

C11
Richard

Memorandum

To Mr. James Carter
Tulip Corporation

Page 1

Subject **Lead, Arsenic, and SVOC Remediation Technical Memorandum**

From Richard Mazurkiewicz, AECOM

Date September 13., 2012

AECOM Technical Services, Inc. (AECOM) was retained by Tulip Corporation (Tulip Corp.) to conduct soil stabilization activities at Tulip facility located at 3125 Highland Avenue Niagara Falls, New York (Site; Figure 1). The project approach identified in AECOM's proposal is to chemically stabilize the lead and arsenic impacted soil in the historic coal pile area of the Site. AECOM's approach is to use calcium oxide (quick lime) via soil mixing to depths of 5 to 8 feet below ground surface (bgs) to stabilize the lead impacts, based on Redox-Tech's bench scale test results. The soil stabilization area is located on the north side of the building near the location of a historical coal pile storage area. This memorandum provides a detailed description of the anticipated Site activities and an update of the associated estimated cost for the soil stabilization action. We ask that you review this plan with the facility staff to ensure there are no concerns with the activities described.

General Site Information

The Site consists of approximately 9 acres of land located at 3125 Highland Ave in Niagara Falls, New York in a commercial and residential area. The Site is improved with a building complex at a combined area of approximately 123,115 square feet. The Site is currently active and produces molded plastic products for the automotive industry and injection molded recycling containers and other specialized plastic containers. A Site layout map illustrating site features is presented as Figure 2.

Remediation Area Subsurface Conditions

Native soils consist primarily of reddish-brown silty clay with up to 6 feet of sand and coarse sand and gravel fill overlying the clay, based on nine borings that were advanced to between 10 and 14 feet bgs at the Site in the area of the historic coal pile. The native clay soil immediately below the fill material was soft and moist to wet, indicating the presence of perched water; however, groundwater was not encountered in the soil borings at the time of the drilling. Based on the depth to groundwater in the monitoring wells installed in the soil borings at the Site, the water table is estimated to occur at a depth of approximately 6.5 feet bgs (based on groundwater elevation data collected from monitoring well MW-3 during AECOM's August 2011 Site investigation activities). A map of the soil stabilization area is presented as Figure 3.

Contaminants of Concern

Soil in an area located immediately north of the building, near the former coal pile and storage silo, contains concentrations of lead, arsenic, and semi-volatile organic compounds (SVOCs) at concentrations exceeding the New York State Department of Environmental Conservation (NYSDEC) Subpart 375-6, Remedial Program Soil Cleanup Objectives (SCOs; December 14, 2006). Additionally, lead concentrations in this area of the Site exceed the leachable characteristics for hazardousness.

Based on AECOM's August and November 2011 Phase II Environmental Site Assessments (ESAs) conducted at the Site, the most elevated concentrations of lead and arsenic found to date are located in the area outside the north side of the building. The vertical extent of SCO exceedances was generally defined during the Phase II assessments. The lateral extent of lead and arsenic SCO exceedances was not fully delineated; however, based on the concentration distribution and physical Site features, the extent was estimated, as was discussed previously with you. The estimated extent of the lead and arsenic is illustrated as the blue dashed line on **Figure 3**.

Based on the Phase II ESAs, the most elevated concentrations of SVOCs found to date are located in the area north and east of the former coal pile area. Although SCO exceedances were reported in samples from the soil borings at each of the depths analyzed, the most elevated concentrations were in the shallow samples collected from the fill material, with significantly lower concentrations in the underlying native clay soil. Neither the lateral or vertical extents of SVOC SCO exceedances were fully defined by the previous subsurface investigation at the Site. Based on the concentration distribution and physical Site features, the SVOC extent was estimated to be within that of the lead and arsenic area (within the blue dashed line on **Figure 3**).

The remedial objective is to 1) chemically stabilize (in-situ) the lead-impacted soils in the historic coal pile area by binding it within the soil matrix to render the soil non-hazardous by leachability characteristic and less leachable to groundwater and 2) place an engineered barrier (asphalt pavement) over the treated soil to provide a physical barrier to mitigate the potential for direct human contact with the stabilized soil beneath. The bench scale testing results indicated that the arsenic concentrations in soil in the planned remediation area are non-hazardous by leachability characteristics (see below), thus do not have to be chemically stabilized. Note that the soil mixing remedial option chosen for the Site does not directly address the SVOC impacts in soil; however, some reduction of SVOCs will occur during the soil-mixing process through volatilization.

Lead and Arsenic Bench Scale Testing Activities and Results

On July 18, 2012, AECOM mobilized to the Site to collect soil samples for lead and arsenic laboratory bench scale testing. The purpose of the bench scale testing was to determine the appropriate quantities of chemical soil amendments to be blended into the soil to chemically stabilize the lead and arsenic-impacted soils in the former coal pile area of the Site. The goal of chemical stabilization is to achieve a Toxicity Characteristic Leaching Procedure (TCLP) metals analysis result of the remediated soil that is less than 5 milligrams per liter (mg/L) for lead and arsenic. Tested soils with TCLP analysis results greater than 5 mg/L are considered as hazardous waste. The reason for stabilizing the soils is to minimize the potential of lead and arsenic to leach into the groundwater. The soil stabilization area will also have an asphalt barrier placed over it, which acts as a partial infiltration barrier, to further minimize future soil-to-groundwater contamination from surface water percolating through the affected soils.

AECOM collected four soil samples on July 18, 2012 for bench scale testing from previous locations (P-11B, P-16, P-18, and P-20) within the planned remediation area that had the most elevated total

lead (16,800 to 90,000 milligrams per kilogram [mg/kg]) and arsenic (13.7 to 50.2 mg/kg) previously found. AECOM's bench scale samples were collected from similar material (black sand and gravel) and from a similar depth (0 to 1 foot bgs) as the initial samples exhibiting the high lead concentrations. The rationale was to collect samples from the highest, known impacted areas of COCs as a conservative measure to ensure that the soils within the focus area are stabilized to objective levels. AECOM contracted Redox Tech, LLC (Redox Tech; Downers Grove, Illinois) to perform the bench scale testing.

Lead and Arsenic Bench Scale Testing Results

The results of the July 2012 pre-bench scale soil sample characterization testing documented total lead concentrations ranging from 2,200 to 85,000 mg/kg and total arsenic concentrations ranging from 16 to 37 mg/kg in the bulk soil samples. The results of TCLP analyses documented lead concentrations ranging from 210 to 930 mg/L, which exceed the hazardous TCLP value for lead of 5 mg/L. TCLP analyses documented arsenic concentrations ranging from below the laboratory method detection limit to 0.045 mg/L. Based on these results, the arsenic concentrations in soil do not exceed the TCLP hazardous criteria of 5 mg/L. Therefore chemical stabilization of arsenic is not an objective for the soils located in the historic coal pile area.

TOTAL
VS
TCLP

Redox Tech submitted each soil sample to a series of dosage trials (1%, 5%, 7%, and 8% by weight) of three different commercial-grade basic reagents which were calcium oxide, magnesium oxide, and Portland cement to assess stabilization efficacy. The dosed samples were subsequently leached using the TCLP screening level procedure. Redox Tech determined that the optimal reagent (based on performance) and dosage for the planned remediation was calcium oxide at 7%. Each of the bench scale samples were effectively stabilized below the TCLP regulatory level for lead (5 mg/L) when dosed with 7% calcium oxide with leachable concentrations ranging from 0.067 to 0.16 mg/L. This represents TCLP lead reductions of 99.7% to 99.99% with resultant TCLP concentrations well below the TCLP limit for hazardousness. A copy of Redox-Tech's *Lead and Arsenic Treatability Study Report* is provided as Attachment A.

Storm Sewer Preservation and Repair

To complete the planned soil mixing and compaction activities, two storm sewers, identified during Site investigation activities, will need to be temporarily taken out of service and replaced. The remediation area storm sewers are illustrated on Figure 4. One storm sewer, the main, starts at a manhole near the building and flows northward through the soil stabilization area to convey water off-Site. The main sewer is constructed of 8-inch clay tile and is approximately 4.5 bgs. The other storm sewer is a catch basin in the driveway north of the soil stabilization area and apparently conveys water back to the manhole near the building. It is constructed of 6-inch plastic pipe at approximately 3 feet bgs.

The soil stabilization will be completed to the extent possible to the east and west of the storm sewer main, which runs perpendicular to the building through the remediation area, before interrupting its continuity. The storm sewer main will be cut and capped near the north and south boundaries of the remediation area, after which the remainder of the soil mixing will occur. The catch basin sewer will be cut and capped at the northern boundary of the remediation area. The mixed soil will be in a non-compacted condition following the mixing, and structurally unsuitable for placement of the planned asphalt barrier, so the soil will be excavated and stockpiled adjacent to the remediation area following the mixing operation, as is described below. The excavation, replacement and compaction process will be initiated within an estimated day or two following completion of the mixing operation. The storm sewers taken out of service for the mixing operation will be replaced concurrently with the soil replacement process. It is estimated that the storm

sewers will be out of service for 5 to 7 days. Provisions have been made with the contractor to pump water from the manhole adjacent to the building and onto the green space north of the building and east of the soil stabilization area should there be rain events during the period that exceed the capacity of the other sewer pipe exiting the manhole adjacent to the building.

Remediation Area Preparation

Prior to the start of the soil mixing activities, Redox-Tech will prepare the remediation area by removing fencing, moving two debris piles, and removing asphalt pavement that covers the northern portion of the remediation area. The location and extent of these features are illustrated on **Figure 5**.

Redox-Tech will cut and remove approximately 110 feet of chain link fence near the north end of the remediation area. This will provide access to the area for the soil mixing and to the finished asphalt paved area.

In addition, Redox-Tech will move two debris piles of broken concrete that is overgrown with weeds and bushes. These two debris piles will be moved to the east of the remediation area.

Redox-Tech will also remove approximately 1,925 square feet of asphalt pavement at the northern portion of the remediation area. The asphalt debris will be placed on plastic sheeting to the east of the remediation area. The asphalt debris will be handled as special waste. Op-Tech will remove the asphalt debris, broken concrete and removed fencing at the time of asphalt paving. Our current plans do not include replacing the fencing that was removed.

In-Situ Soil Mixing of Lead, Arsenic, and SVOC Impacted Soil

The proposed excavation area covers an area of approximately 88 feet (from east to west) by 86 feet (from north to south) as shown on **Figure 3**. The excavation area has been divided into two general areas, the inner area that will be mixed to 8 feet bgs and the area around the inner area that will be mixed from 1 to 5 feet bgs as illustrated on **Figure 4**. Redox-Tech will perform the soil mixing activities.

The soil mixing bounds within the asphalt area (north of the fence) will be saw-cut. The AECOM on-Site representative will aid Redox-Tech during the soil mixing activities by identifying the soil mixing limits. The approximate bounds of the soil mixing area are illustrated on **Figures 3 and 4**. Based on Site field measurements of the remediation area and clearances around structures and underground utilities, AECOM estimates that approximately 2,300 tons of lead, arsenic, and SVOC impacted soil will be mixed at the Site. Redox-Tech estimates that approximately 161 tons of calcium-oxide (7% by weight of 2,300) will be blended into the planned remediation area.

Note that only the top 2 feet of soils will be treated within 8 feet of the building to preserve the east-west trending portion of the roof drain storm sewer lateral. In addition, soils along the storage silo will be treated to a depth of 1 foot deep (for soils within 1 foot away from the silo) and to 2 feet deep (for soils from 1 foot to 8 feet away from the silo) to prevent damage to the plastic bead storage silo. The depths of soil mixing are illustrated on **Figure 6**. The asphalt debris generated during the exposure of soils at the northern portion of the remediation area will be temporary stockpiled on the Site (at the vegetated area to the east of the remediation area). The asphalt debris will be disposed of by Op-Tech subsequent to their final asphalt paving activities. Please note that no soil mixing activities will be performed without the on-Site AECOM representative being present.

Air Monitoring

AECOM will perform air dust monitoring, as required by the New York Community Air Monitoring Program (CAMP) during the excavation activities. The air monitoring will be conducted daily during the soil mixing and soil excavation and compaction activities. Three dust monitoring stations (one at the up-wind property boundary, one at the down-wind property boundary and one near the down-wind edge of the work area) will be established prior to initiating soil mixing and excavation activities. Hourly air monitor readings would be collected during Site work to measure particulates. If particulate levels at the down-wind property boundary are more than 1 milligram per cubic meter higher than the up-wind levels, dust suppression measures (spraying the work area with water and/or waiting until winds reduce) will be implemented.

Confirmation Soil Sampling

Subsequent to the soil mixing activities, AECOM will confirm the efficacy of the treatment by collecting three soil samples for lead and arsenic TCLP analysis. These samples will be collected from the locations and depths of highest pre-treatment lead concentrations (near former borings P-11B, P-18, and P-20) at approximately 1 foot bgs as soon as the mixing is completed at these locations. The soil samples will be analyzed for lead and arsenic by TCLP. The analytical results of the post-remediation soil confirmation samples will be compared to the lead and arsenic TCLP hazardous limit of 5 mg/L. The post-stabilization confirmation soil sampling will be conducted concurrently with the soil mixing operations such that the subsequent removal, replacement, and compaction of the loose, mixed soil and storm sewer re-connections can be initiated as soon as possible following the completion of the overall mixing operations.

Remediation Area Compaction

Subsequent to confirming that the soils have been chemically stabilized, Op-Tech will excavate, remove, and compact the treated soils to provide a structurally suitable base for the asphalt barrier. The estimated 2,300 tons of mixed soil will be excavated and stored on plastic sheeting prior to being placed back into the remediation area. The material will be backfilled in 12-inch lifts and mechanically compacted with a vibratory compactor. Compaction of the soil from 8 feet to 3 feet bgs will be to 92% of maximum dry density moisture content referenced to American Society for Testing and Materials standard e1557, Modified Proctor Test and to 95% from 3 feet to 1 foot bgs. Op-Tech will contract to conduct in-field density testing (at least one field test per lift per 2,000 square feet). The final lift will be graded to 9 inches below the approximate grade of the existing asphalt parking area located to the north of the remediation area in preparation of the final asphalt pavement application.

Engineered Cap/Barrier Installation Activities

AECOM will provide oversight of the engineered cap/barrier (asphalt paved area) over the remediation area. Several tasks are required to be completed to install the asphalt cap, including removing excess soils from the remediation area in preparation for applying the asphalt pavement and collecting waste characterization samples of the surficial material, which is required by the landfill to accept the removed material.

Waste profile sampling will consist of one composited sample from 3 to 5 locations within the treatment area from depths of approximately 3 to 6 inches bgs. The waste profile sample will be collected for specific analyses required by the disposal facility. In addition, prior analytical data will be used to the extent accepted by the landfill. For purposes of this memorandum, it is assumed that TCLP metals, total VOCs and SVOCs, and polychlorinated biphenyls analyses would be

required. AECOM will collect the landfill waste profiling samples subsequent to receipt of the soil confirmation sample laboratory results (approximately two weeks after completion of the soil mixing.

Op-Tech will dispose of approximately 750 tons of treated non-hazardous lead, arsenic, and SVOC impacted waste from the remediation area in preparation of asphalt paving. The excess soils to be disposed consists of the extra soil over the unpaved southern portion of the remediation area (approximately 450 tons) and from the 161 tons of soil displaced by the calcium-oxide added as part of the remedial action. This extra soil, which will be chemically stabilized, will need to be removed to extend the asphalt cap/barrier over the remediation area at the same approximate grade as the existing paved area to the north. In addition, Op-Tech will dispose of the approximately 35 tons of asphalt debris that is to be removed from the northern portion of the remediation area as non-hazardous special waste. All non-hazardous lead, arsenic, and SVOC-impacted soils and asphalt debris will be taken to landfill selected by Tulip Corp. —??

Op-Tech will place a 6-inch layer of 2-inch crushed limestone over the remediation area to the extents of the planned asphalt capped area. The extents of the asphalt cap/barrier are illustrated on Figure 7. A final layer of 3-inch asphalt pavement will be applied over the remediation area.

Schedule and Costs

AECOM anticipates starting the remediation October 8, 2012 and has confirmed the following schedule with both our subcontractors Redox-Tech and Op-Tech.

Task Description	Schedule Start Date	Schedule End Date
Soil Mixing	10/8/2012	10/14/2012
Soil Confirmation Sampling and Waste Disposal Sampling	10/11/2012	10/12/2012
Treated Soil Compaction and Asphalt Paving	10/15/2012	10/26/2012

AECOM will perform the services described above on a time-and-material basis, in accordance with our current agreement for this project. Our estimated fee of \$375,000 for these services is based on the estimated effort required to complete the scope of work itemized herein and on contractor estimates, which may change. If additional services or expenses are required, which would cause our fee to be greater than those estimated; we will obtain your authorization before proceeding.

We do note the following changes from the scope of services described in the current agreement:

- 1 We have included excavation, stockpiling, replacement in engineering lifts and compaction which was not part of our initial proposal. ← ?
- 2 We have included removal and replacement of the storm sewers through the soil stabilization area which was specifically excluded from our prior proposal.

- 3 We have included 2 days of water management from rain events in the approach described in this plan, which was specifically excluded in our prior proposal.
- 4 The volume of the soil stabilization is less than described in the initial proposal, though the bench scale testing identified the need for more soil amendment than was included, so the net cost for soil mixing is similar.

Closing

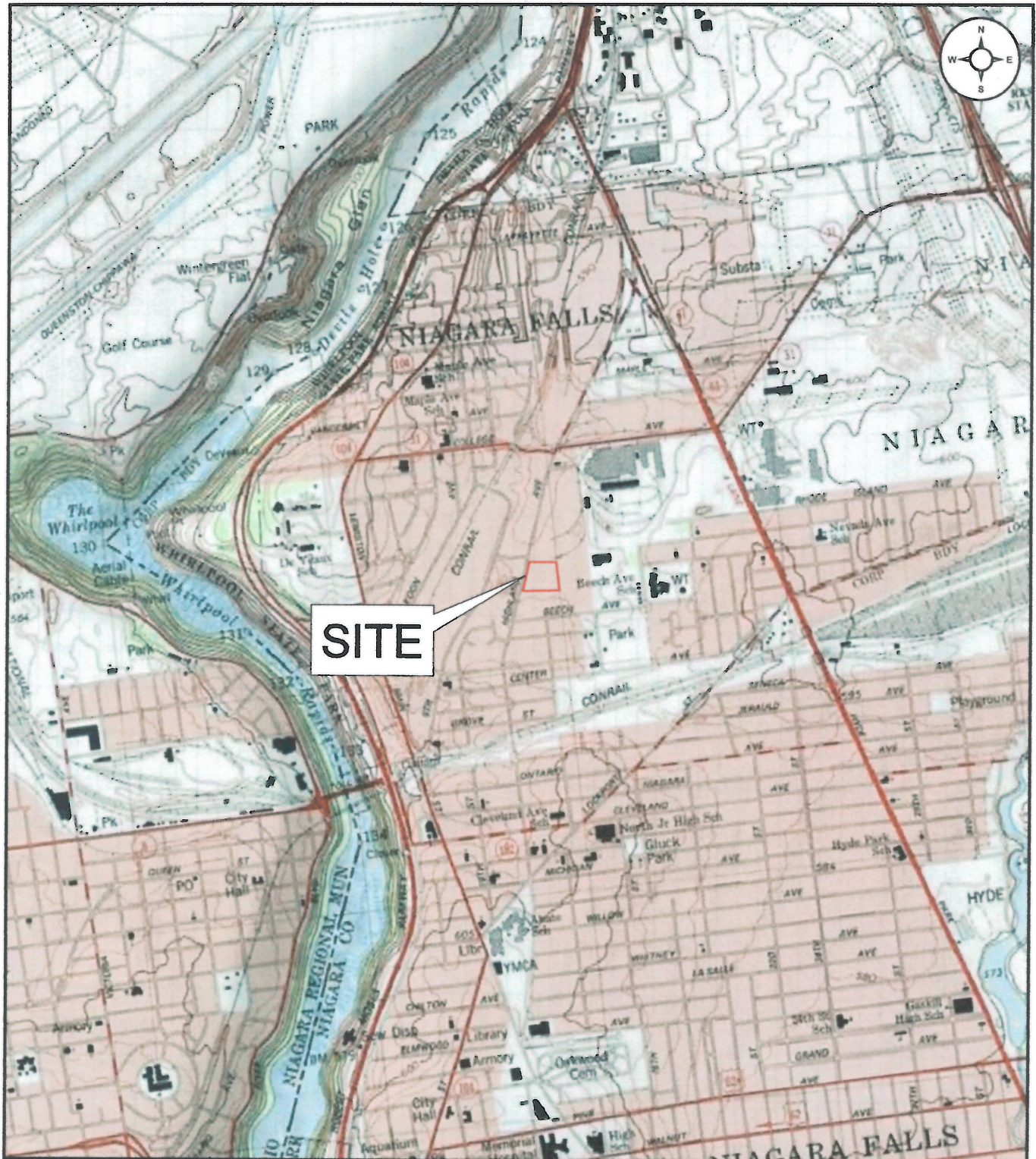
We appreciate the opportunity to be of service to you on this project and will proceed with the execution of the activities described herein upon your concurrence. We are available to discuss any questions you or the facility representatives have concerning this plan, upon your request.

Attachments:

- Figure 1 – Site Location Map
 - Figure 2 – Site Layout Map
 - Figure 3 – Remediation Area Map
 - Figure 4 – Sewer Preservation and Repair Map
 - Figure 5 – Concrete and Vegetation Debris Map
 - Figure 6 – Remediation Area Soil Mixing Depth Map
 - Figure 7 – Engineered Asphalt Cap/Barrier Map
- Attachment A – Lead and Arsenic Treatability Study Report

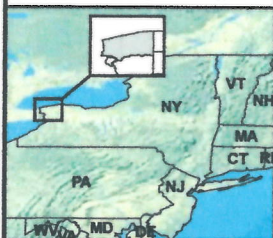
Figures

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SITE

Site Location (Niagara County)



SITE LOCATION MAP
Tulip Corporation Property
3125 Highland Avenue
Niagara Falls, New York 14305

AECOM Project: 60220285.1

Date: 08/22/11

0 0.25 0.5 0.75 1
Miles

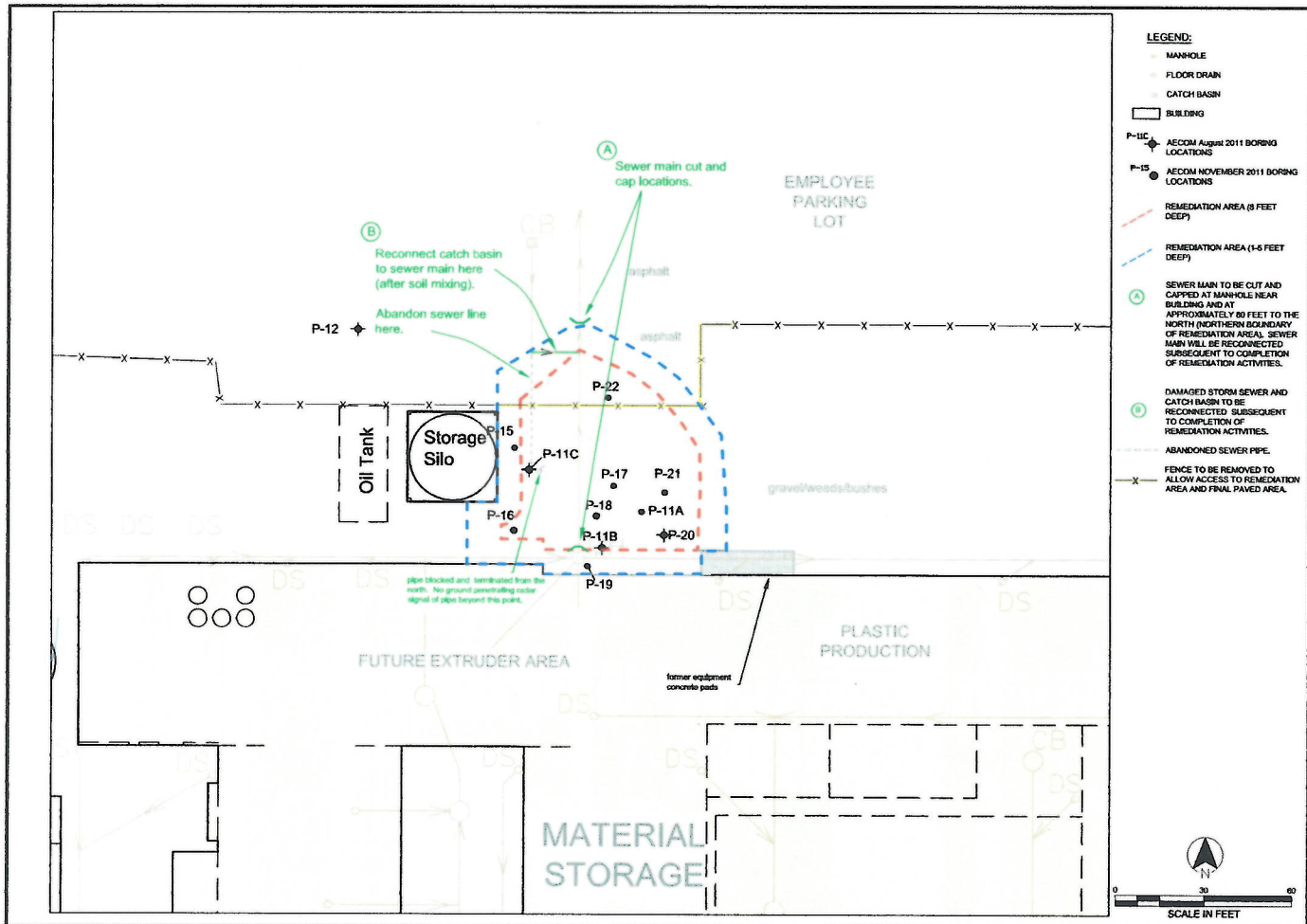
Source: NGS USA Topographic Maps
Copyright: © 2009 National
Geographic Society

AECOM

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www.aecom.com

FIGURE 1





NO.	DESCRIPTION	DATE	BY
1	ISSUED FOR PERMIT	08/18/12	AS NOTED
2	REVISED	08/18/12	AS NOTED
3	REVISED	08/18/12	AS NOTED
4	REVISED	08/18/12	AS NOTED
5	REVISED	08/18/12	AS NOTED
6	REVISED	08/18/12	AS NOTED
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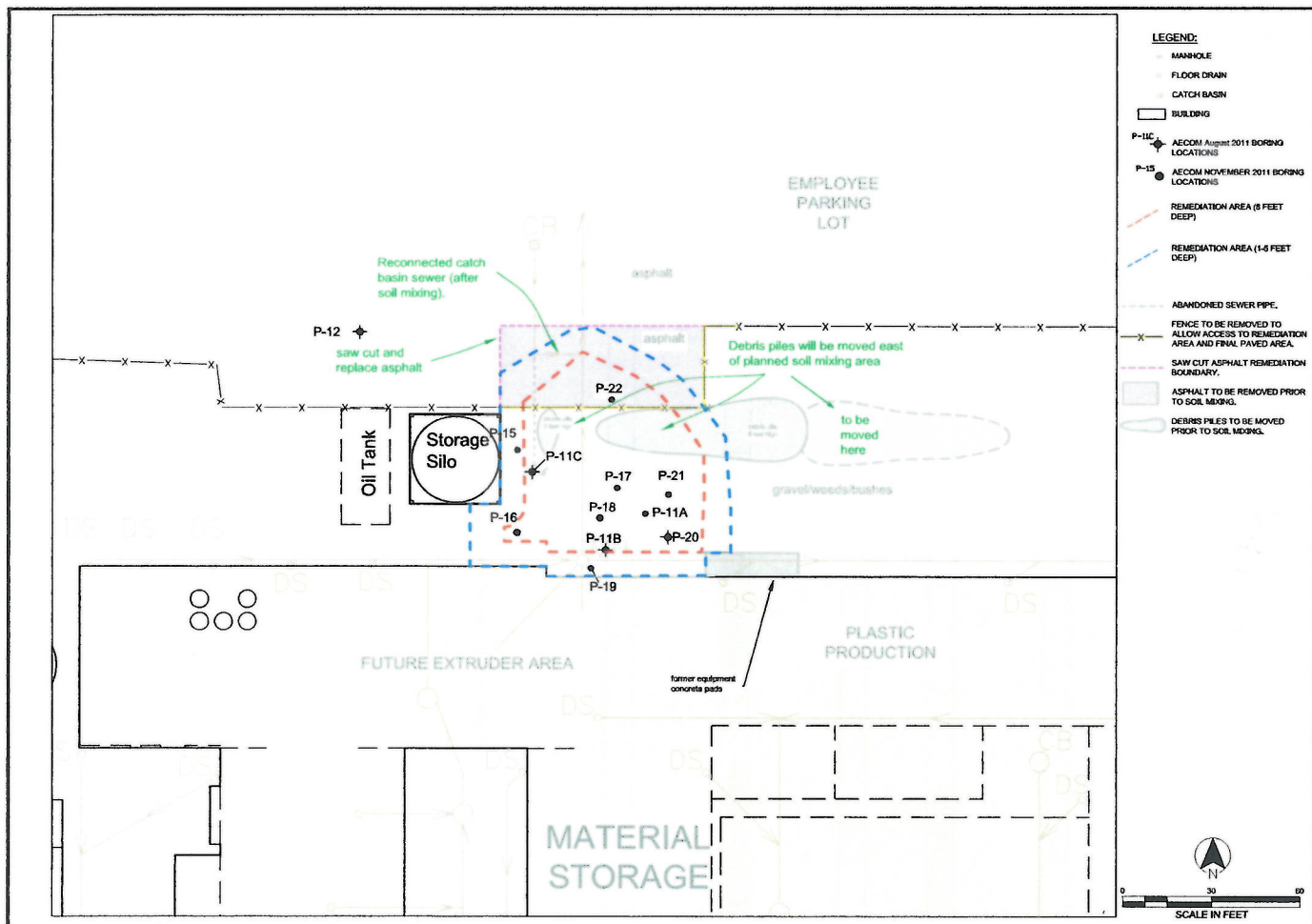
AECOM

AECOM Environment
3125 Highland Avenue
Niagara Falls, New York 14201
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Sewer Preservation and Repair Map

Tulip Corporation
3125 Highland Avenue
Niagara Falls, New York

DATE: 08/18/12
KEY: SEE SHEET 0021775

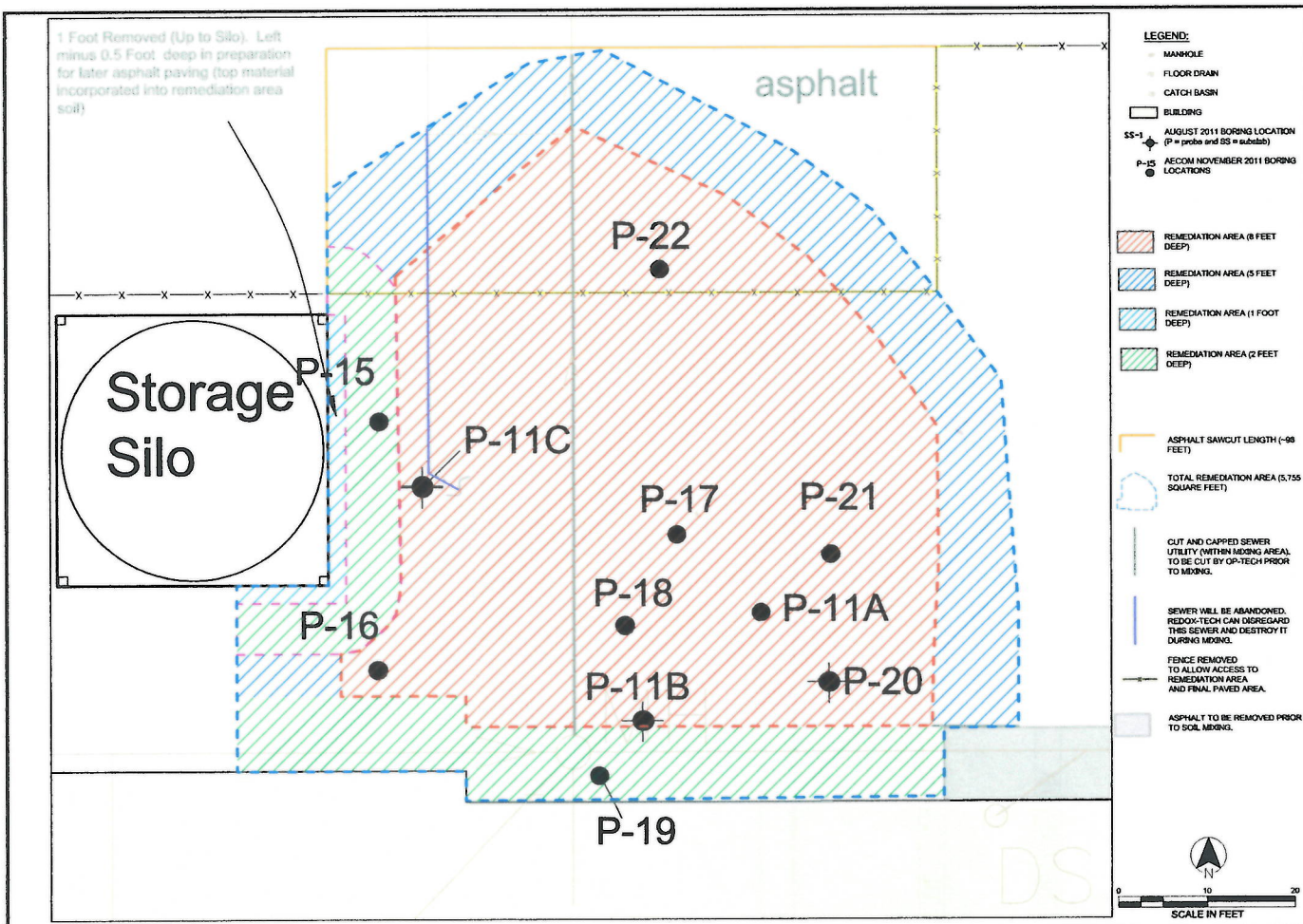


NO.	DATE	BY
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AECOM

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3125 Highland Avenue
Niagara Falls, New York
14178-3400
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Remediation Area Preparation Map	DATE	BY	CHECKED BY	DATE
Tulip Corporation	08/11/2011	JM	AS NOTED	08/11/2011
3125 Highland Avenue				
Niagara Falls, New York				



NO.	DATE	BY	CHKD BY	DATE
1	11/15/2011	SS	SS	11/15/2011
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3	11/15/2011	SS	SS	11/15/2011
4	11/15/2011	SS	SS	11/15/2011
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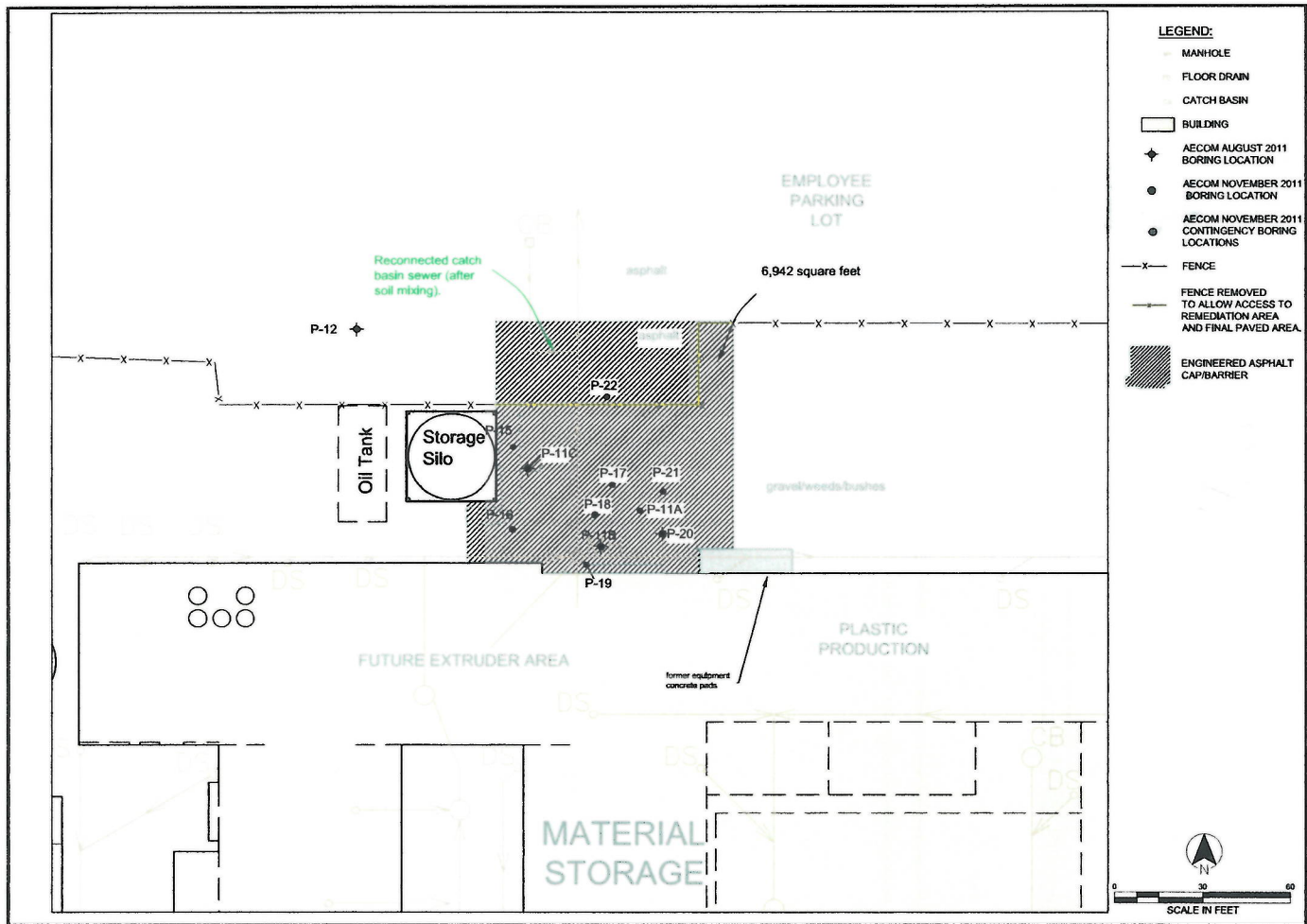
AECOM

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Remediation Area Soil Mixing Depth Map

Tulip Corporation
3125 Highland Avenue
Niagara Falls, New York

SCALE: AS NOTED
DATE: 08/01/2012
AECOM PROJECT: 00211770



NO.	DESCRIPTION	DATE	BY
1	ISSUED BY		
2	APPROVED BY		

AECOM

AECOM Engineering
AECOM Engineering Inc.
Niagara Falls, New York 14304
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Engineered Asphalt Cap/Barrier Map

Tullo Corporation
3125 Highland Avenue
Niagara Falls, New York

SCALE: AS NOTED

DATE: 09/01/2012

AECOM PROJECT: 05271770

7

CELL FIELD MAP

REMIX AREAS IN RED



AECOM

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Figure 1

Attachment A

REDOX TECH, LLC

"Providing Innovative In Situ Soil and Groundwater Treatment"

August 6, 2012

Via Email

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RE: Lead and Arsenic Treatability Study Report
Tulip Corporation Site, Niagara Falls, NY

Dear Mr. Mazurkiewicz:

Redox Tech is pleased to present the following treatability study report. This testing was conducted on site-specific soil for purposes of determining an appropriate method for stabilizing lead and arsenic.

Introduction

Redox Tech, LLC (Redox Tech) proposes to stabilize lead and arsenic in soil at the Tulip Corporation site in Niagara Falls, New York using a soil blending technique, addressing soils to a depth of up to 8 feet below ground surface. Area soil is sand and gravel. As part of the cleanup strategy, the remediation area will likely be paved after stabilization activities area completed. To avoid a dewatering step, the chemistry evaluation for this project focused on dry reagents. Current site soil is adequate for construction of the parking lot.

Soil samples indicate lead concentrations as high as 17,000 mg/kg, and arsenic concentrations as high as 30 mg/kg. The goal is to stabilize lead and arsenic to achieve a non-hazardous, TCLP goal of 5.0 mg/L for both lead and arsenic.

Sample Collection.

The following samples collected by AECOM were used in the treatability study:

- | | | |
|------------------------------------|-----------------------|----------------------------|
| <input type="checkbox"/> Sample A: | P-20 (0-1') – 071812 | (ReSP Lab. No 2012 07 001) |
| <input type="checkbox"/> Sample B: | P-16 (0-1') – 071812 | (ReSP Lab. No 2012 07 002) |
| <input type="checkbox"/> Sample C: | P-18 (0-1') – 071812 | (ReSP Lab. No 2012 07 003) |
| <input type="checkbox"/> Sample D: | P-11b (0-1') – 071812 | (ReSP Lab. No 2012 07 004) |

Redox Tech, LLC

Initial Sample Characterization.

Each soil sample was reduced in size to pass through a 3/8-inch sieve and homogenized. Each sample was analyzed for total and untreated TCLP arsenic and lead. A summary of the initial analyses and treatability study results is provided in **Table 1**.

Arsenic

Study samples A, B, C and D had total arsenic concentrations of 16, <15, <16, and 37 mg/kg, respectively; and TCLP arsenic concentrations of <0.030, 0.035, <0.030 and 0.045 mg/L, respectively (see Table 1). All of these TCLP values are well below the TCLP regulatory level of 5 mg/L. There appears to be no correlation between the total arsenic concentrations and the untreated arsenic TCLP concentrations.

Lead

Samples A, B, C, and D had total lead concentrations of 2200, 42,000, 19,000 and 85,000 mg/kg lead, respectively; and TCLP lead concentrations of 220, 690, 210 and 930 mg/L, respectively (see Table 1). Lead has a weak correlation between the total lead concentrations and the TCLP lead concentration with a correlation coefficient of 0.79.

Stabilization Study.

Each soil sample was subjected to a series of dosage trials (1%, 5% and 8% by weight) of three different commercial-grade basic reagents including calcium oxide (CaO), magnesium oxide (MgO) and Portland Cement. The dosed samples were subsequently leached using the TCLP screening level procedure.

Arsenic

The arsenic concentrations in the untreated TCLP leachate were well below the regulatory level of 5 mg/L (see Table 1). The leachate of the dosed samples for all three reagents was analyzed for arsenic to document any effect the stabilization chemistry used for lead had on the arsenic solubility. The TCLP arsenic remained very low (at or less than 0.21 mg/L) for all of the dosage trials. Most results (37 of the 44 dosage trials) were below the detection limit.

Lead

Calcium Oxide

All of the Samples A, B, C and D were effectively stabilized below the TCLP regulatory level of 5 mg/L for lead when dosed with 8% CaO with leachable concentrations of 1.4, 0.14, 0.10 and 0.20 mg/L, respectively. This represents lead reductions of 99.4, 99.98, 99.95 and 99.98 percent, respectively. At dosages of 1% and 5% CaO, lead remained relatively soluble in the TCLP test.

Since, 8% CaO dosage demonstrated an effective remedy for all samples, a series of dosages between 5% and 8% CaO were tested for lead on each of the samples to identify the optimal treatment dose. All of the Samples A, B, C and D were effectively stabilized below the TCLP regulatory level for lead when dosed with 7% CaO with leachable concentrations of 0.70, 0.067, 0.066 and 0.16 mg/L, respectively. This represents lead reductions of 99.7, 99.99, 99.97 and 99.99 percent, respectively. At 6% CaO dosage, lead in all four samples remained relatively soluble in the TCLP test and exceed the target concentration of 5 mg/L.

Magnesium Oxide

Samples A, B and D were effectively stabilized below the TCLP regulatory level of 5 mg/L for lead when dosed with 8% MgO with leachable concentrations of 4.8, 2.3 and 0.83 mg/L, respectively. This represents lead reductions of 98.1, 99.7 and 99.9 percent respectively. Sample C had a TCLP lead concentration of 8.8 mg/L, slightly above the regulatory limit. For dosages of 1% and 5% MgO, lead remained relatively soluble in the TCLP test.

Portland Cement

Lead remained relatively soluble in the TCLP test for each of the Portland Cement dosage trials in all four samples at cement dosages of up to 8 weight percent. The leachable lead results in these trials were all above 80 mg/L.

The TCLP extract from the 7% CaO treatment from each sample was sent to ESC Laboratory in Mt. Juliet, Tennessee for certified verification of the screening arsenic and lead analysis. The verification results are provided in Table 1. The certified lab and the screening arsenic and lead results demonstrate excellent agreement of between the analyses.

Application Parameters.

The best performing reagent for the site samples is CaO, which demonstrated the highest reduction in leachable lead at 8% dosage and performed equally well at the 7% dosage. The application and mixing of the reagent at the site has raised concerns about post-application geotechnical strength and heat generation. Three empirical bench tests on the samples were performed to help provide information in making application decisions. The three tests, performed on all four samples, included percent moisture, heat generation and strength. The results of the application parameters are provided in Table 2.

Percent moisture was tested for samples that were untreated and dosed with 7% CaO. The moisture results were between 4.5% and 6.8%. The 7% dosed samples experienced a drying effect where each sample had a decrease in moisture between 0.2% and 0.6%.

Heat generation and strength testing was performed for samples that were either untreated or dosed with 8% CaO, and then saturated with deionized water. The untreated samples experienced no temperature increase. Each of the samples dosed with CaO experienced a

temperature increase between 3.1 C° and 5.5 C°. None of the samples had measurable geotechnical strength as measured with a hand penetrometer. However, each of the samples dosed with CaO had the ability to support the weight of the penetrometer, in that the penetrometer did not sink into the sample. None of the untreated samples could support the weight of the penetrometer.

Conclusions.

For the site samples, there appears to be a weak correlation between the total concentrations for lead and the untreated TCLP concentrations. There appears to be no correlation between the total concentrations for arsenic and the untreated TCLP arsenic concentrations.

All of the samples had untreated arsenic concentrations in the TCLP test well below the regulatory level. The arsenic concentrations remained very low in the TCLP test for all of the reagent dosage trials.

Three of the four samples were stabilized for lead using 8% MgO. All of the samples were stabilized for lead using 7% CaO.

The addition of CaO has a slight drying effect on the site samples as demonstrated by the moisture measurements.

There is a measurable increase in temperature with the addition of CaO and water to each of the samples, indicating heat generation.

There is noticeable improvement in geotechnical strength with the addition of CaO to the site samples.

The certified lab and the screening arsenic and lead results demonstrate excellent agreement between the analyses.

Thank you for the opportunity to conduct these tests for AECOM. If you have any questions or concerns, please do not hesitate to call me at (630) 705-0390.

Regards,

Steve Markesic
Redox Tech, LLC

Table 1
Treatability Study Results - AECOM, Niagara Falls, New York

Soil Sample	Formulation (wt %)			Arsenic			Lead		
	CaO	MgO	Portland Cement	Total Arsenic (mg/kg)	Leachable Arsenic (mg/L)	Reduction in Arsenic (%)	Total Lead (mg/kg)	Leachable Lead (mg/L)	Reduction in Lead (%)
Treatment Goals					5			5	
A P-20 (0'-1') 071812 2012 07 001	--	--	--	16	<0.030		2,200	220	
	1.0	--	--		<0.030	N/A		210	16
	5.0	--	--		<0.030	N/A		100	60
	6.0	--	--		<0.030	N/A		57	77
	7.0	--	--		<0.030	N/A		0.70	99.7
				lab verification	<0.020	N/A	lab verification	0.08	99.97
	8.0	--	--		<0.030	N/A		1.4	99.4
	--	1.0	--		<0.030	N/A		210	16
	--	5.0	--		<0.030	N/A		150	40
	--	8.0	--		<0.030	N/A		4.8	98.1
	--	--	1.0		<0.030	N/A		250	0.0
	--	--	5.0		<0.030	N/A		220	12
B P-16 (0'-1') 071812 2012 07 002	--	--	--	<15	0.035		42,000	690	
	1.0	--	--		<0.030	N/A		440	36
	5.0	--	--		<0.030	N/A		150	78
	6.0	--	--		<0.030	N/A		52	93
	7.0	--	--		<0.030	N/A		0.067	99.99
				lab verification	<0.020	N/A	lab verification	0.055	99.99
	8.0	--	--		<0.030	N/A		0.14	99.98
	--	1.0	--		<0.030	N/A		510	26
	--	5.0	--		<0.030	N/A		210	70
	--	8.0	--		<0.030	N/A		2.3	99.67
	--	--	1.0		0.049	0.0		620	10
	--	--	5.0		<0.030	N/A		470	32
C P-18 (0'-1') 071812 2012 07 003	--	--	--	<16	<0.030		19,000	210	
	1.0	--	--		<0.030	N/A		219	0.5
	5.0	--	--		<0.030	N/A		120	45
	6.0	--	--		<0.030	N/A		76	66
	7.0	--	--		<0.030	N/A		0.066	99.97
				lab verification	<0.020	N/A	lab verification	0.059	99.97
	8.0	--	--		<0.030	N/A		0.10	99.95
	--	1.0	--		<0.030	N/A		220	0.0
	--	5.0	--		<0.030	N/A		160	27
	--	8.0	--		<0.030	N/A		8.8	96
	--	--	1.0		<0.030	N/A		210	4.5
	--	--	5.0		<0.030	N/A		170	23
	--	--	8.0		<0.030	N/A		80	64

Table 1
Treatability Study Results - AECOM, Niagara Falls, New York

Soil Sample	Formulation (wt %)			Arsenic			Lead		
	CaO	MgO	Portland Cement	Total Arsenic (mg/kg)	Leachable Arsenic (mg/L)	Reduction in Arsenic (%)	Total Lead (mg/kg)	Leachable Lead (mg/L)	Reduction in Lead (%)
Treatment Goals					5			5	
D P-11b (0'-1') 071812 2012 07 004	--	--	--	37	0.045		85,000	930	
	1.0	--	--		<0.030	N/A		640	43
	5.0	--	--		0.036	83		440	61
	6.0	--	--		<0.030	N/A		170	85
	7.0	--	--		<0.030	N/A		0.16	99.99
				lab verification	<0.020	N/A	lab verification	0.18	99.98
	8.0	--	--		<0.030	N/A		0.20	99.98
	--	1.0	--		0.13	38		920	19
	--	5.0	--		0.031	85		440	61
	--	8.0	--		<0.030	N/A		0.83	99.9
	--	--	1.0		0.21	0.0		1110	1.8
	--	--	5.0		0.10	51		1130	0.0
	--	--	8.0		0.10	51		200	82
Notes: -- No chemical added for the treatment.									
N/A Data is not available.									
The result is at or below the treatment goal.									

Table 2
Application Parameters - AECOM, Niagara Falls, New York

Sample	CaO (Quicklime) (% by weight)	Maximum Temperature ¹ (C°)	Strength ² (ton/ft² penetrometer)	Moisture ³ (% by weight)
P-20 (0'-1') - 071812 (ReSP Lab No. 2012 07 001)	0	24.0	<0.5	5.3
	7	N/A	N/A	5.1
	8	29.5	<0.5	N/A
P-16 (0'-1') - 071812 (ReSP Lab No. 2012 07 002)	0	24.1	<0.5	6.8
	7	N/A	N/A	6.2
	8	27.9	<0.5	N/A
P-18 (0'-1') - 071812 (ReSP Lab No. 2012 07 003)	0	23.7	<0.5	6.0
	7	N/A	N/A	5.4
	8	27.5	<0.5	N/A
P-11b (0'-1') - 071812 (ReSP Lab No. 2012 07 004)	0	23.4	<0.5	5.1
	7	N/A	N/A	4.5
	8	26.5	<0.5	N/A
<p>Notes:</p> <p>¹ Fifty grams of the untreated material was mixed with 8% by weight CaO and then mixed with 30% by weight deionized water. The temperature measured for the table above indicates the highest temperature reached within the first 30 minutes following the addition of water to the treated sample.</p> <p>² The samples from the maximum temperature test were allowed to rest for 24 hours in sealed containers. Then each sample was measured for strength using a pocket penetrometer. None of the samples had strength above 0.5 ton/ft². None of the untreated samples could support the weight of the penetrometer. However, all of the samples with 8% CaO could support the weight of the penetrometer.</p> <p>³ Each of the as-received samples were mixed with 7% by weight CaO and tested for moisture content.</p>				