Program (BCP) Site No. C915337, located at 3500 River Road in the Town of Tonawanda, Erie County, New York (Site, see **Figure 1-1**).

The interpretations of this study are based on the results of bench tests performed by two vendors, CERES Remediation Products located in Los Angeles, California (CERES) and Redox Solutions located in Carmel, Indiana (Redox).

1.1 PURPOSE

This report provides:

1. A summary of pertinent previously collected BCP-Site soil and groundwater analytical data.
2. A summary of results (including baseline) from two bench tests, which evaluated reagents for potential in situ fixation of arsenic in fill.
3. The full data set collected in the bench tests.
4. Summary reporting and recommendations/estimates for treatment from CERES and Redox.

1.2 SITE DESCRIPTION

A full site description and history was provided in the Remedial Investigation Report[1] (RIR). The BCP Site consists of the southernmost 34.80 acre portion of the larger, 93-acre, Huntley property, which is identified as follows (see **Figures 1-1 and 1-2**):

Tax Map/Parcel No.: 0.064.16-1-1.2
Street Address: 3500 River Road, Town of Tonawanda.

The BCP Site is bounded as follows:

- North: by the adjoining remaining portions of 3500 River Road;
- East: by a bike path, beyond which is River Road;
- South: by the Erie County Water Authority;
- West: by the Niagara River.

Dredging records indicate an area from the existing south pond and westward was excavated in the 1940s, connected directly to the Niagara River, and deeper than the existing pond. This area is referred to as the "1945 Excavation Area" and runs from the eastern edge of the south pond to the west. This created a large basin connected to the river through

[1] "Remedial Investigation Report Huntley Power South Parcel, Tonawanda, New York, Brownfield Cleanup Program, Site No. C915337". Prepared for NYSDEC, Region 9, Buffalo New York by GZA, dated April 29, 2022.

an excavated channel out into the river. See **Figure 1-4** for the approximate location of this excavation on the BCP Site. This excavation extended approximately 40 feet below grade in some areas. Aerial photographs are not available showing the maximum extent of the excavation, but remnants of the excavation can be seen in the 1951 aerial photo (**Appendix A)**. In this photo, an apparent dam or roadway was constructed across the channel which isolated the pond from the Niagara River. Significant backfilling of the northeastern portion of the excavation was underway. It is assumed the primary fill for the excavation was Coal Combustion Residual material. Data derived from test pits, well installation logs, and laboratory analytical results support the approximate excavation area, depth, and that the backfill primarily consists of Coal Combustion Residuals. Material deposited under the existing South Pond was not considered for in-situ treatment during these studies, as the intent is to remove ash-like material to native depths via pond dredging. The area considered for in situ stabilization extends from the west bank of the south pond westward toward the Niagara River and is estimated to be approximately 330,000 square feet. **Figure 1-4** delineates the area under consideration for in situ fixation.

1.3 STANDARDS FOR CONCENTRATIONS OF METALS IN GROUNDWATER AT THE SITE

As documented in the "Alternatives Analysis Report and Remedial Action Work Plan" (RAWP)[2], APTIM Environmental and Infrastructure, LLC (APTIM) derived site-specific Ground Water Protection Standards (GPS) for arsenic and lithium through statistical evaluation of samples collected from upgradient CCR network monitoring well CCR-3[3,4]. The CCR Rule requires that groundwater meet these site-specific GPS, as sampled from CCR downgradient monitoring wells A-2, CCR-1 and CCR-2. In addition, Class GA Ambient Water Quality Standards (Class GA) for iron and manganese were specifically considered during the bench testing described in this Report. The relevant standards for these metals are provided as follows.

Metal	**Standard Concentration (mg/L)**	**Source of Standard***
Arsenic	0.016	GPS
Iron	0.3	CLASS GA
Iron + Manganese (sum)	0.5	CLASS GA
Lithium	0.05	GPS
Manganese	0.3	CLASS GA
* *GPS = derived site-specific Ground Water Protection Standards* *CLASS GA = Class GA Ambient Water Quality Standards*		

[2] GZA GeoEnvironmental of New York, "Alternatives Analysis Report and Remedial Action Work Plan, Huntley Power South Parcel, Tonawanda, New York, NYSDEC BCP Site Number C915337," dated June 28, 2022.

[3] APTIM Environmental & Infrastructure, LLC, "CCR Compliance Assessment of Corrective Measures, South Settling Pond, Huntley Generating Station," dated August 2019.

[4] APTIM Environmental & Infrastructure, LLC, "CCR Compliance Assessment of Corrective Measures, South Settling Pond, Huntley Generating Station," dated March 2021.

2.0 SUMMARY OF RELEVANT HISTORICAL DATA

Analysis of groundwater samples conducted during the Remedial Investigation (RI) detected some metals (arsenic, iron, magnesium, manganese, and sodium) at elevated concentrations at several locations. The RI further included extensive groundwater and soil sampling, and the RIR used these to describe the extent of arsenic contamination in the area of the 1945 Excavation Area.

Figure 1-3 shows the locations of the monitoring wells, soil borings, and test pits used to sample groundwater and site material during the RI. **Table 1-1** and **Table 1-2** provide data on select groundwater and site material samples, respectively, in and around the area of the 1945 Excavation Area during the RI. These results indicate:

- Samples of site groundwater from wells CCR-2, CCR-7 and CCR-8 contained elevated levels of dissolved arsenic above the standard (0.016 mg/L), at concentrations ranging 0.031 – 0.216 mg/L. (CCR-2 is located just outside the boundary of the BCP, southwest of the Equalization Basins and near the Niagara River. CCR-7 is located just east of the slurry wall that bounds the Former Coal Pile area and at the northwest edge of the 1945 Excavation Area. CCR-8 is located between the South Settling Pond and the Equalization Basins, central to the 1945 Excavation Area.) Groundwater samples from other wells in and around the 1945 Excavation Area did not contain levels of arsenic above the standards, although the majority of samples did have detections of iron, manganese, and lithium at concentrations above their respective standards.

- Samples of site material from soil borings and test pits from all areas of the 1945 Excavation Area were found to contain arsenic at levels exceeding the Commercial Soil Use standard (16 mg/kg), at concentrations as high as 168 mg/kg. The majority of these samples were at depths less than 10 ft bgs.

3.0 BENCH-SCALE TESTING

Beginning in August, 2023, GZA sub-contracted with two vendors, CERES Remediation Products of Los Angeles, CA (CERES) and Redox Solutions of Carmel, IN (Redox) to perform bench-scale testing, with the goals of 1) identifying reagents that could be used for in situ remediation of the CCR to reduce the leaching of arsenic into groundwater to levels below the identified standard, and 2) obtaining estimates for the costs of such remediation. Additionally, testing of these reagents was to include data necessary to assess whether treatment could cause lithium, iron, and/or manganese to leach into groundwater at concentrations above their respective standards.

Both vendors were provided with historical data on the concentrations of arsenic in soil and groundwater from the areas understood to contain CCR. Additional data provided to these vendors included boring logs from soil borings and well installations, field parameters from well sampling events (pH, oxidation reduction potential (ORP), dissolved oxygen (DO), and conductivity), hydraulic conductivity testing results, and site maps.

3.1 SAMPLING

In August 2023, five test pits were excavated to obtain material for use in the bench tests (see **Figure 1-3**). Four of these (TP-46, TP-47, TP-48, and TP-49), located around the equalization basins to obtain representative samples of the area, were sampled in two-foot intervals from 0 – 10 ft bgs, followed by five-foot intervals from 10 – 20 ft bgs. The initial plan had been to composite material from all four test pits by sampling interval (e.g., all samples from 0 – 2 ft bgs from all four test pits would be composited into one sample for testing), to yield a single sample for each of the seven intervals. However, at the time of sampling, groundwater was encountered at different depths, and it was decided that it would be better not to mix saturated and unsaturated samples into composites. Thus, only the unsaturated samples in the 0 – 10 ft bgs intervals were used, while only the saturated samples in the 10 – 20 ft bgs intervals were used. The table below shows which samples from test pits were composited.

Depth	**TP-46**	**TP-47**	**TP-48**	**TP-49**	***Included Material Type***
0 - 2 ft	Included	Included	Included	Included	*Unsaturated*
2 - 4 ft	Included	Included	Included	Included	
4 - 6 ft	Included	Included	Included	Included	
6 - 8 ft	Included	Not Included (Saturated material)	Included	Included	
8 - 10 ft	Included	Not Included (Saturated material)	Included	Included	
10 - 15 ft	Included	Included	Not Included (Unsaturated)	Not Included (Unsaturated)	*Saturated*
15 - 20 ft	Included	Included	Included	Not Included (Unsaturated)	

In addition, TP-50, located closer to the river and between the Equalization Basin #2 and the outlet of the settling pond, was constructed specifically to obtain samples from the saturated zone, for use in anticipated column studies designed to test the potential for use of a permeable reactive barrier (PRB) in this area. Saturated material was found and collected in the 10 – 15 ft bgs interval from TP-50.

Samples from the various intervals in all test pits were initially collected into 5 gal buckets. Some material from these buckets was then used to make the composite samples and sent to vendors for testing. The remaining material from each interval and well was stored separately in the sealed 5 gal buckets onsite, in the event more would be needed at a later date.

During the August 2023 mobilization to the field to construct and sample the test pits, water was collected from well CCR-8 for use in bench tests and column studies. CERES requested the water to be collected in nitrogen-purged “kegs” to preserve the environment of the water as it was collected, which was expected to be anoxic and exhibit reducing ORP, based on historical data. Redox did not initially request this, so water was simply collected in clean bottles. However, initial bench test results from Redox (see below) suggested that allowing the groundwater from the site to be exposed to air may have caused anomalous results, so additional water samples from CCR-8 were collected in nitrogen-purged kegs in October 2023 for Redox to use in further bench tests.

3.2 BASELINE ANALYTICAL RESULTS

Both CERES and Redox analyzed the site groundwater upon receipt (**Table 2-1**). Of note, the water received by CERES, which had been transported in nitrogen-purged kegs, was found to have negative (reducing) ORP, while the water received by Redox was found to have positive (oxidizing) ORP. Though care was taken to completely fill the bottles sent to Redox, leaving no air at the top, it seems likely that exposure to air during the sampling, transport, and/or analysis processes allowed oxygen into the water and shifted the ORP to be more oxidizing. It is also noteworthy that filtering the samples appeared to have reduced the arsenic concentrations. Whether filtered or not, all water samples contained arsenic at levels above the standard of 0.016 mg/L (0.0372 – 0.121 mg/L), although at concentrations lower than detected previously (0.2159 mg/L, **Table 1-1**).

Both vendors performed synthetic precipitation leaching procedure (SPLP) tests on each composited sample interval and analyzed both the material and the leachate for pH, arsenic, and iron (**Table 2-2**). Additionally, Redox analyzed for manganese and ORP (**Table 2-2**). Results from both vendors indicated higher arsenic concentrations in the top two (unsaturated) intervals (0 – 2 ft bgs, 2 – 4 ft bgs; 47.1 – 65 mg/kg) and bottom two (saturated) intervals (10 – 15 ft bgs; 51.5 – 96 ft bgs). Below 4ft bgs, arsenic concentrations decreased with depth in the unsaturated zone. CERES also analyzed the material from the saturated zone, collected from TP 50, reporting relatively low arsenic at 3.7 mg/kg.

Comparing the concentrations of arsenic in SPLP leachate versus the concentration of arsenic in the tested material (**Table 2-2** and **Figure 2-1**), it appears that the amount of leachable arsenic is relatively low (results in dissolved arsenic concentrations below the standard of 0.016 mg/L) and follows a somewhat linear trend of increased leachable arsenic with increased arsenic concentration in the material, except for a single outlier in each of the two data sets. These outliers show considerably higher leachable arsenic at concentrations above the standard: in the CERES dataset, this outlier was 0.0421 mg/L in the 10 – 15 ft bgs interval, and in the Redox dataset, 0.124 mg/L in the 15 – 20 ft bgs interval. Both of these intervals contained saturated material and are expected to be from an anoxic, reducing environment. Relatively more arsenic leaching from the material from these lower intervals would be in line with the higher known solubility of the reduced form of arsenic, which would be the likely form under the reducing conditions of the saturated zone[5].

3.3 CERES BENCH TESTS

CERES performed two rounds of bench tests to find a product and dosing rate capable of reducing the amount of arsenic leached from the Site material, while also considering the potential impacts on the leachability of other metals of interest, including iron, manganese, and lithium. All tests were performed using SPLP leachate. The vendor-provided summary reports are attached as **Appendix B**.

In the Round 1, material from the intervals with the highest levels of arsenic (0 – 2 ft bgs, 2 – 4 ft bgs, and 10 – 15 ft bgs) was tested. Because the two upper intervals are in the unsaturated zone, while the lower interval is in the saturated zone, CERES recommended testing different products. The unsaturated zone material was tested using a 3% dosage of four different products: magnesium oxide (MgO), ferric oxyhydroxide (FeO(OH)), ferrous sulfide (FeS), and calcium polysulfide (CaS_x). The saturated zone material was tested using a range of dosage rates for FS (1 – 6 %) and zero-valent iron (ZVI; 1 – 4 %). Results are summarized in **Table 3-1**.

Results from the unsaturated intervals (0 – 2 ft bgs, 2 – 4 ft bgs) indicated:

- MgO resulted in a modest decrease in leachable arsenic (−22 – −41%), while maintaining leachable iron to below detection limits. However, it increased the pH above 10.
- FeO(OH) reduced leachable arsenic by −65 – −72%. Leachable iron increased in the 0 – 2 ft bgs test but was still well below the standard, while pH remained essentially the same.
- FeS reduced both leachable arsenic and iron to below detection limits and showed little effect on pH.

[5] Masscheleyn, P. H., et al. (1991). "Effect of redox potential and pH on arsenic speciation and solubility in a contaminated soil." ES & T 25(8): 1414-1419.

- CaS_x increased leachable arsenic above to above the standard, raised pH slightly, and reduced leachable iron to below detection limits.

Results from the saturated interval (15 – 20 ft bgs) indicated:

- FeS was not effective at reducing leachable arsenic below the standard at any dosage tested.

- ZVI at any dosage reduced leachable arsenic by at least −81%, while keeping leachable iron below detection levels and having minimal effect on pH.

Goals in the Round 2 of bench testing were 1) to determine if lower dosage levels for products seen to be effective in Round 1 could achieve acceptable results, and 2) to determine if a single product would be suitable for treatment in both the saturated and unsaturated zones. Both FeO(OH) and FeS were successful at reducing leachable arsenic in the unsaturated zone at 3% dosage, so 1 – 2% dosage rates were tested in Round 2. Similarly, 1% dosage of ZVI in the saturated intervals was highly effective, so 0.5% dosage was tested. Due to its efficacy in the saturated zone, ZVI was added to the list for testing in the unsaturated intervals (dosage rates 0.5 – 1%), while FeO(OH), which was effective in the unsaturated intervals, was added for testing in the saturated interval. FeS was retested on the saturated interval, to verify the unexpected results in Round 1. For both unsaturated and saturated interval tests, lithium and manganese were added to the list of analytes. Results from these tests indicated (**Table 3-2**):

- FeO(OH) at 2% dosage was effective at reducing leachable arsenic below the standard in all intervals. At this dosage, both lithium and manganese increased, but remained below their standards, while pH increased slightly.

- FS at 1% dosage was effective at reducing leachable arsenic below the standard in the saturated interval and below detection limits in the unsaturated intervals. This dosage did result in moderate increases in both lithium and manganese concentrations, though they remained below their respective standards, while pH remained essentially unchanged.

- ZVI at 0.5% dosage was effective at reducing leachable arsenic to below standards in all intervals and resulted in little to no change in lithium and manganese concentrations. ZVI was seen to slightly increase pH in all intervals tested.

3.4 REDOX BENCH TESTS

Redox performed three rounds of bench tests to find a product and dosing rate capable of reducing the amount of arsenic leached from the Site material, while also considering the potential impacts on the leachability of other metals of interest, including iron, manganese, and lithium. Different leachate materials were used, as indicated in the discussion below. A vendor-provided summary report is attached as **Appendix C**.

In Round 1 of testing, all intervals were tested at dosages of 2 and 4% each of FerroBlack-Fe+ (FB-Fe+) and Redox-LDH (R-LDH) using site water as the leachate. As described above, this water had been collected following standard procedures and was likely exposed to air at the time of sampling and/or testing. In addition to arsenic, manganese and iron were included in the list of analytes. The results indicated (**Table 4-1**):

- FB-Fe+ was unable to effectively reduce the concentration of leached arsenic to below standards in both unsaturated and saturated intervals, but instead tended to increase the amount of leached arsenic. FB-Fe+ treatment was also commonly associated with increased concentrations of manganese and iron in the leachate above standards

- Treatment with R-LDH had mixed results in the unsaturated intervals: in some cases, especially those with higher concentrations of arsenic initially, leachable arsenic was reduced to below standards, but in other cases, leachable arsenic increased above standards. In the saturated intervals, R-LDH reduced leachable levels to below standards and, in some cases, to below detection levels. However, concentrations of iron and manganese were significantly increased to above standards in all tests.

After reviewing the results of Round 1 bench tests, it was hypothesized that the use of groundwater, which had become oxidizing by contact with air, was likely not representative of expected site conditions, yielding anomalous results. Therefore, new samples of site water were collected and shipped to the lab using nitrogen-filled kegs to preserve the anoxic, reducing conditions of the water.

For Round 2 of testing, only the top two unsaturated intervals (0 – 2 ft bgs and 2 – 4 ft bgs) and bottom-most saturated interval (15 – 20 ft bgs) were targeted. Samples from these intervals were tested using 2 or 4% dosage rates of three different FerroBlack products (FerroBlack-Fe+, FerroBlack, and FerroBlack-H [FB-Fe+, FB, and FB-H, respectively]), which differ in their ratios of iron and sulfur. Additionally, the results of the tests were checked at both 14 days and 28 days of incubation to investigate the effect of the length of the test. The results (**Table 4-2**) indicated:

- Treatment with FB-H or FB in all intervals resulted in increases in leachable arsenic concentrations well above the standard.

- Treatment with FB-Fe+ resulted in reduction of leached arsenic to concentrations below the standard in unsaturated intervals, although in the saturated interval results were mixed, with concentrations of soluble arsenic near the standard. However, many of the treated samples showed increases in dissolved manganese, compared to baseline. Lithium results were mixed, with many samples showing concentrations above the standard, although it is noted that several of the baseline results were also above the standard. Comparing results of analyzing the leachate at 14 days and 28 days of incubation, the longer time had mixed results, with small increases in leached arsenic in some samples and small decreases in others. Overall, the 2% dosage seemed more effective than the 4% dosage at maintaining lower levels of leachable arsenic over the longer test period.

The goals of Round 3 of bench tests were to test the effects of using SPLP leachate and deionized (DI) water in the unsaturated intervals, versus using site groundwater, and to test lower dosages of treatment. Additionally, the product TerraBond was tested in the unsaturated intervals, and two different mixes of FerroBlack (FerroBlack-Fe and FerroBlack-Fe+S) were added for testing of the saturated interval. The results of these tests (**Table 4-3**) indicated:

- In the unsaturated intervals, both SPLP leachate and DI water leached lower amounts of arsenic than previously seen with site water, in samples treated with either FB-Fe+ or FB, with no samples having arsenic above the standard. In addition, concentrations of leached iron, manganese, and lithium were below standards in all tests. Overall, FB-Fe+ tended to perform better than FB-Fe at preventing arsenic leaching. TerraBond resulted in increased leached arsenic concentrations, although not to the level that they exceeded the standard.

- In tests of the saturated interval, all products tested at all dosages maintained both leached arsenic and iron concentrations below the standard. FB-H and FB-Fe+S were the most effective, reducing leachable arsenic by 71 – 88%. Lower dosages of products tended to hold leached manganese to below the standard, while 3% of FB-Fe+S, 4% of FB-Fe, and 4% of FB-Fe+ resulted in manganese concentrations above the standard. FB-H was arguably the most effective at both reducing concentrations of arsenic and maintaining concentrations of iron and manganese below the standards. All products at all dosages resulted in increases of leached lithium, although the baseline was above the standard.

4.0 SUMMARY AND CONCLUSIONS

- The highest levels of arsenic in site material were found in the upper-most, unsaturated layer (0 – 2 ft bgs) and the saturated zone (>10 ft bgs).
- Site material from the unsaturated zone below approximately 4 ft bgs has significantly lower levels of arsenic, resulting in much lower concentrations of leached arsenic. It is speculated that the lower levels of arsenic are the result of this material having been in place longer—thus having more time for the arsenic to have leached out from rain infiltration and/or from fluctuating groundwater.
- Leached arsenic concentrations increase with higher concentrations of arsenic in the site material.
- Anoxic and reducing conditions contribute to significantly increased concentrations of leached arsenic.
- The use of site groundwater to test the leachability of metals from site material in the unsaturated zone is likely not representative of actual field conditions, as the site groundwater is anoxic, has reducing ORP, and contains dissolved arsenic, iron, and manganese (**Table 2-1**). In contrast, the leaching of metals from the unsaturated zone is expected to be driven by infiltration of rainwater.
- Both vendors identified iron-based products and dosages thereof that were effective at reducing leachable levels of arsenic to below standards, while also maintaining levels of leachable iron and manganese below standards. In most tests of these products, lithium concentrations were also held below standards, though there were some mixed results.

4.1 POTENTIAL NEXT STEPS

If it were to be determined that in situ fixation is an appropriate and cost-effective remedial option, both vendors recommend performing column studies to test the longer-term efficacy of treatment, as well as determine optimal dosage rates. For the purposes of considering next steps, both vendors were asked to provide cost estimates for in situ remedial treatment of the CCR area (excluding sediment under the South Settling Pond), which are provided in **Appendix B (CERES)** and **Appendix C (Redox)** and range from $1.2 million to $3.2 million.

Tables

TABLE 1-1 - Selected Analytical Results of Groundwater Samples from RIR

Huntley Power South Parcel

Town of Tonawanda, New York

Well ID	Sample Name	Sample Date	Area[3]	Arsenic	Iron	Manganese	Lithium
			Units	mg/L	mg/L	mg/L	mg/L
			GPS[1]	0.016			0.05
			CLASS GA[2]		0.3	0.3	
A-1	A-1	11/20/2020	In BD	< 0.00016 U	40.2 JH	0.3468	0.1218
CCR-1	CCR-1	11/18/2020	Outside BD	0.00265	1.21 JH	0.8091	0.0092
CCR-2[4]	CCR-2	10/7/2020	In BD	0.031	N/A	N/A	0.13
CCR-3	CCR-3	11/20/2020	Outside BD	0.00278	11 JH	1.407	0.01344
CCR-7	CCR-7	11/20/2020	In BD	0.03104	28.2 JH	1.238	0.1994
CCR-8	CCR-8	11/18/2020	In BD	0.2159	8.23 JH	0.3504	0.2261
CCR-9	CCR-9	11/18/2020	In BD	0.00429	0.745 JH	0.1629	0.111
CCR-10	CCR-10	11/19/2020	In BD	0.00193	23.1 JH	0.4415	0.1188
CCR-11	CCR-11	11/18/2020	Outside BD	0.00258	0.727 JH	0.5195	0.04022
MW-3	MW-3-080321	8/3/2021	Outside BD	0.00281	2.46 JH	0.4162	
MW-4D	MW-4D	11/18/2020	Outside BD	0.00428	0.153 JH	0.02848	0.00951
MW-5D	GW DUP EXP	11/19/2020	In BD	0.00688	12.4 JH	0.7273	
MW-5D	MW-5D	11/19/2020	In BD	0.00688	12.2 JH	0.7356	0.3628
MW-6D	MW-6D	11/18/2020	In BD	0.00393	27.4 JH	0.4293	
MW-8S	MW-8S	11/20/2020	Outside BD	0.00089	2.4 JH	0.1957	

1. Analytical result greater than derived site-specific Ground Water Protection Standards (GPS)
2. Analytical result greater than New York State Class GA Groundwater Standard and/or guidance.
3. "In BD": Sampling location is inside the approximate area of the Big Dig. "Outside BD": Sampling location is outside, but near, the approximate location of the Big Dig
4. CCR-2 was not sampled as part of the RI but sampled in October, 2020 prior to the RI sampling round. This well was historically found to have elevated levels of arsenic and is required by the CCR rule to meet the GPS, as a downgradient well, so it is included here.

TABLE 1-2 - Selected Analytical Results of Soil Samples from RIR
Huntley Power South Parcel
Town of Tonawanda, New York

Exploration Type	Location ID	Sample Name	Depth Range of Sample (ft bgs)	Sample Date	Area[1]	Native or Fill	Arsenic	Iron	Lithium	Manganese
						Analyte	Arsenic	Iron	Lithium	Manganese
						Units	mg/kg	mg/kg	mg/kg	mg/kg
				375 SOIL - UNRESTRICTED USE[2]			13			1600
				375 SOIL - COMMERCIAL USE[3]			16			10000
SB	SB-03	SB-03-0-4	0-4	10/27/2020	Outside BD	Fil	11.1	21,200 JH		271 JH
SB	SB-03	SB-03-10-11	10-11	10/27/2020	Outside BD	Fil	5.08	23,000 JH		424 JH
SB	SB-04	SB-04-0-2	0-2	11/9/2020	Outside BD	Fil	10.9	18,600		276
SB	SB-04	SB-04-2-6	2-6	11/9/2020	Outside BD	Fil	71.7	45,800		96.5
SB	SB-04	SB-04-6-8	6-8	11/9/2020	Outside BD	Fil	14.5	53,700		2,150
SB	SB-04	SB-04-8-14	8-14	11/9/2020	Outside BD	Native	3.79	12,800		157
SB	SB-04	SB-04-15	15	11/9/2020	Outside BD	Native	4.2	12,000		167
SB	SB-04	SB-04-32-35.5	32-35.5	11/9/2020	Outside BD	Native	2.06	9,160		335
SB	SB-05	SB-05-0.5-2	0.5-2	11/6/2020	In BD	Fil	46.8	26,000 JH		189 JH
SB	SB-05	SB-05-2-6	2-6	11/6/2020	In BD	Fil	17.9	18,000 JH		210 JH
SB	SB-05	SB-05-6-10	6-10	11/6/2020	In BD	Fil	113	70,300 JH		890 JH
SB	SB-05	SB-05-14-20	14-20	11/6/2020	In BD	Native	4.59	19,600 JH		368 JH
SB	SB-05	SB-05-28-32	28-32	11/6/2020	In BD	Native	3.06	6,360 JH		185 JH
SB	SB-06	SB-06-0.5-4	0.5-4	11/5/2020	In BD	Fil	168	42,800 JH		188 JH
SB	SB-06	SB-06-4-8	4-8	11/5/2020	In BD	Fil	49.2	108,000 JH		700 JH
SB	SB-06	SB-06-8-12	8-12	11/6/2020	In BD	Native	22.4	40,100 JH		487 JH
SB	SB-06	SB-06-12-19	12-19	11/5/2020	In BD	Native	2.9	12,400 JH		211 JH
SB	SB-06	NATIVE FULL DUPLICATE		11/5/2020	In BD	Fil	2.84	7,110 JH		101 JH
SB	SB-06	SB-06-24-32	24-32	11/5/2020	In BD	Native	3.83	7,860 JH		120 JH
SB	SB-08	SB-08-11-20	11-20	10/28/2020	Outside BD	Fil	5.01	13,200 JH		158 JH
SUB	SP-01	SP-1-11-12	11-12	10/20/2020	In BD	Fil	26.4	38,900 JH		103
SUB	SP-02	SP-2-15.5-20	15.5-20	10/20/2020	In BD	Fil	< 0.173 U	89,700 JH	64.7 J	101
SUB	SP-03	SP-3-0.5-4	0.5-4	10/20/2020	In BD	Fil	4.76	19,900 JH		524
SUB	SP-04	SP-4-4-20	4-20	10/19/2020	In BD	Fil	106	29,700 JH	49.3 J	83.8
SUB	SP-05	SP-5-16-32	16-32	10/19/2020	In BD	Fil	3.03	22,400 JH	10.8 J	287
SUB	SP-06	SP-6-0.5-6	0.5-6	10/20/2020	In BD	Fil	12.3	12,100 JH	19.5 J	349
SUB	SP-07	SP-7-4-14	4-14	10/19/2020	In BD	Fil	33.4	32,400 JH	28.9 J	173
TESTPIT	TP-14	TP-14-2-8	2-8	10/28/2020	In BD	Fil	23.5	49,200 JH	27.6 J	659 JH
TESTPIT	TP-14	TP-14-16-18	16-18	10/28/2020	In BD	Native	3.92	23,400 JH		460 JH
TESTPIT	TP-17	TP-17-6-6.5	6-6.5	10/28/2020	In BD	Fil	70.3	159,000 JH	< 18.6 UJ	91.7 JH
TESTPIT	TP-18	TP-18-0.5-2	0.5-2	10/29/2020	In BD	Fil	11.2	16,500 JH	14.1 J	720 J
TESTPIT	TP-19	TP-19-6-8	6-8	10/27/2020	In BD	Fil	71.6	32,800 JH	< 6.9 UJ	36.5 JH
TESTPIT	TP-20	TP-20-1-9	1-9	10/14/2020	In BD	Fil	50.7	14,800	23.5 J	49.8 JH
TESTPIT	TP-21	TP-21-15-18	15-18	10/28/2020	In BD	Fil	5.59	77,200 JH	< 3.7 UJ	85.4 JH
TESTPIT	TP-22	TP-22-0.5-1.5	0.5-1.5	10/30/2020	In BD	Fil	4.83	18,000 JH	26.3 J	443
TESTPIT	TP-22	TP-22-2-10	2-10	10/30/2020	In BD	Fil	144	26,600 JH		62.8
TESTPIT	TP-23	TP-23-2-4	2-4	10/30/2020	In BD	Fil	47.8	27,500 JH		76.4
TESTPIT	TP-23	SUBSURFACE FULL DUP		10/30/2020	In BD	Fil	90.1	17,400 JH		37.7
TESTPIT	TP-23	TP-23-4-10	4-10	10/30/2020	In BD	Fil	78.6	17,300 JH	13.4 J	38.4
TESTPIT	TP-24	SUBSURFACE DUP		10/29/2020	Outside BD	Fil	4.84	8,540 JH		113
TESTPIT	TP-24	TP-24-5-8	5-8	10/29/2020	Outside BD	Fil	4.33	9,020 JH	22.1 J	135
TESTPIT	TP-25	TP-25-3.5-7	3.5-7	10/30/2020	Outside BD	Fil	6.58	11,900 JH	12.7 J	255
TESTPIT	TP-25	TP-25-7-8	7-8	10/30/2020	Outside BD	Fil	59.9	36,000 JH		113

1. "In BD": Sampling location is inside the approximate area of the Big Dig. "Outside BD": Sampling location is outside, but near, the approximate location of the Big Dig

2. Concentration exceeds the Unrestricted Soil Use standard.

3. Concentration exceeds the Commercial Soil Use standard.

TABLE 2-1 - Baseline Groundwater Analytical Results

Huntley Power South Parcel

Town of Tonawanda, New York

Vendor	CERES	Redox	Redox
Filtered?	Yes	No	Yes
pH	7.23	7.86	nt
ORP	-83	122.1	nt
As (mg/L)	0.065	0.121	0.0372
Mn (mg/L)	nt	0.21	0.22
Fe (mg/L)	1.38	3.91	0.0747

TABLE 2-2 - Baseline Leaching Test[1] Results

Huntley Power South Parcel

Town of Tonawanda, New York

	Vendor 1: CERES					
	pH		Arsenic		Iron	
Depth	Material	Leachate	Material (mg/kg)	Leachate[2] (mg/L)	Material (mg/kg)	Leachate[2] (mg/L)
0'-2'	7.69	8.02	65	0.0152	15,000	0.0273
2'-4'	7.88	8.19	61	0.0135	17,000	0.163
4'-6'	7.52	7.79	24	0.004	8,200	<0.025
6'-8'	7.54	7.67	39	0.0054	15,000	<0.025
8'-10'	7.72	8.03	19	0.0065	10,000	0.172
10'-15'	7.76	8.37	96	**0.0421**	12,000	<0.025
15'-20'	7.56	8.16	56	0.0127	9,700	0.0305
TP 50 (Sat)			3.7		8,300	

	Vendor 2: Redox Solutions										
	pH		Arsenic		Iron		Manganese		ORP	
Depth	Material	Leachate	Material (mg/kg)	Leachate[2] (mg/L)	Material (mg/kg)	Leachate[2] (mg/L)	Material (mg/kg)	Leachate[2] (mg/L)	Material mV	Leachate[2] mV
0'-2'	7.49	7.5	41.3	0.0172	14,400	0.182	191	0.00568	171.3	220
2'-4'	7.88	7.29	47.1	0.0072	25,600	0.002	64.9	0.028	184	142.5
4'-6'	7.89	7.06	15.2	0.0141	13,900	**1.35**	402	**2.14**	143	83.6
6'-8'	7.43	7.08	23.9	0.0048	19,800	0.101	245	**1.66**	122.4	104.3
8'-10'	7.69	7.33	18.9	0.0033	7,940	0.0322	90.9	0.246	177.1	113
10'-15'	6.58	7.4	51.5	0.0177	6,030	0.0263	43.2	0.0437	173.1	106.9
15'-20'	7.01	7.38	60.3	**0.124**	8,520	0.067	64.1	0.0687	119.1	108.1

1. Leaching tests were performed following standard SPLP, using SPLP leachate
2. Results in **bold red** exceed Site standards for arsenic (0.016 mg/L), iron (0.300 mg/L), or manganese (0.300 mg/L) in groundwater.

TABLE 3-1 - Results of CERES Bench Tests, Round 1

Huntley Power South Parcel

Town of Tonawanda, New York

Sample Depth	Reagent	Dose (wt.% soil)	pH (SU)	Arsenic		Iron	
				(mg/L)	% Change[2]	(mg/L)	% Change2
Standard	**--**	**--**	**--**	**0.016**	**--**	**0.3**	**--**
0-2	*None*	*0*	*7.69/8.13*	*0.0152*	---	*0.0273*	---
	MgO	3	10.06	0.009	-41	<0.025	-56
(unsaturated zone)	FeOOH	3	8.57	0.0053	-65	0.0487	78
	FeS	3	8.22	<0.0035	-88	<0.025	-56
	CaS_x	3	9.55	0.0501	230	<0.025	-56
2-4	*None*	*0*	*7.88/8.53*	*0.0135*	---	*0.163*	---
	MgO	3	10.36	0.0105	-22	<0.025	-92
(unsaturated zone)	FeOOH	3	8.08	0.0038	-72	<0.025	-92
	FS	3	8.14	<0.0035	-87	<0.025	-92
	CaS_x	3	9.38	0.0342	153	<0.025	-92
15-20	*None*	*0*	*8.37/8.53*	*0.0421*	---	*0.0125*	---
	FS	1	9.38	0.0583	38	<0.025	0
		3	9.93	0.0351	-17	<0.025	0
(saturated zone)		6	10.25	0.0196	-53	<0.025	0
	ZVI	1	8.86	0.0078	-81	<0.025	0
		2	8.81	0.0076	-82	<0.025	0
		4	8.58	0.0048	-89	<0.025	0

1. Analytical result greater than site-specific Ground Water Protection Standards or New York State Class GA Groundwater Standard, as appropriate.

2. Where starting or ending concentrations were below detection limits, one-half of the detection limits was used to calculate the change

TABLE 3-2 - Results of CERES Bench Tests, Round 2
Huntley Power South Parcel
Town of Tonawanda, New York

Sample Depth	Reagent	Dose (wt.% soil)	pH (SU)	Arsenic		Manganese		Lithium	
				(mg/L)	% Change[2]	(mg/L)	% Change2	(mg/L)	% Change2
Standard	--	--	--	**0.016**	--	**0.3**	--	**0.05**	--
0-2	*None*	*0*	*7.69/8.13*	*0.0152*	---	*<0.0024*	---	*0.0109*	---
	FeOOH	1	8.61	0.0061	-60	0.0051	325	0.013	19
		2	8.78	0.0056	-63	0.0141	1075	0.0194	78
(unsaturated zone)	FS	1	7.84	<0.0035	-88	0.0058	383	0.0137	27
		2	7.94	<0.0035	-88	0.0269	2142	0.0122	11
	ZVI M200	0.5	8.59	<0.0035	-88	<0.0024	0	0.0118	8
		1	8.57	0.0076	-50	<0.0024	0	0.0088	-19
2-4	*None*	*0*	*7.88/8.53*	*0.0135*	---	*<0.0024*	---	*0.0044*	---
	FeOOH	1	8.68	0.007	-48	0.0145	1108	0.0079	80
		2	8.86	<0.0035	-87	0.0128	967	0.0113	157
(unsaturated zone)	FS	1	8.08	<0.0035	-87	0.0206	1617	0.0060	36
		2	7.97	<0.0035	-87	0.0473	3842	0.0080	82
	ZVI M200	0.5	8.89	0.0038	-72	<0.0024	0	0.0037	-16
		1	8.83	0.007	-48	<0.0024	0	0.0034	-23
15-20	*None*	*0*	*8.37/8.53*	*0.0421*	---	*<0.0024*	---	*0.0105*	---
(saturated zone)	FS	1	7.96	0.0086	-32	0.0055	358	0.0142	35
	ZVI	0.5	8.92	0.0115	-73	<0.0024	0	0.0099	-6
	FeOOH	2	8.98	0.0126	-70	0.004	233	0.0272	169

1. Analytical result greater than site-specific Ground Water Protection Standards or New York State Class GA Groundwater Standard, as appropriate.

2. Where starting or ending concentrations were below detection limits, one-half of the detection limits was used to calculate the change

TABLE 4-1 - Results of Redox Bench Tests, Round 1

Huntley Power South Parcel

Town of Tonawanda, New York

Sample Depth	Reagent	Dose (wt.% soil)	pH (SU)	ORP (mV)	Arsenic		Iron		Manganese	
					(mg/L)	% Change[2]	(mg/L)	% Change[2]	(mg/L)	% Change[2]
Standard	--	--	--	--	**0.016**	--	**0.3**	--	**0.3**	--
0-2 (unsaturated zone)	*None*		*7.5*	*220*	*0.0172*	---	*0.182*	---	*0.00568*	---
	FB-Fe+	2	7.69	211.8	0.0268	56	0.573	215	0.501	8720
		4	7.9	185.1	0.0583	239	0.523	187	0.295	5094
	Redox-LDH	2	7.25	115	0.0027	-84	2.53	1290	1.67	29301
		4	7.36	110.4	0.0044	-74	1.51	730	2.16	37928
2-4 (unsaturated zone)	*None*		*7.29*	*142.5*	*0.0072*	---	*0.002*	---	*0.028*	---
	FB-Fe+	2	7.68	124.4	0.119	1553	0.288	14300	0.479	1611
		4	8.06	120.3	0.138	1817	0.531	26450	0.155	454
	Redox-LDH	2	7.18	3.9	0.0261	263	4.66	232900	1.86	6543
		4	7.04	-40.3	0.0412	472	8.17	408400	2.14	7543
4-6 (unsaturated zone)	*None*		*7.06*	*83.6*	*0.0141*	---	*1.35*	---	*2.14*	---
	FB-Fe+	2	7.18	-0.2	0.014	-1	3.5	159	2.02	-6
		4	7.44	41	0.0149	6	1.2	-11	1.16	-46
	Redox-LDH	2	6.95	-71.3	0.0089	-37	10.5	678	3.36	57
		4	7	-53.7	0.008	-43	9.37	594	3.58	67
6-8 (unsaturated zone)	*None*		*7.08*	*104.3*	*0.0048*	---	*0.101*	---	*1.66*	---
	FB-Fe+	2	7.23	92	0.0134	179	2.28	2157	1.12	-33
		4	7.36	89.3	0.0187	290	1.49	1375	0.88	-47
	Redox-LDH	2	6.9	-36	0.0063	31	10.7	10494	2.09	26
		4	6.88	-62.3	0.0163	240	15.8	15544	2.91	75
8-10 (unsaturated zone)	*None*		*7.33*	*113*	*0.0033*	---	*0.0322*	---	*0.246*	---
	FB-Fe+	2	7.56	108.6	0.0038	15	0.41	1173	0.376	53
		4	7.87	93.8	0.0199	503	0.246	664	0.15	-39
	Redox-LDH	2	7.07	136.4	0.0011	-67	0.551	1611	1.5	510
		4	7.21	44.4	< 0.0010	-85	2.27	6950	1.58	542
10-15 (saturated zone)	*None*		*7.4*	*106.9*	*0.0177*	---	*0.0263*	---	*0.0437*	---
	FB-Fe+	2	7.64	91.9	0.0053	-70	0.701	2565	0.32	632
		4	7.88	89.8	0.0416	135	0.282	972	0.142	225
	Redox-LDH	2	7.37	55.4	< 0.0010	-97	1.87	7010	1.12	2463
		4	7.57	67.8	< 0.0010	-97	1.15	4273	1.16	2554
15-20 (saturated zone)	*None*		*7.38*	*108.1*	*0.124*	---	*0.067*	---	*0.0687*	---
	FB-Fe+	2	7.7	97.9	0.0512	-59	0.254	279	0.237	245
		4	8.06	85.8	0.114	-8	0.282	321	0.0925	35
	Redox-LDH	2	7.45	113.7	0.0036	-97	0.552	724	0.528	669
		4	7.55	108.4	0.0114	-91	0.205	206	1.06	1443

1. Analytical result greater than site-specific Ground Water Protection Standards or New York State Class GA Groundwater Standard, as appropriate.

2. Where starting or ending concentrations were below detection limits, one-half of the detection limits was used to calculate the change

TABLE 4-2 - Results of Redox Bench Tests, Round 2
Huntley Power South Parcel
Town of Tonawanda, New York

Sample Depth	Reagent	Dose (wt.% soil)	Days	pH (SU)	ORP (mV)	Arsenic		Iron		Manganese		Lithium	
						(mg/L)	% Change[2]	(mg/L)	% Change[2]	(mg/L)	% Change[2]	(mg/L)	% Change[2]
Standard	--	--	--	--	--	**0.016**	--	**0.3**	--	**0.3**	--	**0.05**	--
0-2	*None*		*14*	*7.79*	*230.5*	*0.0148*		*0.015*		*<0.00020*		*0.133*	
	FB-H	2	14	8.71	40.6	1	6657	0.0162	8	0.00742	na	< 0.02	-92
	FB-H	4	14	9.96	-297.3	3.45	23211	0.11	633	0.00099	na	< 0.02	-92
	FB-H	2	28	6.62	96.8	0.554	3643	0.503	3253	0.0865	na	<0.01	-96
	FB-H	4	28	9.46	-353	6.34	42738	<0.05	67	<0.0020	na	<0.01	-96
	FB	2	14	7.57	129.4	0.0159	7	0.0378	152	0.329	na	0.0257	-81
(unsaturated zone)	FB	4	14	9.42	66.9	0.171	1055	0.0116	-23	0.00198	na	< 0.02	-92
	FB	2	28	7.91	74.3	0.016	8	< 0.05	67	1.11	na	0.0364	-73
	FB	4	28	7.96	52.5	0.336	2170	0.748	4887	0.0657	na	< 0.01	-96
	FB-Fe+	2	14	7.65	148.8	0.0031	-79	0.157	947	0.881	na	0.128	-4
	FB-Fe+	4	14	7.96	144.8	0.0033	-78	0.0178	19	0.212	na	0.077	-42
	FB-Fe+	2	28	7.2	135.7	0.0048	-68	0.0619	313	1.78	na	0.158	19
	FB-Fe+	4	28	7.43	139.8	0.0132	-11	< 0.05	67	0.82	na	0.111	-17
2-4	*None*		*14*	*7.73*	*232*	*0.0127*		*0.0189*		*<0.00020*		*0.162*	
	FB-H	2	14	8.43	-34.3	1.56	>1000	0.0711	276	0.00978	na	< 0.02	-76
	FB-H	4	14	10.04	-431.8	4.24	>1000	0.025	32	0.00048	na	< 0.02	-76
	FB-H	2	28	7.6	125.5	1.25	>1000	0.144	662	0.112	na	0.0164	-90
	FB-H	4	28	9.23	0.3	5.34	>1000	< 0.05	32	<0.0020	na	<0.01	-79
	FB	2	14	8.25	76.4	0.268	>1000	0.0618	227	0.0737	na	< 0.02	-76
(unsaturated zone)	FB	4	14	9.83	-102.1	3.69	>1000	0.239	>1000	0.00296	na	< 0.02	-76
	FB	2	28	8.17	132.3	0.237	>1000	0.105	456	0.524	na	0.0205	-87
	FB	4	28	9.29	18.8	3.26	>1000	0.055	191	0.00364	na	< 0.010	-79
	FB-Fe+	2	14	7.82	114	0.0095	-25	0.0157	-17	0.65	na	0.154	-5
	FB-Fe+	4	14	8.02	114.9	0.0074	-42	0.0297	57	0.21	na	0.095	-41
	FB-Fe+	2	28	7.61	132.4	0.0088	-31	0.174	821	2.51	na	0.191	18
	FB-Fe+	4	28	7.86	131	0.0203	60	<0.05	32	0.653	na	0.118	-27
15-20	*None*		*14*	*7.8*	*232.9*	*0.0093*		*0.0305*		*0.00701*		*0.11*	
	FB-H	2	14	7.8	-40.9	2.31	>1000	0.296	870	0.0389	455	< 0.02	-91
	FB-H	4	14	10.14	-342.5	3.48	>1000	0.068	123	0.00079	-89	< 0.02	-91
	FB-H	2	28	8.2	137.9	1.24	>1000	0.178	484	0.149	>1000	0.0295	-73
	FB-H	4	28	9.62	95.3	6.16	>1000	0.0749	146	<0.002	-86	<0.01	-95
	FB	2	14	8.23	39.4	0.405	>1000	0.0296	-3	0.0959	>1000	0.0206	-81
(saturated zone)	FB	4	14	9.15	-33.1	0.121	>1000	0.00832	-73	0.00256	-63	< 0.02	-91
	FB	2	28	8.62	85.6	0.255	>1000	0.0625	105	0.215	>1000	0.029	-74
	FB	4	28	8.84	70.6	0.873	>1000	<0.05	-18	0.0125	78	< 0.01	-95
	FB-Fe+	2	14	7.96	97.3	0.0071	-24	0.0685	125	0.362	>1000	0.206	87
	FB-Fe+	4	14	8.13	99.9	0.0156	68	0.0199	-35	0.208	>1000	0.144	31
	FB-Fe+	2	28	8.1	113.4	0.0143	54	0.0977	220	0.492	>1000	0.211	92
	FB-Fe+	4	28	8.02	112.6	0.012	29	< 0.05	-18	0.398	>1000	0.172	56

1. Analytical result greater than site-specific Ground Water Protection Standards or New York State Class GA Groundwater Standard, as appropriate.

2. Where starting or ending concentrations were below detection limits, one-half of the detection limits was used to calculate the change

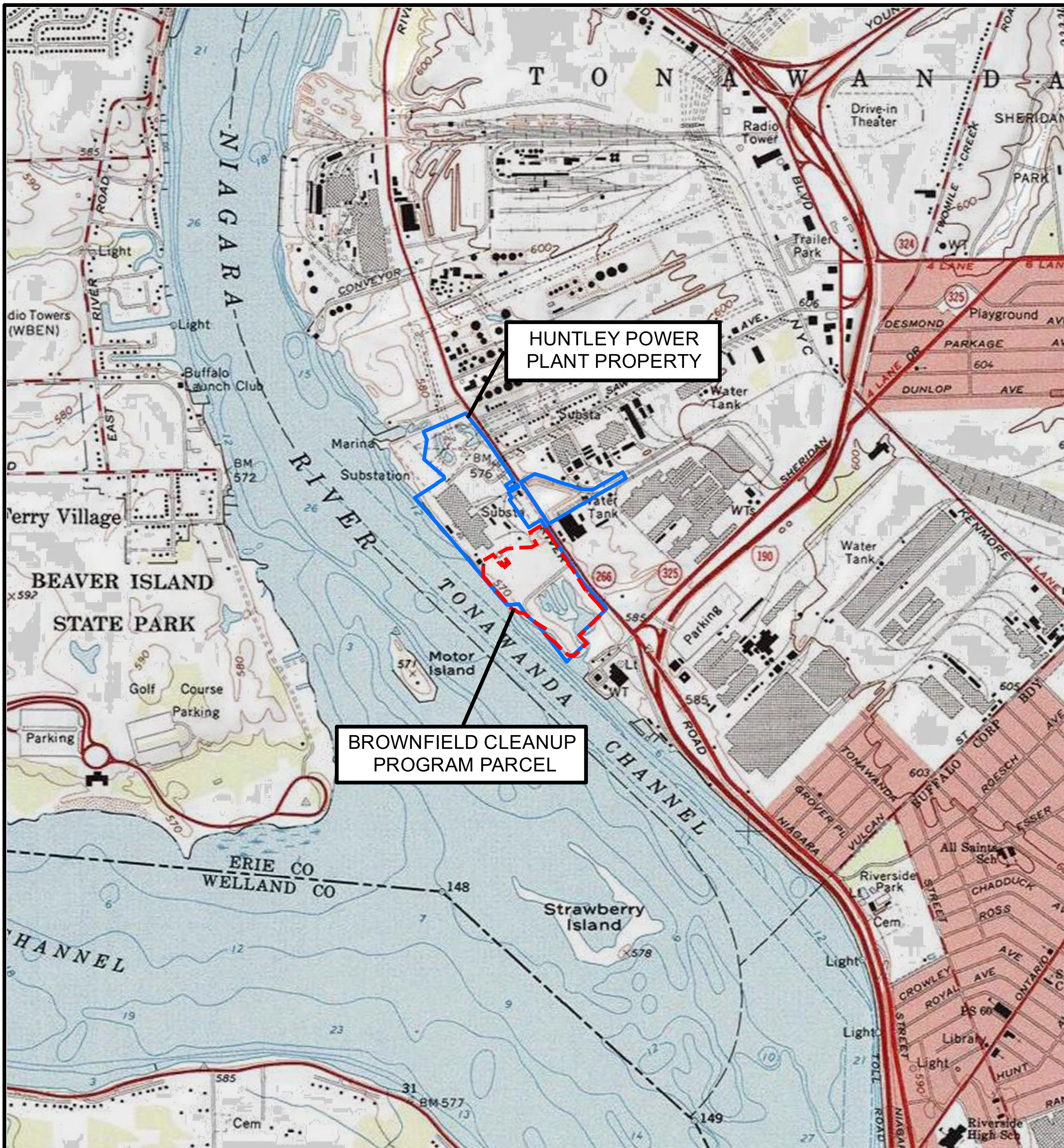
TABLE 4-3 - Results of Redox Bench Tests, Round 3
Huntley Power South Parcel
Town of Tonawanda, New York

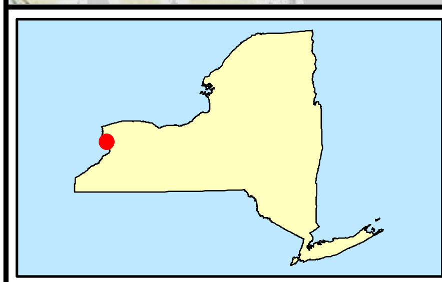
Sample Depth	Reagent	Dose (wt.% soil)	pH (SU) Initial	pH (SU) Final	ORP (mV)	Arsenic (mg/L)	Arsenic % Change[2]	Iron (mg/L)	Iron % Change[2]	Manganese (mg/L)	Manganese % Change[2]	Lithium (mg/L)	Lithium % Change[2]
Standard	--	--	--	--	--	**0.016**	--	**0.3**	--	**0.3**	--	**0.05**	--
0-2 / 2-4	*None*	*0*	*4.2*	*9.65*	*109*	*0.008*		*0.291*		*0.00195*		*0.0104*	
(unsaturated zone)	FB-Fe+	1	4.18	9.64	118.3	0.00301	-62	0.0759	-74	0.000599	-69	0.0079	-24
		3	4.18	9.59	127.7	0.00156	-81	0.0135	-95	0.000212	-89	0.0082	-21
	FB	1	4.18	9.63	130.9	0.00292	-64	0.179	-38	0.00145	-26	0.0092	-12
		3	4.18	9.7	129.3	0.00549	-31	0.124	-57	0.0009	-54	0.0068	-35
SPLP	TerraBond	2	4.21	9.69	70	0.0125	56	<0.0050	-99	0.000781	-60	0.0116	12
		4	4.21	9.81	73	0.013	63	<0.0050	-99	0.000544	-72	0.0102	-2
0-2 / 2-4	*None*	*0*	*N/A*	*9.63*	*153.2*	*0.0059*		*<0.0050*		*0.00022*		*<0.05*	
(unsaturated zone)	FB-Fe+	1	N/A	9.54	145.6	0.003	-49	0.0078	212	0.00022	0	<0.05	na
		3	N/A	9.61	147.2	0.0022	-63	0.0152	508	0.00022	0	<0.05	na
	FB	1	N/A	9.59	128.2	0.0036	-39	0.0102	308	0.00019	-14	<0.05	na
		3	N/A	9.62	122	0.0023	-61	0.0152	508	0.00089	305	<0.05	na
DI	TerraBond	2	N/A	9.68	76.8	0.0073	24	0.0069	176	0.00057	159	<0.05	na
		4	N/A	9.8	72.4	0.0129	119	0.0074	196	0.00032	45	<0.05	na
10 - 15	*None*		*N/A*	*7.8*	*232.9*	*0.0093*		*0.0305*		*0.00701*		*0.11*	
	FB-Fe+S	3	N/A	7.21	200	0.0011	-88	<0.0050	-92	0.145	1968	0.216	96
	FB-Fe+	2	N/A	7.79	190.6	0.0151	62	0.0321	5	0.00247	-65	0.208	89
		3	N/A	7.75	185.6	0.0108	16	0.0129	-58	0.0191	172	0.207	88
(saturated zone)		4	N/A	7.75	184	0.0105	13	0.0324	6	0.46	6462	0.281	155
	FB-Fe	2	N/A	7.74	188.6	0.0141	52	0.0838	175	0.00178	-75	0.193	75
		3	N/A	7.77	188.8	0.01	8	0.26	752	0.0746	964	0.176	60
Site GW		4	N/A	7.78	186.3	0.0037	-60	0.0689	126	0.464	6519	0.201	83
	FB	2	N/A	7.71	190.3	0.0062	-33	0.0119	-61	0.258	3580	0.214	95
	FB-H	2	N/A	7.82	201.2	0.0027	-71	0.0728	139	0.188	2582	0.191	74
		2	N/A	7.59	208.1	0.0026	-72	0.0528	73	0.282	3923	0.188	71

1. Analytical result greater than site-specific Ground Water Protection Standards or New York State Class GA Groundwater Standard, as appropriate.

2. Where starting or ending concentrations were below detection limits, one-half of the detection limits was used to calculate the change

Figures





SOURCE : USGS TOPOGRAPHIC QUADRANGLES SCANNED BY
THE NATIONAL GEOGRAPHIC SOCIETY & I-CUBED, COPYRIGHT 2011

Data Supplied by : esri

0 1,000 2,000 4,000 6,000
SCALE IN FEET

N W E S

GZA

PROJ. MGR.: JR
DESIGNED BY: EJT
REVIEWED BY: BK
OPERATOR: EJT

DATE: 02-16-2022

LOCUS PLAN

HUNTLEY POWER
3500 RIVER ROAD
TONAWANDA, NY

JOB NO.
21.0056855.20

FIGURE NO.
1-1

LEGEND

- NEW MONITORING WELL
- EXISTING GROUNDWATER MONITORING WELLS
- SITE FEATURES
- BCP SITE BOUNDARY

SOURCE

1) THIS MAP CONTAINS THE ESRI ARCGIS ONLINE BING MAPS AERIAL LAYER PACKAGE, PUBLISHED NOVEMBER 25, 2013 BY ESRI ARCIMS SERVICES AND UPDATED MONTHLY. THIS SERVICE USES UNIFORM NATIONALLY RECOGNIZED DATUM AND CARTOGRAPHY STANDARDS AND A VARIETY OF AVAILABLE SOURCES FROM SEVERAL DATA PROVIDERS.
2) THE BASE MAP FEATURES WERE LOCATED FROM A "PRELIMINARY" UNTITLED ELECTRONIC CAD FILE PREPARED BY WENDEL COMPANIES, RECEIVED VIA EMAIL ON 07-01-2018, FILE: 419418-BOUNDARY.DWG, AND FROM A PDF PREPARED BY WENDELL COMPANIES ENTITLED "180816 HUNTLEY BCP PARCEL - SIGNED.PDF", DATED: 06-04-2018, ORIGINAL SCALE: 1" = 100 FEET, PROJECT NUMBER: 419418.
3) THE HISTORICAL UTILITY DATA WAS REFERENCED FROM ELECTRONIC FILES PROVIDED BY HUNTLEY POWER LLC,, RECEIVED VIA EMAIL ON 09-06-2019, FILES: 34735SH01.CIT, 34736SH02.CIT, 34737SH03.CIT, 34738SH04.CIT, 34739SH05.CIT, 34740SH06.CIT,34741SH07.CIT, 34742SH08.CIT AND FROM A PDF PREPARED BY NIAGRA MOHAWK POWER CORPORATION ENTITLED "STATION SITE PLAN, ENLARGED COMPOSITE OF STRUCTURES, AND YARD PIPING" DATED: 03-23-1977, ORIGINAL SCALE: 1" = 20 FEET.
4) THE ADDITIONAL UTILITY DATA AND SITE EASEMENTS WERE REFERENCED FROM ELECTRNOIC FILES PROVIDED BY HUNTLEY POWER LLC., RECEIVED VIA EMAIL ON 09-17-2019, FILE: NRG HUNTLEY - EASEMENT FIGURE - STANDARD.ZIP
5) LOCATIONS OF MONITORING WELLS WERE REFERENCED FROM MONITORING WELL AS-BUILTS SURVEYED BY WENDEL ON NOVEMBER 18TH 2020. ALL OTHER SITE FEATURES ARE APPROXIMATE PENDING RECIEPT OF FINAL AS-BUILTS.

HUNTLEY POWER SOUTH PARCEL
3500 RIVER ROAD
TONAWANDA, NEW YORK

SITE PLAN

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: NRG HUNTLEY POWER, LLC	
PROJ MGR: JJR	REVIEWED BY: DJT	CHECKED BY: BK	FIGURE
DESIGNED BY: JJR	DRAWN BY: EMD / SMW	SCALE: 1 " = 150 FEET	1-2
DATE: 03/09/2022	PROJECT NO. 21.0056855.20	REVISION NO.	

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LEGEND

- Groundwater Monitoring Wells
- Soil Sample
- Pre-existing Groundwater Monitoring Wells
- Soil Probe
- Test Pit
- Temporary Piezometer
- Pond Borings Associated With Frontier Technical Group Report
- SLURRY WALL
- BCP SITE BOUNDARY

SOURCE

1) THIS MAP CONTAINS THE ESRI ARCGIS ONLINE BING MAPS AERIAL LAYER PACKAGE, PUBLISHED NOVEMBER 25, 2013 BY ESRI ARCIMS SERVICES AND UPDATED MONTHLY. THIS SERVICE USES UNIFORM NATIONALLY RECOGNIZED DATUM AND CARTOGRAPHY STANDARDS AND A VARIETY OF AVAILABLE SOURCES FROM SEVERAL DATA PROVIDERS.
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HUNTLEY POWER SOUTH PARCEL
3500 RIVER ROAD
TONAWANDA, NEW YORK

Approximate Locations of Monitoring Wells, Soil Test Pits, and Soil Borings

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: NRG HUNTLEY POWER, LLC	
PROJ MGR: TB	REVIEWED BY: DJT	CHECKED BY: BK	FIGURE 1-3
DESIGNED BY: EJT	DRAWN BY: EJT	SCALE: 1 " = 150 FEET	
DATE: 10/15/2024	PROJECT NO. 21.0056855.20	REVISION NO.	

LEGEND

- APPROXIMATE EXTENT OF 1945 EXCAVATION
- SLURRY WALL
- BCP SITE BOUNDARY

SOURCE

1) THIS MAP CONTAINS THE ESRI ARCGIS ONLINE BING MAPS AERIAL LAYER PACKAGE, PUBLISHED NOVEMBER 25, 2013 BY ESRI ARCIMS SERVICES AND UPDATED MONTHLY. THIS SERVICE USES UNIFORM NATIONALLY RECOGNIZED DATUM AND CARTOGRAPHY STANDARDS AND A VARIETY OF AVAILABLE SOURCES FROM SEVERAL DATA PROVIDERS.
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HUNTLEY POWER SOUTH PARCEL
3500 RIVER ROAD
TONAWANDA, NEW YORK

Approximate Extent of 1945 Excavation Area

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com	PREPARED FOR: NRG HUNTLEY POWER, LLC	
PROJ MGR: TB	REVIEWED BY: DJT	CHECKED BY: BK
DESIGNED BY: EJT	DRAWN BY: EJT	SCALE: 1 " = 150 FEET
DATE: 02/11/2025	PROJECT NO. 21.0056855.20	REVISION NO.

FIGURE 1-4

LEGEND

- APPROXIMATE AREA UNDER CONSIDERATION FOR IN SITU FIXATION
- SLURRY WALL
- BCP SITE BOUNDARY

SOURCE

1) THIS MAP CONTAINS THE ESRI ARCGIS ONLINE BING MAPS AERIAL LAYER PACKAGE, PUBLISHED NOVEMBER 25, 2013 BY ESRI ARCIMS SERVICES AND UPDATED MONTHLY. THIS SERVICE USES UNIFORM NATIONALLY RECOGNIZED DATUM AND CARTOGRAPHY STANDARDS AND A VARIETY OF AVAILABLE SOURCES FROM SEVERAL DATA PROVIDERS.
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HUNTLEY POWER SOUTH PARCEL
3500 RIVER ROAD
TONAWANDA, NEW YORK

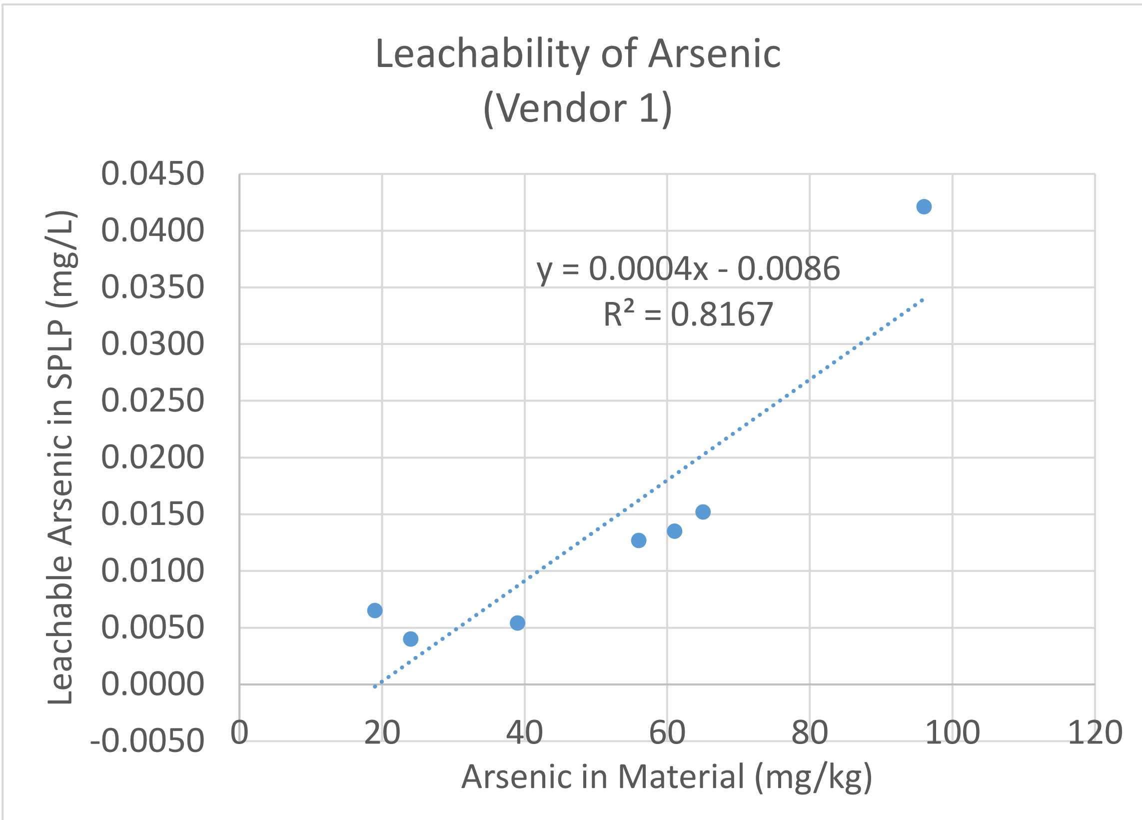
Approximate Area Under Consideration For In Situ Fixation

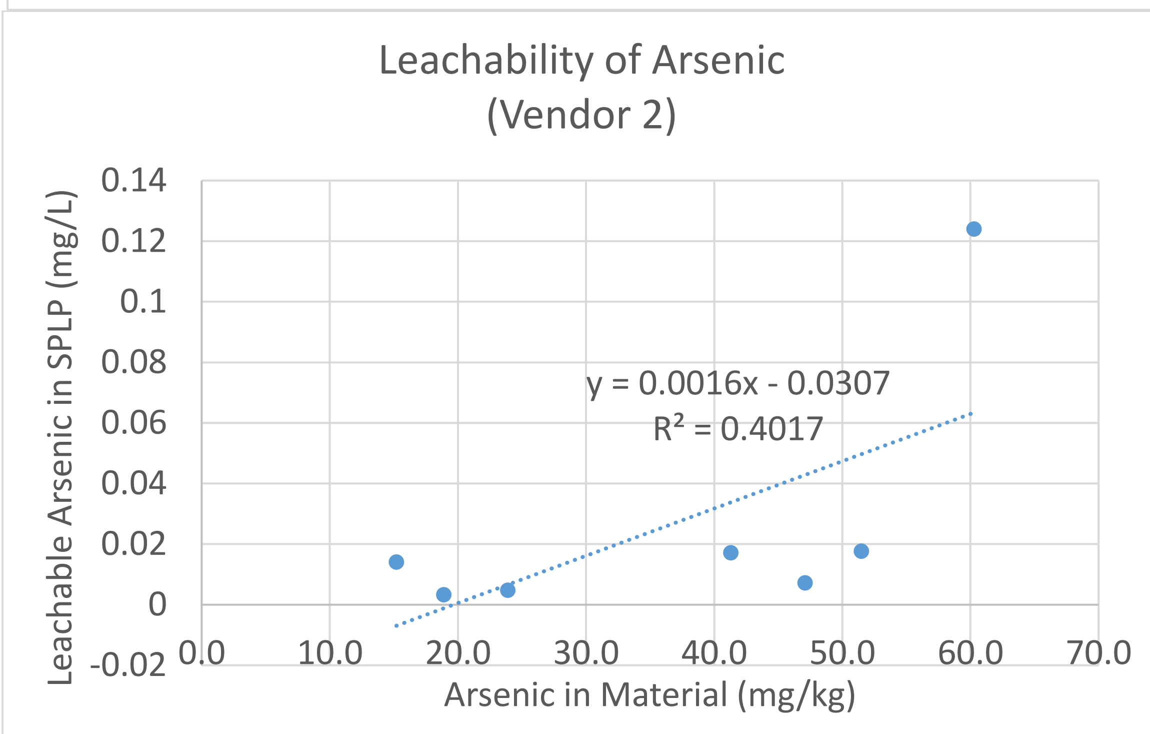
PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		PREPARED FOR: NRG HUNTLEY POWER, LLC	
PROJ MGR: TB	REVIEWED BY: DJT	CHECKED BY: BK	FIGURE
DESIGNED BY: EJT	DRAWN BY: EJT	SCALE: 1 " = 150 FEET	1-5
DATE: 02/11/2025	PROJECT NO. 21.0056855.20	REVISION NO.	

Figure 2-1: Leachability of Arsenic from Baseline Analyses

Arsenic Concentration in SPLP versus Material from which it was Leached

(Data from Table 2-2)





Appendix A

Historical Aerial Photographs

3500 River Rd

3500 River Rd

Tonawanda, NY 14150

Inquiry Number: 5584159.3

March 08, 2019

The EDR Aerial Photo Decade Package

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

EDR Aerial Photo Decade Package

03/08/19

Site Name:

3500 River Rd
3500 River Rd
Tonawanda, NY 14150
EDR Inquiry # 5584159.3

Client Name:

Frontier Technical Assoc.
9120 Main Street
Clarence, NY 14031
Contact: David.harty@frontiertechnical.c

Environmental Data Resources, Inc. (EDR) Aerial Photo Decade Package is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's professional researchers provide digitally reproduced historical aerial photographs, and when available, provide one photo per decade.

Search Results:

Year	***Scale***	***Details***	***Source***
2017	1"=500'	Flight Year: 2017	USDA/NAIP
2013	1"=500'	Flight Year: 2013	USDA/NAIP
2009	1"=500'	Flight Year: 2009	USDA/NAIP
2006	1"=500'	Flight Year: 2006	USDA/NAIP
1995	1"=500'	Acquisition Date: March 28, 1995	USGS/DOQQ
1985	1"=500'	Flight Date: May 03, 1985	USDA
1983	1"=500'	Flight Date: March 17, 1983	USDA
1978	1"=500'	Flight Date: October 31, 1978	USDA
1966	1"=500'	Flight Date: June 12, 1966	USDA
1962	1"=500'	Flight Date: November 26, 1962	USGS
1959	1"=500'	Flight Date: October 20, 1959	USDA
1951	1"=500'	Flight Date: September 20, 1951	USDA
1938	1"=500'	Flight Date: August 03, 1938	USDA

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INQUIRY #: 5584159.3

YEAR: 2017

= 500'

N


INQUIRY #: 5584159.3
YEAR: 2013
= 500'
N
EDR

INQUIRY #: 5584159.3

YEAR: 2009

= 500'

N

EDR

INQUIRY #: 5584159.3

YEAR: 2006

= 500'

N

EDR


INQUIRY #: 5584159.3
YEAR: 1995
= 500'
N

INQUIRY #: 5584159.3

YEAR: 1985

= 500'

N

EDR

INQUIRY #: 5584159.3

YEAR: 1983

= 500'

N

EDR

INQUIRY #: 5584159.3

YEAR: 1978

= 500'

N

EDR

INQUIRY #: 5584159.3

YEAR: 1966

= 500'

N

INQUIRY #: 5584159.3

YEAR: 1962

= 500'

N

EDR

INQUIRY #: 5584159.3

YEAR: 1959

= 500'

N

EDR

INQUIRY #: 5584159.3

YEAR: 1951

= 500'

N

EDR

INQUIRY #: 5584159.3

YEAR: 1938

= 500'

N

EDR®

Appendix B

Summary Report and Estimate for Remediation from CERES Remediation Products

DRAFT Technical Memo
for

Bench Scale Testing and MTS® Performance Verification Study

at

Huntley CCR South Site,
Tonawanda, New York

For

GZA Environmental

Prepared by

CERES Corporation
Lowell Kessel, P.G.

June 26, 2024

Introduction

CERES was retained by GZA Environmental Inc., to provide a treatability study for the reduction of soluble and leachable Arsenic derived from coal combustion residues (CCR) in the Operable Unit defined by the South Settling Pond (SSP) at the Huntley South Site in Tonawanda, New York. The goal is to reduce the concentration of arsenic in the groundwater to less than 0.016 mg/L through reduction of arsenic leaching from unsaturated and saturated soil.

Site Information

Groundwater chemistry upgradient and downgradient of the SSP is assumed to be represented by samples from CCR-3 and CCR-8[2] as summarized below:

Analyte	Units	Upgradient	Downgradient
		CCR-3	CCR-8
pH	SU	6.36 to 6.92	7.08 to 7.50
ORP	mV	20 to -84	-120 to -160
DO	mg/L	0.9 to 3.0	0.7 to 1.1
SEC	µS/cm	3,480	1,300
Turbidity	NTU	27	1.0
Arsenic, total	**mg/L**	**0.00492**	**0.150**
Arsenic, dissolved[1]	**mg/L**	**0.00488**	**0.147**
Arsenic, not specified	**mg/L**	**0.00278 to <0.005**	**0.222 to 0.2159**
Iron, total	mg/L	5.93	16.1
Iron, dissolved[2]	mg/L	3.04	16.3
Iron, not specified	mg/L	11.0	8.23
Calcium, not specified	mg/L	417	208
Magnesium, not specified	mg/L	157	17.8
Sodium, not specified	mg/L	155	17.2
Sulfate, not specified	mg/L	762	239
Sulfide, not specified	mg/L	<0.10	<0.10

Arsenic concentrations at the PRB location are on the order of the 0.200 mg/L. Iron concentrations in the water are relatively high (approaching 20 mg/L) as a result of the low ORP (-98 to -160 mV).

[1] Assumed filtered at 0.45 µm.
[2] Summary tables provided by GZA. Note there are no data from CC2-2 near the proposed location of the permeable reactive barrier.

There are no data regarding the arsenic concentrations in the unsaturated soil or data regarding the leachate chemistry of the soil.

CERES has proposed two treatment trials:

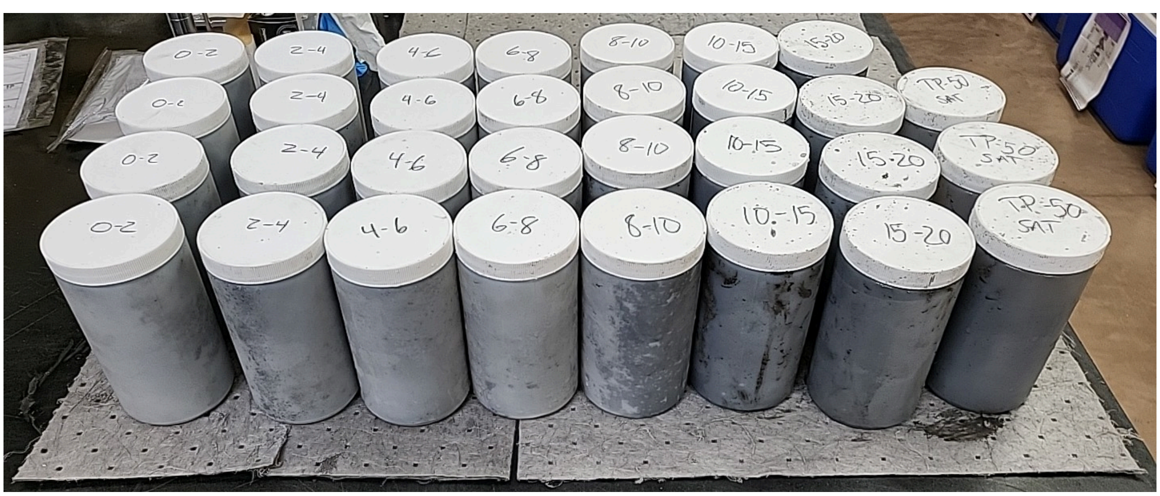
- Batch trials to evaluate reagent amendment to the unsaturated soil to reduce the concentrations of leachable arsenic to <0.016 mg/L, and
- Column trials to evaluate reagent emplacement to reduce groundwater concentrations of arsenic to <0.016 mg/L.

<u>Sample Collection</u>

GZA collected seven unsaturated soil samples from four locations composited to produce a total of seven samples (that is, all the 0-2 ft intervals from the 4 sample pits will be composited into one sample) as follows:

Sample ID	Sample Mass (kg)
0-2	3.99
2-4	4.85
4-6	3.86
6-8	4.02
8-10	5.85
10-15	6.12
15-20	6.75

The goal was to collect at least 6 kg of soil from each of the seven composite samples; 5 of 7 samples were below target soil sample material.



GZA also collected one soil sample, TP-50 SAT, from the saturated zone at one location where a PRB was proposed. Groundwater from monitoring well CCR-8 was to be slowly added to the bottles to displace entrapped air to the extent possible and filled to zero-headspace to the extent possible. The 4.99 kg sample met the goal of at least 4 kg. All soil samples were placed on ice for shipment to RP by overnight delivery service. The seven composite unsaturated soil samples were independently homogenized upon receipt, returned to the sample bottles and placed in refrigerated storage until used in the study. The saturated soil sample was independently homogenized under a nitrogen atmosphere (0.40% O_2) upon receipt, returned to the sample bottles and placed in refrigerated storage until used in the study.

GZA collected groundwater from monitoring well CCR-8 in two, 9.5-L nitrogen-purged canisters provided by RP using low-flow pumping methods. The canisters are designed to maintain the low ORP of the groundwater until used in the treatability study. Each was placed in a cooler for shipment to RP by overnight delivery service.

Baseline Testing Results

Unsaturated soil samples were subjected to compositional analyses and leaching by the Synthetic Leaching Procedure (SPLP) East leachant. RP measured the pH of the SPLP leachate and CT Laboratories (CTL) in Baraboo, Wisconsin, determined the arsenic and iron content of the soil and the dissolved (<0.45 µm) arsenic and iron content of the SPLP leachate. The results are summarized in Table 1 and CTL reports are provided in Appendix 1.

The unsaturated soil samples were slightly alkaline and averaged 51 mg/kg arsenic (range of 24 to 96 mg/kg). The average iron content was 12,000 mg/kg (range of 8.200 to 17,000 mg/kg). There is a general increase in arsenic content with increasing iron content, with sample 10-15 having an anomalously high arsenic content. The leachable arsenic content increases with the soil arsenic content (Figure 1), with only sample 10-15 concentration greater than the 0.016 mg/L groundwater goal. There was a general increase in arsenic content with increasing iron content, with sample 10-15 having an anomalously high arsenic content (Figure 2).

A saturated soil sample aliquot was submitted to CTL for determination of arsenic and iron content. The results are summarized in Table 2 and CTL reports are provided in Appendix 1.

The saturated soil contains 3.7 mg/kg arsenic and 8,300 mg/kg iron. Both concentrations are lower than those found in the unsaturated soil.

Groundwater was homogenized in the canisters provided. An aliquot of the groundwater was analyzed for pH, ORP and sulfate by RP, and dissolved arsenic and iron by CTL. The results are summarized in Table 3 and CTL reports are provided in Appendix 1. The received groundwater pH was comparable to historical observations while the ORP was approximately 60 mV higher and the sulfate content was 80 mg/L lower. The arsenic content was 0.0650 mg/L, less than half of the historical arsenic content. The iron content was 1.38 mg/L, more than 10 times less than the historical results.

Baseline Testing Discussion

Baseline As and Fe results were lower than expected based on-site investigation data presented to CERES at the start of the evaluation. CERES recognized increased ORP values which may have indicated the samples were oxygenated during drilling and sampling process and/or during homogenization of samples.

Additionally, unsaturated soil samples did not present sufficiently high As concentrations above action levels in all samples. Specifically, composite sample intervals from 4 ft to 10 ft bgs revealed As concentrations too low to perform testing in accordance with the proposed treatability study.

Composite samples from 0-2 and 2-4 ft bgs, respectively revealed As concentrations just below action levels. However, As concentrations were deemed sufficient to proceed with the treatability study with a reduced testing scope (i.e. eliminating composite samples from 4 ft to 10 ft bgs.

The saturated soil sample from 10-15 ft bgs more closely approximated conditions from historical field sampling and monitoring events and was deemed acceptable for proceeding with the treatability study as planned. Composite sample interval 15-20 ft bgs revealed As concentrations just below action levels. While not ideal, the 15-20 ft bgs composite sample may still be utilized in the planned study and provide valuable results in the future, if needed. However, this composite sample interval was also eliminated from the current treatability study.

Soil Batch Trials

Phase 1 Batch Trial Procedures

Each batch trial included 100 grams of soil wetted with SPLP East leachant to saturation to facilitate a 7-day reagent reaction with the soil. Soil samples 0-2 and 2-4 were amended with 3 wt.% of MTS® Reagents 200 MgO (magnesium oxide), 201 FeOOH (iron oxy-hydroxide), 106 FS (iron sulfide) and industrial calcium polysulfide (CaS_x). Leachable arsenic concentrations from these two samples were slightly less than the remediation goal of 0.016 mg/L. The baseline results were substituted for an unamended control. This resulted in eight (8) trials. Reactors were capped and maintained at room temperature. After a 1-week reaction period, each of the trials were subjected to the SPLP-East. Testing of pH and sample collection by filtered (0.45 µm) aliquots for arsenic and iron analyses were performed by CTL under standard laboratory 10-day TAT.

Soil sample 10-15 was tested in Phase 1 using MTS® reagents MTS® 106 FS at 1, 3, and 6 wt.% and CERES ZVI Micro 200 at 1, 2 and 4 wt.% for a total of six (6) trials. Reactors were capped and maintained at room temperature. After a 4-week reaction period, each of the trials were subjected to the SPLP-East. Testing of pH and sample collection by filtered (0.45 µm) aliquots for arsenic and iron analyses were performed by CTL under standard laboratory 10-day TAT.

The results are summarized in Table 4 and laboratory reports are provided in Appendix 1.

Phase 1 Batch Trials Results Discussion

Composite Sample Intervals 0-2 and 2-4 ft bgs

All MTS® technologies, including MTS® 200MgO, MTS®201FeOOH and MTS®106FS, achieved reductions of Arsenic within the composite samples and ranged from 20 to 87% reduction of soluble Arsenic. The MTS® 106 FS achieve the highest Arsenic reduction of 88% for both composite samples at a dose of 3%wt.

Calcium polysulfide (CaSx) was also included in the testing and was unsuccessful. CaSx resulted in an increase of Arsenic concentration of 53% and 127% for composites 2-4 ft bgs and 0-2 ft bgs, respectively.

Composite Sample Interval 10-15 ft bgs

CERES ZVI Micro 200 performed well at all dosage applications within the saturated soil matrix, with the result being relatively insensitive to dose. The lowest dosage of 1wt% achieved As reduction of approximately 81%. A dosage of 2% wt resulted in similar result. A 4%wt dosage achieved 89% reduction in As. All results achieve target treatment goals.

MTS® 106 FS did not achieve reduction of As at low dosage of 1% wt. in the Saturated zone soil matrix. A modest reduction of As by 17% was achieved with a dosage of 3%wt. A 6%wt dosage achieved a 53% reduction in As. Linear interpolation of MTS® 106 FS sample results suggests that 7 wt.% MTS® 106 FS would achieve the goal of 0.016 mg/L. Considering the high dosage requirements, MTS® 106 FS would result in a significantly higher cost to achieve As treatment goals.

Phase 2 Batch Trial Procedures

A total of 29 trials were performed for Phase 2 batch trials for composite samples 0-2 and 2-4 ft bgs. As a result of MTS® 106 FS achieving lower performance in the saturated zone compared to ZVI Micro 200, phase two batch trials were modified to include ZVI Micro 200 into the 0-2 and 2-4 ft bgs composite sample testing. MTS®201FeOOH and MTS®106FS were further evaluated at a dosage of 1 and 2%wt to assess dosage response and optimization. MTS® 200MgO and CaSx were removed from additional testing for phase 2 batch trials.

Additional changes to the Phase 2 Batch Trials included the addition of lithium and manganese to the inorganic analyte list to evaluate if other potential compounds of concern were increased as a result of the As treatment with the selected reagents. Controls for lithium and manganese were included to supplement the baseline arsenic and iron analyses that were used in lieu of controls. The results are summarized in Table 4 and laboratory reports are provided in Appendix 1. Below is a summary table of the analyte list for phase 2 batch trials.

Sample	Reagent	Dose (wt.%)	Analyses
0-2(BS1)	Control	0	Li, Mn
0-2(BS1)	FeS	1	As, Li, Mn
0-2(BS1)	FeS	2	As, Li, Mn
0-2(BS1)	FeOOH	1	As, Li, Mn
0-2(BS1)	FeOOH	2	As, Li, Mn
0-2(BS1)	ZVI M200	0.5	As, Li, Mn
0-2(BS1)	ZVI M200	1	As, Li, Mn
2-4(BS2)	Control	0	Li, Mn
2-4(BS2)	FeS	1	As, Li, Mn
2-4(BS2)	FeS	2	As, Li, Mn
2-4(BS2)	FeOOH	1	As, Li, Mn
2-4(BS2)	FeOOH	2	As, Li, Mn
2-4(BS2)	ZVI M200	0.5	As, Li, Mn
2-4(BS2)	ZVI M200	1	As, Li, Mn
10-15(BS7)	Control	0	Li, Mn
10-15(BS7)	FeOOH	1	As, Li, Mn
10-15(BS7)	FeOOH	2	As, Li, Mn
10-15(BS7)	ZVI M200	0.5	As, Li, Mn

Phase 2 Batch Trials Results Discussion

Composite Sample Intervals 0-2 and 2-4 ft bgs

ZVI Micro 200 achieved 88% and 72% reduction in As at composite sample intervals of 0-2 and 2-4 ft bgs, respectively. Lithium and Manganese were also relatively stable with the exception of a small increase of lithium concentration of approx. 8% in composite 0-2 at a

ZVI Micro 200 dosage of 0.5% wt. This is a small change but should be considered in future column study evaluations of lithium mobilization due to any reagent or treatment approach.

MTS®201FeOOH and MTS®106FS both achieved As reduction up to below detection limits at lower dosage. However, Lithium and manganese both demonstrated higher concentrations with these reagents.

Composite Sample Interval 10-15 ft bgs

ZVI Micro 200 was tested at a lower dosage of 0.5% to identify a lower dosage range that may achieve As reduction goals and also to evaluate potential impacts to lithium and manganese solubilization. A dosage of 0.5% wt of ZVI achieved a 73% reduction in As, a 6% reduction in lithium and no change or increase in manganese. A 0.5%wt dosage of ZVI Micro 200 achieves stated treatment goals.

MTS®106FS was retested (i.e. TS2-BS6-FS-1) at a dose of 1%wt to reevaluate low dose response and also evaluate potential impacts to lithium and manganese solubilization. As was reduced by 32% but lithium and manganese increased by 35% and 358%, respectively.

MTS®201FeOOH was included in the batch trials of the saturated zone to evaluate its performance considering the successful reduction of As in the vadose zone composite samples. Unfortunately, As reduction was not observed and increases in lithium and manganese increased 169% and 233%, respectively.

Proposed Column Trials

A column study design is recommended for the final evaluation process to document stability with pore volume exchanges with site groundwater. The column study will utilize 2-inch PVC approximately 12 inches in length with assumed soil density of 2.65 g/cm^3 (~1.11 kg soil mass from composite 10-15 ft bgs), water velocity of 14 cm/d, residence time of approximately 2 days, and a total column flow duration of 60 days under a nitrogen atmosphere to mimic the low ORP of the site.

Three columns are recommended with one unamended control, and two ZVI dosages of 0.5%wt and 1%wt. Site groundwater will be passed through the column from bottom to top. Three sampling time periods will be approximately 20 days apart not to exceed 60 days. At each selected time period, one influent and two effluent groundwater samples will be collected, filtered (0.45 µm) and analyzed for pH, ORP, sulfate, arsenic, lithium, and iron.

Additional column testing may be warranted if recycled concrete aggregate (RCA) is planned for use as backfill material upgradient of any ZVI treatment area. Due to the known impacts of RCA as backfill or base materials for construction, it is common to observe elevated pH up to a pH of 12 and formation of calcium carbonate precipitation resulting from the calcium hydroxide leachate and residue that RCA generates. Due to these potential concerns, if future onsite development or pond closure activities include the use of RCA, additional parameters such as CaCO3 precipitation, CaOH, MgOH, alkalinity and inorganics that appear to be associated with RCA such as aluminum, iron and copper should be included in the testing program.

Preliminary Remediation Design Estimates and Recommendations

The following is a preliminary design for Arsenic treatment at the site Huntly Power South Parcel. The following figure provides a site plan map view of the target treatment area outlined in blue.

	Area	10' BGS	15' BGS	20' BGS
	Square Feet	cubic feet	cubic feet	cubic feet
Northern Equalization Basin Bottom	43908	87816	219540	219540
Southern Equalization Basin Bottom	23521	47042	117605	117605
Qualization Basin Slopes	55133	330798	275665	275665
Area Outside Equalization basins	172087	1720870	860435	860435
Total Volume	Cubic Ft	2186526	3659771	5133016
Assumed Density	Pounds per Cubic Ft	107	107	107
Mass	Pounds	233,958,282	391,595,497	549,232,712
Mass	Tons	116,979	195,798	274,616

The estimated area calculated by GZA Environmental is approximately 295,000 sq ft with an associated volume of soil and groundwater of 1,475,000 cu ft or estimated mass of 79,000 tons (assuming 107 lb/cu ft).
The treatment goals for target compounds of concern are as follows:

- As: 0.015 mg/L
- Fe, Mn: 0.30 mg/L individual, 0.50 mg/L sum
- Li: 0.050 mg/L

Order of Magnitude (OoM) Reagent Demand Estimate
The OoM reagent demand estimate for soil and groundwater utilizes the area and volumes/mass calculated by GZA based on historical site operations and understanding of local regulatory guidance and requirements to manage arsenic on site.

Treatment Interval 10-15 ft bgs
Treatment Volume= 1,475,000 cuft

Treatment Mass= 79,000 tons of soil (dry weight)

Reagent ZVI-Micro 200 achieved goals at a 0.5%wt dosage however a 1% dosage may prove to be more resilient to change in site conditions. Such considerations may be evaluated during column studies.

- Best Case Dosage 0.5% wt= demand of 395 tons
- Worst Case Dosage 1% wt= demand of 790 tons

Application Approach
The remedial design approach will require either mechanical soil mixing of the ZVI with the target soils or fluidized hydraulic injection utilizing either vertical or horizontal drilling methods.

Brief Overview of Emplacement/mixing Methods
Soil mixing
In order to mechanically mix the soils at the depth of 10-15 ft bgs, the overburden soils must be excavated and removed from the area temporarily to expose the target depth interval for soil mixing. The zone is saturated so this approach may be limited or infeasible if slope stability controls and safety measures are unattainable or cost prohibitive.

Hydraulic Injection
Most groundwater treatment applications utilizing ZVI employ hydraulic injection methods for emplacement. No overburden soil removal is required and site safety is more easily managed during the field activities.

In order to emplace the ZVI at the target depth of 10 to 15 ft bgs and achieve effective distribution of the reagent, multiple injection intervals with 2.5 ft spacing is recommended at approximately 10, 12.5 and 15 ft bgs.

Drilling may be accomplished with direct push drilling methods which is relatively fast and low cost to implement. Hydraulic pumps are connected to the direct push drilling rods (2-3 in diameter hollow steel rods) for injection once they reach the target depth intervals.

Alternatively, for large or elongated treatment areas, horizontal drilling may be preferred to achieve the desired distribution of reagents through the target depth intervals. The methods of injection is different and will have a different orientation and injection interval process that is horizontal at 2 depth intervals rather than vertical at three depth intervals.

Soil type or media properties where the injections will occur shall require analysis of hydraulic conductivity in order to confirm the injection methods required to achieve successful distribution and hydraulic containment of the target contaminants in groundwater.

Cost estimates and injection design support is available from CERES by request.
A cost estimate for the purchase and delivery of the ZVI Micro 200 is provided under separate cover.

C.E.R.E.S.

Table 1. Unsaturated soil baseline analyses.

Sample ID	Soil			SPLP Leachate		
	pH SU	Arsenic (mg/kg)	Iron (mg/kg)	pH SU	Arsenic (mg/L)	Iron (mg/L)
0-2	7.69	65	15,000	8.02	0.0152	0.0273
2-4	7.88	61	17,000	8.19	0.0135	0.163
4-6	7.52	24	8,200	7.79	0.0040	<0.025
6-8	7.54	39	15,000	7.67	0.0054	<0.025
8-10	7.72	19	10,000	8.03	0.0065	0.172
10-15	7.76	96	12,000	8.37	**0.0421**	<0.025
15-20	7.56	56	9,700	8.16	0.0127	0.0305

Exceeds 0.016 mg/L groundwater goal.

Table 2. Saturated soil baseline analyses.

Analyte	Units	Results
Arsenic	mg/kg	3.7
Iron	mg/kg	8,300

Table 3. Groundwater (CCR-8) baseline analyses.

Analyte	Units	Results
pH	SU	7.23
ORP	ORP	-83
Sulfate	mg/L	159
Arsenic[1]	mg/L	**0.0650**
Iron[1]	mg/L	1.38

1. Dissolved (0.45 filtered) concentration.

Table 4. Results of Phase 1 (pH, Fe and As) and 2 (pH, As, Li and Mn) SPLP batch trials. The arsenic remediation goal is 0.016 mg/L.
Red text indicates exceedance of goals or increase over baselines.
No goals were specified for lithium or manganese. (arh QC)

Soil Sample	Reagent	Sample ID	Dose (wt.% soil)	pH (SU)	Iron (mg/L)	Arsenic		Lithium		Manganese	
						(mg/L)	% Change	(mg/L)	% Change	(mg/L)	% Change
0-2 (unsaturated zone)	**None**	**Baseline Soil (a)**	**0**	**7.69/8.13**	**0.0273**	**0.0152**	**---**	**0.0109**	**---**	**<0.0024**	**---**
	MgO	TS1-BS1-MGO-3	3	10.06	<0.025	0.0090	-41	NA	---	NA	---
	FeOOH	TS1-BS2-FEO-1	1	8.61	NA(c)	0.0061	-60	**0.0130**	**+19**	**0.0051**	**+325**
		TS1-BS2-FEO-2	2	8.78	NA	0.0056	-63	**0.0194**	**+78**	**0.0141**	**+1,075**
		TS1-BS1-FEO-3	3	8.57	0.0487	0.0053	-65	NA	---	NA	---
	FS 6.5% (slurry)	TS2-BS1-FS-1	1	7.84	NA	<0.0035	-88 (b)	**0.0137**	**+27**	**0.0058**	**+383**
		TS2-BS1-FS-2	2	7.94	NA	<0.0035	-88 (b)	**0.0122**	**+11**	**0.0269**	**+2,142**
		TS1-BS1-FS-3	3	8.22	<0.025	<0.0035	-88 (b)	NA	---	NA	---
	CaS_x	TS1-BS1-CS-3	3	9.55	<0.025	**0.0501**	**+227**	NA	---	NA	---
	ZVI M200	TS2-BS1-ZVI-0.5	0.5	8.59	NA	<0.0035	-88 (b)	0.0118	**+8**	<0.0024	0
		TS2-BS1-ZVI-1	1.0	8.57	NA	0.0076	-50	0.0088	-19	<0.0024	0

C.E.R.E.S.

Soil Sample	Reagent	Sample ID	Dose (wt.% soil)	pH (SU)	Iron (mg/L)	Arsenic		Lithium		Manganese	
						(mg/L)	% Change	(mg/L)	% Change	(mg/L)	% Change
2-4 (unsaturated zone)	**None**	**Baseline Soil (a)**	**0**	**7.88/8.53**	**0.163**	**0.0135**	**---**	**0.0044**	**---**	**<0.0024**	**---**
	MgO	TS1-BS2-MGO-3	3	10.36	<0.025	0.0105	-22	NA	---	NA	---
	FeOOH	TS2-BS2-FEO-1	1	8.68	NA	0.0070	-48	**0.0079**	**+80**	**0.0145**	**+1108**
		TS2-BS2-FEO-2	2	8.86	NA	<0.0035	-87 (b)	**0.0113**	**+157**	**0.0128**	**+967**
		TS1-BS2-FEO-3	3	8.08	<0.025	0.0038	-72	NA	---	NA	---
	FS 6.5% (slurry)	TS2-BS1-FS-1	1	8.08	NA	<0.0035	-87 (b)	**0.0060**	**+36**	**0.0206**	**+1617**
		TS2-BS1-FS-2	2	7.97	NA	<0.0035	-87 (b)	**0.0080**	**+82**	**0.0473**	**+385**
		TS1-BS1-FS-3	3	8.14	<0.025	<0.0035	-87 (b)	NA	---	NA	---
	CaS_x	TS1-BS1-CS-3	3	9.38	<0.025	**0.0342**	**+153**	NA	---	NA	---
	ZVI M200	TS2-BS2-ZVI-0.5	0.5	8.89	NA	0.0038	-72	0.0037	-16	<0.0024	0
		TS2-BS2-ZVI-1	1.0	8.83	NA	0.0070	-48	0.0034	-23	<0.0024	0

Soil Sample	Reagent	Sample ID	Dose (wt.% soil)	pH (SU)	Iron (mg/L)	Arsenic		Lithium		Manganese	
						(mg/L)	% Change	(mg/L)	% Change	(mg/L)	% Change
10-15 (saturated zone)	None	**Baseline Soil (a)**	0	**8.37/8.53**	**0.0125**	**0.0421**	**---**	**0.0105**	**---**	**<0.0024**	**---**
	FS 6.5% (slurry)	TS1-BS6-FS-1	1	9.38	<0.025	**0.0583**	**+38**	NA	---	NA	---
		TS2-BS6 FS-1	1	7.96	NA	0.0086	-32	**0.0142**	**+35**	**0.0055**	**+358**
		TS1-BS6-FS-3	3	9.93	<0.025	**0.0351**	-17	NA	---	NA	---
		TS1-BS6-FS-6	6	10.25	<0.025	0.0196	-53	NA	---	NA	---
	ZVI	TS2-BS6-ZVI-0.5	0.5	8.92	NA	0.0115	-73	0.0099	-6	<0.0024	0
		TS1-BS6-ZVI-1	1	8.86	<0.025	0.0078	-81	NA	---	NA	---
		TS1-BS6-ZVI-2	2	8.81	<0.025	0.0076	-82	NA	---	NA	---
		TS1-BS6-ZVI-4	4	8.58	<0.025	0.0048	-89	NA	---	NA	---
	FeOOH	TS2-BS6 FEO-2	2	8.98	NA	0.0126	-1	**0.0272**	**+169**	**0.0040**	**+233**

Notes: (a) Phase 1 used baseline As, Fe and pH results in lieu of control and while Phase 2 had a separate control for pH, Li and Mn.
(b) Based on ½ of the reporting limit.
(c) NA = not analyzed.

Figure 1. Leachable arsenic as a function of soil arsenic content (average of 0.025%).

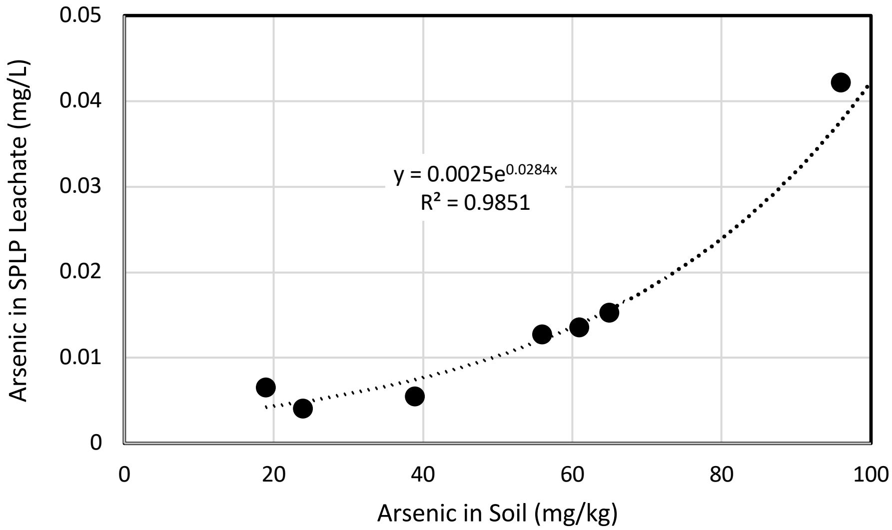
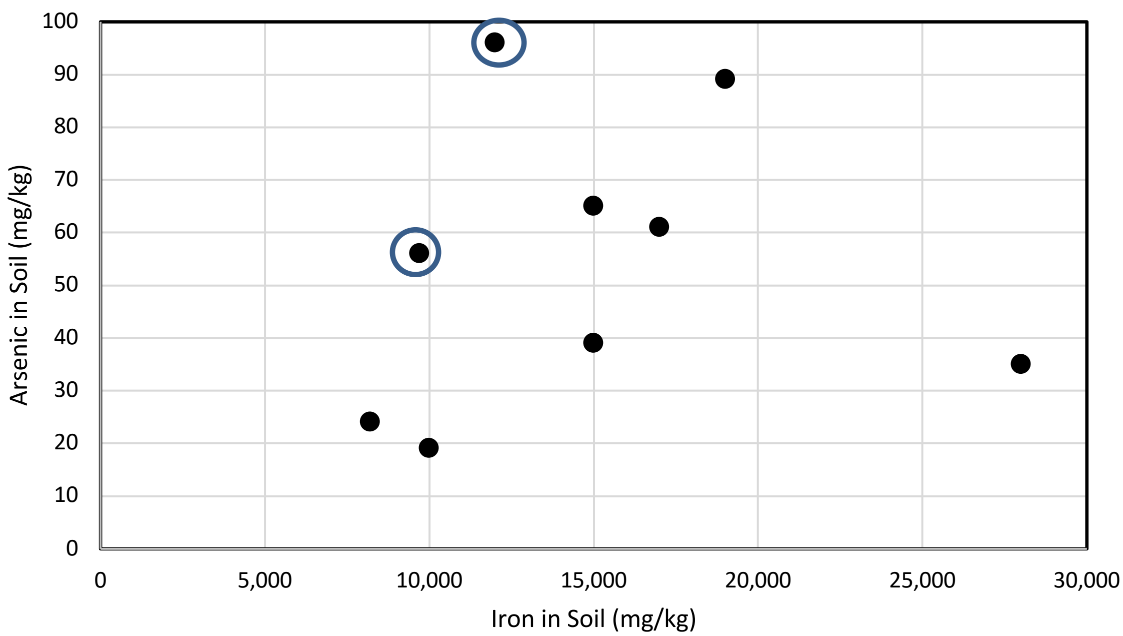


Figure 2. Arsenic content in soil as a function of soil iron content.
Circled points are assumed to be from the saturated zone.



Quote

 # QT-001273

CERES Remediation Products
4712 Admiralty WayUnit 250
Marina Del Rey California 90292
U.S.A
7147093683
lowell@ceresrp.com
www.ceresrp.com

Bill To
GZA Environmental Inc.
56 Main Street
PO Box 1578
Meredith
03253 New Hampshire
U.S.A

Quote Date : 26 Jun 2024

#	Item & Description	Qty	Rate	Amount
1	ZVI Micro 200 Zero Valent Iron Powder (Micro 200) Quantity: Pounds Packaging: Bulk Bags (2,400lb) Specifications: Density: 3.0 g/cc Fe composition: 94-98% by wt Size Distribution: 10-75 microns	790,000 lb	0.75	592,500.00

Sub Total	592,500.00
Tonawanda NY (8.75%)	51,843.75
Shipping charge	570,000.00
Total	**$1,214,343.75**

Terms & Conditions

Purchase Order Required
Order Retainer 25%
Net 30

Appendix C

Summary Report and Estimate for Remediation from Redox Technology Group, LLC

Wednesday, June 26, 2024

GZA
Jeremiah Duncan, Ph.D.
56 Main Street,
PO Box 1578
Meredith, NH 03253

Dear Jeremiah:

Redox Technology Group, LLC (dba Redox Solutions) is pleased for the opportunity to provide the following estimated pricing for FerroBlack® delivered to your project in Tonawanda, NY.

Redox Solutions is proud to own and operate the only chemical plant in North America that produces "mackinawite structured iron sulfide" (FeS) based treatment reagents which are marketed under the trade name - **FerroBlack®**.

Having the ability to vary the molar ratios of iron (Fe), sulfide (S), and aluminum (Al) in the production process, we can synthesize custom reagents tailored for your specific needs. Our process begins by synthesizing a layered double hydroxide (LDH) and then sulphonating the LDH to produce the final product.

The treatability study was designed in two phases. The first phase of the study, which was completed, consisted of a series of batch reactors with a low and high dose of the amendments to test their effectiveness in reducing the mobility (i.e., release into the aqueous phase) of the metal contaminants in the soils & groundwater. The purpose of the Batch Studies was to determine the amendments and doses that might be suitable for reducing the concentrations of metals in site groundwater. The proposed second phase of the study was to use column reactors to further evaluate the two amendments that performed the best in the Batch Studies (i.e., FerroBlack®-H40 and FerroBlack®-Fe+). Flow-through column reactors would be packed with contaminated site soil into which the amendments had been added. Contaminated groundwater would be passed through the amended soil, and metals concentrations were measured in the effluent water to determine the effectiveness of the amendments in removing metals from the site groundwater and minimizing leaching of the metals from the soil. The purpose of the column reactors is to evaluate amendments for their potential to be used in a more "site like" application to minimize off-site migration of the metals in groundwater and surface water.

From the testing completed to date with the site soils and groundwater, the analytical data indicates a 2%-3% dose rate of FerroBlack-Fe+ will meet compliance for dissolved arsenic in the groundwater. FerroBlack-H40 at a 2% dose rate also met compliance for dissolved arsenic.

The next recommended step would be a column study designed with site soils and groundwater comparing an untreated column to columns dosed at 2% - 3% of both reagents. The pore water would be tested for the indicated contaminants of concern (As, Mn and Fe).

Treatment Reagent

FerroBlack®:	\$0.85 / Lb.
	\$2,530.45 / tote
Transportation (Semi-Van):	\$5,300.00 / load

Based on the information provided the estimated cost for reagent, transportation and tote recycling, at 2% dose rate would be: **\$3,254,572.75***
*** (see attached calculation table)**

The above quotation is based on the following:

- Minimum of 8 totes per order.
- Maximum 14 totes / load.
- 300 gallons / tote. (2,977 lbs.)
- The totes we use are considered "one way" totes and are not re-usable. The empty totes are to be recycled or disposed of after use.
- The invoicing will be based upon the number of totes or pounds identified on the signed Bill of Lading (BOL) for each load.
- Pricing includes Fuel Surcharge (FS) as of quotation date.
- Fuel Surcharge will increase/decrease 1.0% for each \$0.06 over/under diesel pricing on this date based on EIA published national rate: see http://www.eia.gov/oog/info/wohdp/diesel.asp adjusted weekly.
- Transportation costs are subject to change based on the start of the project.
- Demurrage: 1-hour free offloading. Additional time billed at \$95.00/hr.
- Payment Terms: Net 30 days
- Product be stored at > 50^{o} F,
- This quote remains valid for 90 days from the date of quotation.
- Product shipments will be terminated, or interest will be accrued at 1.5% / month on balances past due, or both, at the sole discretion of Redox Solutions.
- Redox Technology Group, LLC shall automatically charge and withhold the applicable sales tax for orders to be delivered to addresses within the State of Indiana. Each customer shall be solely responsible for all sales taxes, or other taxes, on orders shipped to any other state.

REDOX SOLUTIONS

Estimated Injections Costing

On-site labor & Injection: **$1,600,000 (for the install)**

- 2,812 injection points on an asymmetric 10-ft. grid.
- 40-gal per injection point (all FB, no cutwater)
- 2 crews - 100 days
- 1 crew - 200 days

This design should be piloted first due to the ash, but I think we will get good distribution either way. The age of the ash is the reason to pilot the injection center and injection volume (shot/interval).

Ideally, I would do this on 8-ft centers, but that cost was $2.54MM, so we would need to justify it. I believe 10-ft. centers in the ash will be okay, age and settling dependent. We also need to make sure the areas for the injection are safe and accessible to a DPT rig, generator, ATV forklift, and the injection trailer- even if all are not in the same area.

Again, these are estimated costs based on the information provided. If this option would move forward all information would need to be confirmed at that point in time to provide firm pricing.

Thank you for considering Redox Solutions. Please contact Sandy Fox or Tom McCullough at 317-660-6867 should you have any questions.

Sincerely,
Redox Solutions

Thomas P. McCullough

Thomas P. McCullough - CEO / President

*** (attached reagent calculation table)**

79,000	Tons
158,000,000	Lbs.
2%	Dose rate
3,160,000	Lbs. of FerroBlack
$0.85	FB cost
$2,686,000	Reagent Costs
2,977	lbs. / tote
1,061.34	Totes
14	totes / load
75.81	Loads
$5,300.00	Load
$401,791.41	Transportation
1.19	SG
8.34	lbs./ gal water
9.92	Lbs. / gallon of FB
318,400.74	total gallons
$2,200	cost / load empty tote recycling
$166,781.34	Total Tote recycling
$3,087,791.41	Reagent Delivered to site
$3,254,572.75	Estimated total

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GZA GeoEnvironmental, Inc.