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June 12, 2019

Mr. Tracy Smith, Project Manager
New York State Department of Environmental Conservation
Remedial Bureau D
625 Broadway – 12th Floor
Albany, New York 12233-7016

Re: Willis Avenue *In Situ* Solidification/Stabilization Treatability Study Work Plan
Consent Order #R7-0201-87-08 – Site #734026

Dear Mr. Smith:

Enclosed are the revised Willis Avenue *In Situ* Solidification/Stabilization Treatability Study Work Plan and the response to comments addressing the NYSDEC May 7, 2019 letter. These documents were prepared by OBG, part of Ramboll. Please contact Shane Blauvelt, P.E. at (315) 552-9749 (Shane.Blauvelt@parsons.com) if you have any questions or comments.

Sincerely,

Stephen J. Miller, P.E.
Syracuse Remediation Program Manager.

Attachments (2 copies, 1 CD)

Cc:		
	Robert Nunes	USEPA (2 CDs)
	Donald Hesler	NYSDEC (ec)
	Harry Warner	NYSDEC Region 7 (1 copy, 1 CD)
	Maureen Schuck	NYSDOH (ec)
	Mark Sergott	NYSDOH (1 copy, 1 CD)
	Brian D. Israel, Esq.	Arnold & Porter (CD)
	Argie Cirillo, Esq.	USEPA (ec)
	Margaret Sheen, Esq.	NYSDEC, Region 7 (ec)
	Joseph Heath, Esq.	(ec)
	Thane Joyal, Esq.	(1 copy, 1 CD)
	Jeanne Shenandoah	Onondaga Nation (1 copy)
	Hazel Powless	HETF (CD)
	Alma Lowry	(ec)
	Stephen Miller	Honeywell (ec)
	Brad Kubiak	OBG, Part of Ramboll (ec)
	Tony DiNardo	OBG, Part of Ramboll (ec)
	Tom Conklin	OBG, Part of Ramboll (ec)
	Christopher Calkins	OBG, Part of Ramboll (ec)

This document is provided on behalf of Honeywell International Inc. (Honeywell). Based on NYSDEC's review of the draft Willis Avenue Site *In Situ* Solidification Treatability Study Work Plan" (work plan) and the response to comments submitted in our letter dated April 25, 2019, enclosed are our responses to your letter dated May 7, 2019. These response to comments will be addressed in a revised work plan.

Comment/Response #5. The text has not been revised in accordance with the comment and response. Please revise accordingly.

Response. The reference has been corrected.

Comment/Response #11. The Health and Safety Plan was not included with the work plan. Please include this with the final work plan.

Response. The Health and Safety Plan was transmitted as hard-copy and electronic copy on CD due to email space constraints.

Pages 1 and 2, Section 1.2. In this section words such as "solidification" and "solidified" should be revised to include stabilization, which is part of the treatability study.

Response. References to "solidification" has been revised to indicate both "solidification" and "stabilization" treatment approaches will be assessed under this work plan. Accordingly, the study title has also been revised to reflect the added assessment of stabilization reagents.

Page 4, paragraph 5, Section 4. In this paragraph "of material" is repeated. Please revise.

Response. Repeated words have been removed.

Page 4, paragraph 6, Section 4. Please clarify and/or provide the rationale of "a small portion of Target Material" that discussed in this paragraph. Also, the second sentence should be revised by deleting "if recoverable." In addition, the concrete slab should be sampled for mercury.

Response. A portion of the former building slab is proposed for collection during test pitting and provided to Stablex for mercury analysis. Stablex requests approximately 1,000 grams of sample material for their testing purposes. The text has been revised to reflect this.

Page 4, paragraph 8, Section 4. In this paragraph please clarify if an additional Shelby tube will be collected or if the Shelby tube collected during the preliminary borings will be used.

Response. The Shelby tube collected during the preliminary borings will be used during the treatability study. A clarification has been added to the text.

Page 6, paragraph 1, Section 5.1. In the second sentence "coring" should be revised to "trenching."

Response. The reference has revised "coring" to "sample collection" to reflect both observations from both the coring and trenching activities.

Page 6, last paragraph, Section 5.2. The first sentence states nine initial stabilization mix compositions using three different reagents will be prepared. However, Table 5b includes four reagents and it is not clear how the mix compositions will be prepared. The text here and below Table 5b should be revised as necessary.

Response. A total of twelve stabilization mix compositions are proposed, three dosage levels from each of the four proposed reagents. The reference has been corrected in the first paragraph of Section 5.2 and the sentence immediately following Table 5b.

In addition, the second sentence states that each reagent will be prepared at three different addition rates. This is correct for solidification but not for stabilization based on tables 5a and 5b. Please revise as necessary.

Response. Each stabilization reagent is proposed to be mixed at three separate dosages similar to the solidification reagents. However, unlike solidification reagents, stabilization reagent dosages are

selected based on baseline material concentrations and must consider both the demand to convert the mercury and native demand of other constituents in the soil/fill that may also react. Dosage rates for Table 5b will be identified based on Phase I results. NYSDEC will be advised of the stabilization dosage rates selected prior to the preparation of Phase II mixes.

Page 8, paragraph 1, Section 5.2. The rationale for selecting the preferred solidification and stabilization formulations should be discussed. In addition, the results of the mix formulations should also be discussed with NYSDEC prior to selection for analyses. Please revise.

Response. A discussion has been added as requested.

Page 8, Table 7a. In the note for this table, please clarify the basis for omission of the LEAF evaluation.

Response. LEAF testing may be omitted should the results from Phase I and/or II provide appropriate data for decision making without LEAF test results. NYSDEC will be consulted for approval should omission of LEAF testing be found to be appropriate.

Page 9, paragraph 2, Section 6.1. The first three sentences are not relevant for the proposed trenching work. Procedures for addressing material generated by the trenching will need to be discussed. This should include the potential to collect mercury (e.g., with a high efficiency particulate air [HEPA] vacuum) that may collect on the plastic where any excavated material is stored during trenching or in shallow (less than two feet) trenches. Determination of mercury that should be collected would be performed in the field based on discussions between NYSDEC, Honeywell and OBG.

Response. Revised to reflect test pitting/trenching. Elemental mercury observed to express from the staged soil/fill materials and form into recoverable pools will be collected to the extent practicable rather than returned to the excavation when trench spoils are placed as backfill. Mercury recovery will primarily be through manual means (e.g. shovels, scoops, syringes, vacuums, etc). Similar attempts will be made to recover elemental mercury observed pooled in shallow test pits/trenches less than 24-inches in depth from grade where access to such a test pit/trench is allowable by health and safety requirements. Collected material will be placed in an appropriate container and stored in a secure area of the site until such time as appropriate handling and/or disposal is identified. Determination of mercury that should be collected will be based on field discussions between NYSDEC, Honeywell and OBG.

Page 9, paragraph 4, Section 6.2. In the first sentence "drill rig" should be revised to "excavator."

Response. Revised.

Page 10, Section 8. Preliminary information regarding the off-site disposal evaluation should be submitted to NYSDEC when it is available.

Response. Evaluations of the site materials sent to Stablex will be forwarded to NYSDEC when they become available in addition to their inclusion in the study report. Language has been added to Section 5.1 to reflect this.

REVISED WORK PLAN

Willis Avenue *In Situ* Solidification/Stabilization Treatability Study

Honeywell

June 2019

OBG
Part of Ramboll

TABLE OF CONTENTS

LIST OF TABLES (IN TEXT)

LIST OF FIGURES

1. INTRODUCTION

This document presents a Treatability Study Work Plan (TSWP) to evaluate *in situ* solidification/stabilization (ISS) and the potential for off-site disposal of elemental mercury-impacted soil/fill material currently located in the vicinity of the Former Mercury Cell Building Area at the Willis Avenue site (Site). The Site is located in Geddes, New York. A Site Location Map is included as attached **Figure 1** and the Former Mercury Cell Building Area is depicted on **Figure 2**.

A Feasibility Study (FS) for the Site is being conducted pursuant to the Administrative Consent Order (ACO) (R7-0201-87-08) between the New York State Department of Environmental Conservation (NYSDEC) and Honeywell dated August 21, 1990 (NYSDEC 1990). The FS Report (O'Brien & Gere Engineers, Inc. [OBG], 2018) documents the development and evaluation of remedial alternatives such that a final remedy may be selected to address Site soil/fill material and groundwater.

The FS Report includes an ISS process option to address elemental mercury-impacted soil/fill material at the Former Mercury Cell Building. The process option would involve the mixing or injection of treatment reagents to immobilize elemental and oxidized mercury in soil/fill material and form a highly insoluble monolith. Solidification, in particular, is used to increase the treated material's strength, reduce its permeability, and physically immobilize hazardous constituents within it.

1.1 NATURE AND EXTENT OF TARGET SOIL/FILL MATERIAL

The main concern to be addressed by this TSWP is elemental mercury-impacted soil/fill materials in the subsurface at the Former Mercury Cell Building area. The elemental mercury observed is present as residual droplets. The estimated areal extent of soil containing elemental mercury is believed to be confined to the vicinity of the Former Mercury Cell Building, an area of approximately 5,500 square feet (sq ft). Elemental mercury was observed at a maximum depth below grade of approximately 32 ft in this area during the subsurface boring investigation, completed in 1997 and discussed in the *Revised RI Report* (OBG, 2014). The vertical extent of elemental mercury is understood to be confined to the upper unconsolidated geologic units (fill, peat and marl), does not extend to the till unit, and is underlain by a low permeability silt and clay unit acting as a vertical confining layer. Such residual droplets were previously demonstrated to be laterally immobile. The *Revised RI Report* (OBG, 2014) presented calculations based on United States Environmental Protection Agency's (USEPA's) *Methods for the Determination of Inorganic Substances in Environmental Samples* (USEPA 1993) relating to mobility of elemental mercury in the subsurface. These calculations indicated that based on the Site-specific horizontal gradient, even if elemental mercury were present as a pool it would not be expected to be laterally mobile. The mobility of droplets of elemental mercury, as has been observed at the Site, is significantly less than for a pool.

The estimated *in situ* treatment volume for target soil/fill material proposed in the FS Report includes approximately 2,200 cubic yards (cy) from 0 to 15 ft below ground surface (bgs), and an additional 1,800 cy from 15 to 32 ft bgs.

1.2 TREATABILITY STUDY SCOPE EVALUATION AND DEVELOPMENT

The FS Report identified mixing or injecting treatment reagents to immobilize elemental mercury as a representative process option to address elemental mercury in the target soil/fill, comprising the surface soils, subsurface soil/fill material, and soil/fill material below the water table. This TSWP proposes to evaluate solidification of these soil/fill materials with the intent to form a low permeability monolith as a means of isolating elemental mercury present from the surrounding shallow/intermediate groundwater. Once created, it is estimated that the solidified materials will exhibit significantly lower permeability than the surrounding soils, resulting in groundwater movement around rather than through the treated soil/fill material. Stabilization of the materials will also be evaluated to assess potential for chemical fixation of mercury, as a metal sulfide, for example. The overall intent of the study will be to identify methods for immobilization (i.e. physically and/or chemically) in order to minimize potential for dissolution of mercury into groundwater.

Additionally, the shallow/intermediate groundwater at the site will continue to be collected in the existing downgradient collection trench and treated in the existing onsite groundwater treatment facility. These site features are shown on **Figure 2**. Groundwater that does contact the treated soil/fill materials will be collected and treated. This combination of solidification of target soil/fill material and continued collection of groundwater would be expected to achieve the Remedial Action Objectives (RAOs) for protection of Public Health and the Environment reflected in the FS Report.

2. PROJECT TEAM

The following OBG project team will manage and implement this TSWP:

- Christopher Calkins – Program Manager
- Brad Kubiak – Project Manager
- Tim Olean – ISS Subject Matter Expert
- Jim Fenstermacher – Senior Technical Reviewer
- Trevor Staniec – Treatability Study Manager
- Nicole Carfi - Treatability Study Support
- Rob Trent – Sample Collection Field Manager
- Charles Sharpe – Laboratory Coordinator

It is anticipated that the following laboratories and technology vendors will be subcontracted to perform the scope presented herein:

- Baseline and post-treatment: Chemical and leachate analyses by a Honeywell contract laboratory (to be determined)
- Bench-scale treatability study and mix design evaluation by Kemron Environmental Services, Inc. (Kemron) in Atlanta, Georgia.

3. OBJECTIVE/APPROACH

This treatability study is designed to evaluate the effectiveness of ISS for isolating elemental mercury from groundwater. Various mixture designs/dosages (admixtures) will be evaluated by ISS on Site soil/fill materials impacted with elemental mercury for their effectiveness related to increasing compressive strength and decreasing permeability of the treated soil/fill material as compared to the untreated materials. This study will also evaluate, as secondary performance considerations: the leachability of elemental mercury from the target soil/fill material in both treated and untreated forms, and the volumetric expansion that would occur if ISS is implemented. Material will also be provided to an appropriate disposal facility for independent assessment of the suitability of off-site disposal should a portion of the soil/fill materials be considered for removal from the site.

3.1 GENERAL STUDY PLAN

This ISS Treatability Study is proposed to be completed in the following sequential phases:

- Target soil/fill material collection. (**Section 4**)
- Phase 1. Baseline chemical and physical characteristics of the untreated target soil/fill material (**Section 5**)
- Phase 2. Mix Design preparation and assessment of chemical and physical characteristics of treated target soil/fill material (**Section 5**)
- Phase 3. Selection and repeatability assessment of preferred mix design (**Section 5**).

Due to the presence of elemental mercury and other potential Site contaminants of concern (COCs) in the soil/fill materials, samples and reagents will be handled with the appropriate safety and material management precautions throughout the duration of the study. Waste management procedures are detailed in **Section 6,** and health and safety is described in **Section 7**.

Reporting is described in **Section 8.** The overall sequence, schedule, and points at which decisions will be required is presented in **Section 9**.

3.2 PERFORMANCE PARAMETERS

The goal of this treatability study is to evaluate ISS based on the following parameters using the listed analytical methods:

- Increase in compressive strength per American Society for Testing and Materials (ASTM) D2166 and reduction in permeability per ASTM D5084 due to ISS treatments over baseline samples,
  - Tests for these parameters will be performed on baseline and treated soil/fill materials in accordance with established ASTM methods. The results (physical properties) of each treated test cylinder will be compared to the baseline materials.
    - A laboratory derived Unconfined Compressive Strength (UCS) of at least 50 psi will be utilized for assessing solidified materials during mix-design evaluation and reporting.
- Evaluation of effect on mercury leachability due to treatment.
  - Leachability testing by the Synthetic Precipitation Leaching Procedure (SPLP) method for total mercury will be performed by the Honeywell-Contract laboratory per USEPA Methods 1312/7470, on baseline and treated soil/fill materials.
  - Results of treated soil/fill materials will be compared to baseline concentrations to evaluate if mix designs result in an increase, decrease or no net effect on soil/fill materials leachability. It should be noted that the sample preparation procedures of USEPA Method 1312 are anticipated to require destruction of the solidified mass to adhere to the methodology, thereby increasing overall permeability of the solidified soil/fill material sample. Preparation in this manner is anticipated to overestimate leachability potential of the treated materials and is not expected to be reflective of the conditions affecting actual leachability of the *in situ* solidified target material. For the purposes of this study, SPLP results are intended only for comparative purposes to baseline results prepared by the same methodology
  - Leachability Tests on the selected solidification mix design with and without the addition of stabilization reagents by USEPA Method 1315, one of the four types of the USEPA Leach Environmental Assessment Framework (LEAF) Tests available, will be performed by Honeywell-Contract laboratory. Unlike SPLP, this method is non-destructive to the test sample, making it appropriate for evaluating the release rate of inorganic analytes contained in a monolithic or compacted granular material and is more suitable for assessing performance of the treated material *in situ*.
- Degree of volumetric expansion from baseline volume.
- Non-target material geophysical parameters to assess design mix for other material types potentially encountered within the proposed mix area to include percent moisture, particle size distribution, and bulk density in accordance with appropriate ASTM methods.

3.3 REAGENTS

Type I Portland cement, bentonite, and ground-granulated blast furnace slag (GGBS) are the reagents selected for this study, and will be combined at different ratios as presented in Section 5.2 below.

4. SAMPLE COLLECTION

Preliminary borings, completed in March 2019, indicate considerable sub-surface obstructions, believed to be associated with the presence of the former Mercury Cell Building slab and miscellaneous debris historically used as fill. As such, geotechnical boring is not viewed as an effective method for collection of the volume of soil/fill material targeted for this study. However, a Shelby tube was successfully collected during the completion of preliminary borings for use in baseline characterization of materials (Phase I).

Soil/fill targeted for the treatability study will be recovered by excavator through test pitting/trenching. General alignments of the location of text pits are shown on **Figure 3**. The areas near MC-B18/MC-B20 and MC-B4A will be targeted as the primary locations for collection of the soil/fill, however, the exact locations may occur along the alignments shown, as needed, to locate sufficient volume and appropriate areas to penetrate the former slab. These preliminary locations were selected based on observations of the existence of soil/fill that likely contain visible elemental mercury, as noted in both historical and March 2019 boring logs.

Generally, an excavator will be used to remove soil/fill without visual indication of the presence of elemental mercury; preliminary borings indicate this material may be present in thicknesses ranging to approximately 4 feet to 8 feet bgs. This material will be staged in a lined area at grade adjacent to the excavation. Subsurface slabs, if encountered, will be broken up to allow for access to soil/fill beneath. It is anticipated that mercury-impacted soil/fill material will be encountered within the vertical interval between approximately 6 and 12 ft bgs, and it is from this interval that samples will ultimately be recovered for use in this study.

The OBG representative will visually inspect the retrieved soil/fill materials for intervals exhibiting elemental mercury. Collected material will be screened using a photoionization detector (PID) to evaluate the presence of potential volatile organic compounds (VOCs) and a Jerome® Mercury Vapor Analyzer (Jerome Analyzer) for mercury vapor in air. The Jerome Analyzer will be utilized both for health and safety purposes and evaluation of soil intervals potentially exhibiting elemental mercury; the PID will be utilized solely for health and safety purposes. Test pits spoils will be used as backfill to the extent practicable and the general area will be restored with a layer of clean crushed stone.

Target Soil/Fill Material. Soil/fill materials containing elemental mercury evidenced by visual observation or Jerome Analyzer screening data, and up to 1-ft of material adjacent to where elemental mercury is observed, will be selected as Target Material for this study. Target soil/fill material collected will be placed into sealable plastic buckets. An estimated 95 pounds of target material (approximately 10 gallons of bulk soil/fill material) will be required for treatability testing.

Off-Site Disposal Target Soil/Fill Material. A small portion of Target Material (approximately 1,000 grams) will be sub-sampled for off-site disposal evaluation by Stablex. A portion of concrete slab will also be retained if recoverable.

Non-Target Soil/Fill Material. Soil/fill materials not identified as Target Material for the treatability study will be collected for geotechnical analysis to document the variety of soil/fill material conditions observed within the target solidification area. Up to five samples have been assumed; actual number of samples collected will be based on field observations of the material recovered. A composite sample of this material will also be provided to Stablex.

Target and Non-Target Soil/Fill sample material and Shelby tube sample (collected during preliminary borings) will be sealed and shipped by courier to Kemron under chain-of-custody.

Subsampled Target Soil/Fill Material, non-target material, and concrete will be shipped directly to the Stablex facility or affiliated laboratory by courier under chain-of-custody, or relinquished to a Stablex representative directly on-site.

5. *IN SITU* SOLIDIFICATION TESTING AND ASSESSMENT

5.1 PHASE 1 - UNTREATED SOIL/FILL MATERIALS BASELINE CHARACTERIZATION

Once received, Kemron will log and photograph the samples, notify OBG of sample conditions, and advise of any sample concerns prior to proceeding with the remaining scope of work.

A solid sample will be extracted from the undisturbed Shelby Tube soil core and tested in-house by Kemron for the following parameters:

Table 1. Untreated Material Characterization by Kemron

Parameter	Method	No. of Samples
Unconfined Compressive Strength (UCS)	ASTM D2166	1
Permeability	ASTM D5084	1
Particle size distribution	ASTM 422	1

Bulk soil/fill material will be homogenized by Kemron. This homogenized material will be the 'base material' from which the samples detailed for the remainder of treatability mixes are prepared. Untreated base material samples will be collected by Kemron laboratory staff and sent to the Honeywell contract laboratory for analysis (turnaround time for contract lab is noted) by the methods listed below, or tested in-house by Kemron per these ASTM methods:

Table 2a. Untreated Material Chemical Characterization by Honeywell Contract Laboratory

Analysis	Method	No. of Samples
Total TAL Metals	EPA Method 6010/7471	1
SPLP Total Hg	EPA Method 1312/7470	1 (leachate from soil/fill)
PCB	EPA Method 8082	1
Total Organic Carbon	Lloyd Kahn Method	1
ORP	ASTM G200	1
Material pH	EPA Method 9045	1

Table 2b. Untreated Material Physical Characterization by Kemron

Analysis	Method	No. of Samples
Moisture content	ASTM D2216	1
Particle size distribution	ASTM 422	1
Bulk density	ASTM 5057	1
Loss on ignition	ASTM 2974	1

Additionally, Kemron personnel will extract a small volume (approximately 1,000 to 1,500 grams) of material from the bulk material into a sealable plastic bag for headspace gas measurements using a PID, Jerome® Mercury Vapor Analyzer, and hydrogen sulfide (H2S) gas meter.

All other samples submitted for physical characteristics will be segregated from the bulk material sample. The number of samples submitted will vary based on the number of different soil/fill material types observed by field personnel during sample collection (Section 4). It is assumed that up to five non-target material samples will be submitted for the following ASTM methods:

Table 3. Non-target Materials Physical Characterization by Kemron

Analysis	Method	No. of Samples
Moisture content	ASTM D2216	5
Particle size distribution	ASTM 422	5
Bulk density	ASTM 5057	5

Stablex will be responsible for preparation, treatment, and/or analyses of all off-site disposal evaluation samples. It is understood that Stablex will conduct the following scope of analysis at their on-site lab in order to evaluate off-site disposal potential:

Table 4. Untreated Material Chemical Characterization by Potential Disposal Facility

Analysis	Method	No. of Samples
Total Hg	EPA Method 7471	3
SPLP Total Hg	EPA Method 1312/7470	3 (leachate from soil/fill)
Material pH	EPA Method 9045	3
Total VOCs	EPA Method 8260	3
Total Pesticides	EPA Methods 8081/8141/8151	3
Total TAL Metals	EPA Method 6010	4
TCLP Metals	EPA Methods 1311/6010/7471	3 (leachate from soil/fill)
Leachable[1] TAL Metals	Alkaline Leachate/EPA Method 6010	3 (leachate from soil/fill)
Ignitable, Oxidizing, Combustible	EPA Methods 1030, 1040, 1050	3
Ammonia (%)	SM20 4500 NH3-G/350.1	3
Leachable TOC[1]	Alkaline Leachate /USEPA Method 9060	3 (leachate from soil/fill)
Leachable Phenol[1]	Alkaline Leachate/EPA Method 420.4	3 (leachate from soil/fill)
Oil and Grease		3

[1] A modified leaching procedure is to be used as follows: 1 part soil/fill: 20 parts pH > 12 water, stir 30 mins and filter.

Stablex will provide documentation of their evaluation regarding off-site disposal viability to OBG when complete. These data will be forwarded to NYSDEC when they become available.

5.2 PHASE 2 – MIX DESIGN PREPARATION AND ASSESSMENT

Kemron will prepare twelve initial stabilization mix compositions using four different reagents and twelve initial solidification mix compositions using four different reagent mixtures. Each reagent will be prepared at three different addition rates on a basis of reagent to untreated base material by weight for solidification reagents and a basis of reagent to baseline concentrations for stabilization reagents. The dry reagents will be mixed with water to create a pumpable slurry in ratios noted in **Tables 5a** and **5b**; liquid reagents may be diluted with water for workability purposes. **Table 5a** and the text following summarize the proposed test mixtures and procedures to evaluate solidification; **Table 5b** and the text following summarize the evaluation of potential chemical stabilization recipes.

Table 5a. Solidification Design Mix Preparation

Identification No.	Mix Formulation	Water to Total Reagent Ratio (by weight)	% Addition (by weight of untreated soil)
1	Type I Portland Cement (PC)	0:5:1 – 1.5:1	10,15,20
2	PC + 2% bentonite	0:5:1 – 1.5:1	10,15,20
3	60/40 Mix of PC/Ground-granulated blast furnace slag (GGBS)	0:5:1 – 1.5:1	10,15,20
4	60/40 Mix of PC/GGBS + 2% bentonite	0:5 :1 – 1.5:1	10,15,20

Each of the twelve solidification mix formulations will be executed and tested in the following sequence:

- Extraction of a small volume (approximately 1,000 to 1,500 grams) of base material into a table-top bowl. Weight will also be measured to prepare a reagent mix.
- Mix reagent with water in separate container to prepare a water to reagent slurry at the applicable ratio in **Table 5a** for the % Addition of reagent.
- Mixing of the reagent slurry and material will occur in a pulsed fashion with a mechanical paddle mixer (Hobart mixer or equivalent), until all reagent is mixed thoroughly, no unmixed soil or clumps are visible, and only as long as it takes to fully incorporate the reagent slurry.
- Mixed formulation material will be placed in circular molds to cure for UCS (2-inch diameter) and permeability (3-inch diameter) measurements once cured, and the remainder will be allowed to cure in an appropriate container.
- Specimen observations of penetration resistance will be recorded using a pocket penetrometer at 1-, 3-, and 5-day intervals. This test will be performed on the mixture in containers.
- After 28 days of curing, the treated composition will be characterized for UCS and permeability as follows:
  - UCS by ASTM D2166 in-house by the treatability laboratory (Kemron)
  - Permeability by ASTM D5084 in-house by the treatability laboratory (Kemron)
- Volume expansion will be calculated mathematically based on mold specimen weight (for the known mold volume) as compared to the baseline material bulk density observed by ASTM methodology.

Table 5b. Stabilization Design Mix Preparation

Identification No.	Mix Formulation	Water to Total Reagent Ratio (by weight)	% Addition (by weight of untreated soil)
1	Na_2S:S	0:5:1 – 1:1	Dosages (3 per Reagent) dependent on Baseline Hg Concentration
2	Calcium polysulfide (liquid)	--	
3	FerroBlack®-H (liquid)	--	
4	Sodium Thiosulfate	0:5:1 – 1:1	

Each of the twelve stabilization mix formulations will be executed and tested in the following sequence:

1. Select three reagent dosage levels for each test reagent based on Baseline mercury concentration (Phase 1). Liquid reagents may be diluted with water as necessary for workability at the intended dosage.
2. Extraction of a small volume (approximately 1,000 to 1,500 grams) of material from the bulk material into a table-top bowl.

3. Mix/Dilute stabilization reagent with water in separate container to meet water to reagent ratio in **Table 5b** or as necessary to achieve the desired reagent mix dosage level.
4. Mixing of the reagent and material will occur in a pulsed fashion with a mechanical paddle mixer (Hobart mixer, or equivalent), until all reagent is mixed thoroughly and no unmixed soil or clumps are visible.
5. The reagent/material mixture will be extracted from the bowl and placed in temporary plastic disposable storage containers and sealable plastic bags, for periodic specimen observation at ambient temperature for one day.
6. Headspace gas measurements from the mixtures in plastic bags will be recorded using the meters in Phase 1.

The results of each mix formulation will be discussed with OBG and four preferred solidification formulations and four preferred stabilization formulations will be selected for submission to the Honeywell-Contract Laboratory for the analyses presented in **Table 6**. Preferred mixes will be selected based on observations by Kemron regarding overall mix workability, gas generation and indicators of curing (penetration resistance, solidification only); where two or more doses of the same mix formulation are deemed favorable, the lower reagent dose will be selected as "preferred". The rationale for selecting the preferred mix designs will be shared with NYSDEC prior to submission of samples for analysis. Kemron will collect samples from the formulation containers and seal/ship them by courier to the Honeywell contract laboratory under chain-of-custody.

Table 6. Preferred Mix Design Evaluation by Honeywell Contract Laboratory

Analysis	Method	No. of Samples
Total Mercury	EPA Method 6010/7471	8
SPLP Mercury	EPA Method 6010/7470/1312	8 (leachate from soil)
Material pH	EPA Method 9045	8

OBG will evaluate the results and identify a mix design(s) for repeatability in Phase 3 based on the performance parameters described in **Section 3.** Mix designs will primarily compare SPLP leachate concentration of the amended mixes with the results from baseline testing in Phase I; solidified mixes will also compare strength and permeability results to baseline sample data. Mix design selection for repeatability will be discussed with NYSDEC prior to starting Phase 3.

5.3 PHASE 3 –SELECTION AND REPEATABILITY ASSESSMENT

Based on Phase 2 data, two selected mix types will be subjected to repeatability and comparison. One mix will comprise the preferred solidification reagent, and one mix will comprise the preferred solidification reagent amended with a stabilization reagent that does not exhibit interferences.

Three new treated soil/fill samples will be prepared from the base material utilizing each of the two selected mix types for a total of 6 individual sample batches. The base material will be re-homogenized prior to extraction of material. The mixture will be developed according to the steps in Phase 2, allowed to cure for 28-days and sent to the Honeywell contract laboratory for analysis or tested in-house by Kemron per these methods listed below:

Table 7a. Confirmation and Repeatability Assessment by Honeywell Contract Laboratory

Analysis	Method	No. of Samples
Total Mercury	EPA Method 6010/7471	6
SPLP Mercury	EPA Method 6010/7470/1312	6 (leachate from soil)
LEAF Leaching Evaluation	USEPA Method 1315/7470	6

Note: LEAF evaluation may be omitted pending SPLP analysis results in Phase II in consultation with NYSDEC.

Table 7b. Confirmation and Repeatability Assessment by Kemron

Analysis	Method	No. of Samples
Unconfined Compressive Strength (UCS)	ASTM D2166	6
Permeability	ASTM D5084	6

6. HANDLING OF TREATABILITY STUDY-DERIVED WASTES

The following sections describe how the different investigative-derived wastes (IDW) will be handled.

6.1 FIELD-DERIVED WASTE MANAGEMENT

Water reduction procedures, including use of a steam cleaner, will be implemented to reduce the volume of water generated. The water generated (estimated at 20 to 30 gallons) will be containerized in a polyethylene cage tank supplied by the driller for disposal at the Willis Ave Treatment Plant.

In the event that off-site management of water is necessary, one liquid sample would be collected for waste characterization purposes. A sample of generated investigation-derived fluids will be collected by immersing a new, laboratory-cleaned glass container or disposable bailer into the tank and subsequently filling the appropriate laboratory containers. The sample(s) will be analyzed for total VOCs, SVOCs, metals, and mercury by Methods 8260, 8270, 6010B, and 7470A, respectively.

Elemental mercury observed to express from the staged soil/fill materials and form into recoverable pools will be collected to the extent practicable rather than returned to the excavation when trench spoils are placed as backfill. Mercury recovery will primarily be through manual means (e.g. shovels, scoops, syringes, vacuums, etc). Similar attempts will be made to recover elemental mercury observed pooled in shallow test pits/trenches less than 24-inches in depth from grade where access to such a test pit/trench is allowable by health and safety requirements. Collected material will be placed in an appropriate container and stored in a secure area of the site until such time as appropriate handling and/or disposal is identified. Determination of mercury that should be collected will be based on field discussions between NYSDEC, Honeywell and OBG.

6.2 DECONTAMINATION

Non-disposable sampling equipment, as well as other equipment, (*e.g.*, excavators, hand tools, etc), will be decontaminated prior to initiating sampling events, between sample locations, subsequent to completion of sampling events, and prior to leaving the Site in accordance with the procedures set forth in the *Quality Assurance Project Plan Honeywell Syracuse Site Investigations* (QAPP) (OBG, 2011)

6.3 LABORATORY-DERIVED WASTE MANAGEMENT

The Honeywell contract laboratory will dispose of the tested and unused soil/fill sample material through standard laboratory disposal processes. Kemron will return soil/fill material, both treated and all remaining base material not submitted to the analytical laboratory, to the Site for management under the future remedial action.

7. HEALTH AND SAFETY

Fieldwork for this TSWP will be implemented in accordance with the Willis Avenue Site Health and Safety Plan (OBG, 2019) and a specific Job Safety Analysis (JSA) for this work scope. The subcontracted drillers and laboratories will operate under their health and safety plan(s). Known hazard information regarding the Site soil/fill material will be transmitted to the vendors prior to the study.

8. TREATABILITY STUDY REPORT

Upon completion of the treatability study, Kemron will provide a technical report on the procedures and results of the work to OBG. OBG will prepare a comprehensive Treatability Study report with the Kemron study as an attachment for submittal to NYSDEC.

The report will include:

- Summary of the sample collection activities performed
- Summary of the treatability activities performed
- Description of any deviations from this work plan
- Summary of analytical results
- Executed mix formulations for each testing phase
- Discussion of periodic specimen observations during curing
- Physical characterization evaluation of the untreated and post-treated soil/fill material
- Evaluation of leach testing results
- Reporting of off-site disposal site evaluation
- Summary of major findings

The report appendices and exhibits will include:

- Sample collection logs and field notes
- ISS report by Kemron
- Documentation of findings provided by off-site disposal site
- Raw laboratory data
- Backup calculations.

9. TREATABILITY STUDY SCHEDULE

A schedule for the implementation of this Work Plan and reporting is as follows:

- Sample Collection – 1 week
- Initial Characterization – 2 weeks
- ISS Treatability Study – 5 months
- Reports from vendors – 2 weeks from receipt of final phase of test results
- Final Treatability Study Report – 4 weeks from receipt of Vendor Report.

The scope of work is projected to take a total of 7-8 months to complete.

REFERENCES

National Center for Biotechnology Information 2018. PubChem Compound Database; CID=237873, https://pubchem.ncbi.nlm.nih.gov/compound/237873 (accessed June 27, 2018)

NYSDEC 1992. IRM Consent Order between Honeywell and NYSDEC (NYSDEC 1992)

NYSDEC 1990. Administrative Consent Order (ACO) (R7-0201-87-08) between the New York State Department of Environmental Conservation (NYSDEC) and Honeywell dated August 21, 1990 (NYSDEC 1990)

OBG. 2018. *Willis Avenue Site Feasibility Study Report* (OBG, 2018)

OBG. 2014. *Willis Avenue Chlorobenzene Site Remedial Investigation* Report (OBG, 2014)

OBG. 2011. *Honeywell Syracuse Site Investigations. Quality Assurance Project Plan. Camillus, Geddes, and Syracuse, New York.* (OBG, 2011)

OBG 2019. *Willis Avenue Site Health and Safety Plan (HASP)* (OBG, 2019)

USEPA. 1993. USEPA's *Methods for the Determination of Inorganic Substances in Environmental Samples* (USEPA 1993)

Figures

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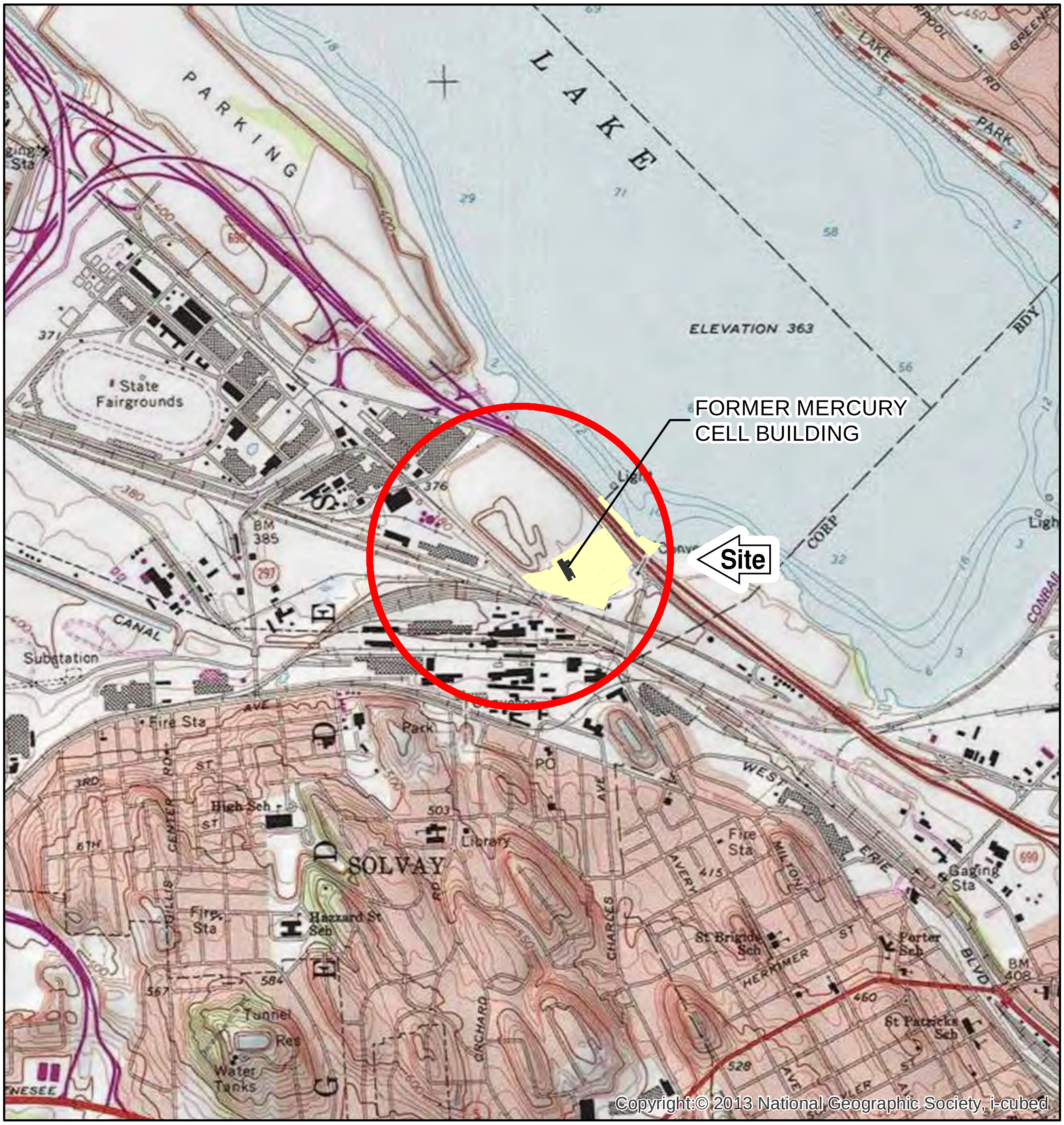
FIGURE 1



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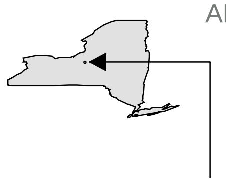

MAP LOCATION

WILLIS AVENUE SITE
TREATABILITY STUDY WORK PLAN
GEDDES, NEW YORK

N

LEGEND

WILLIS PLANT AREA

FORMER MERCURY CELL BUILDING

SITE LOCATION

0 1,000 2,000 4,000
Feet

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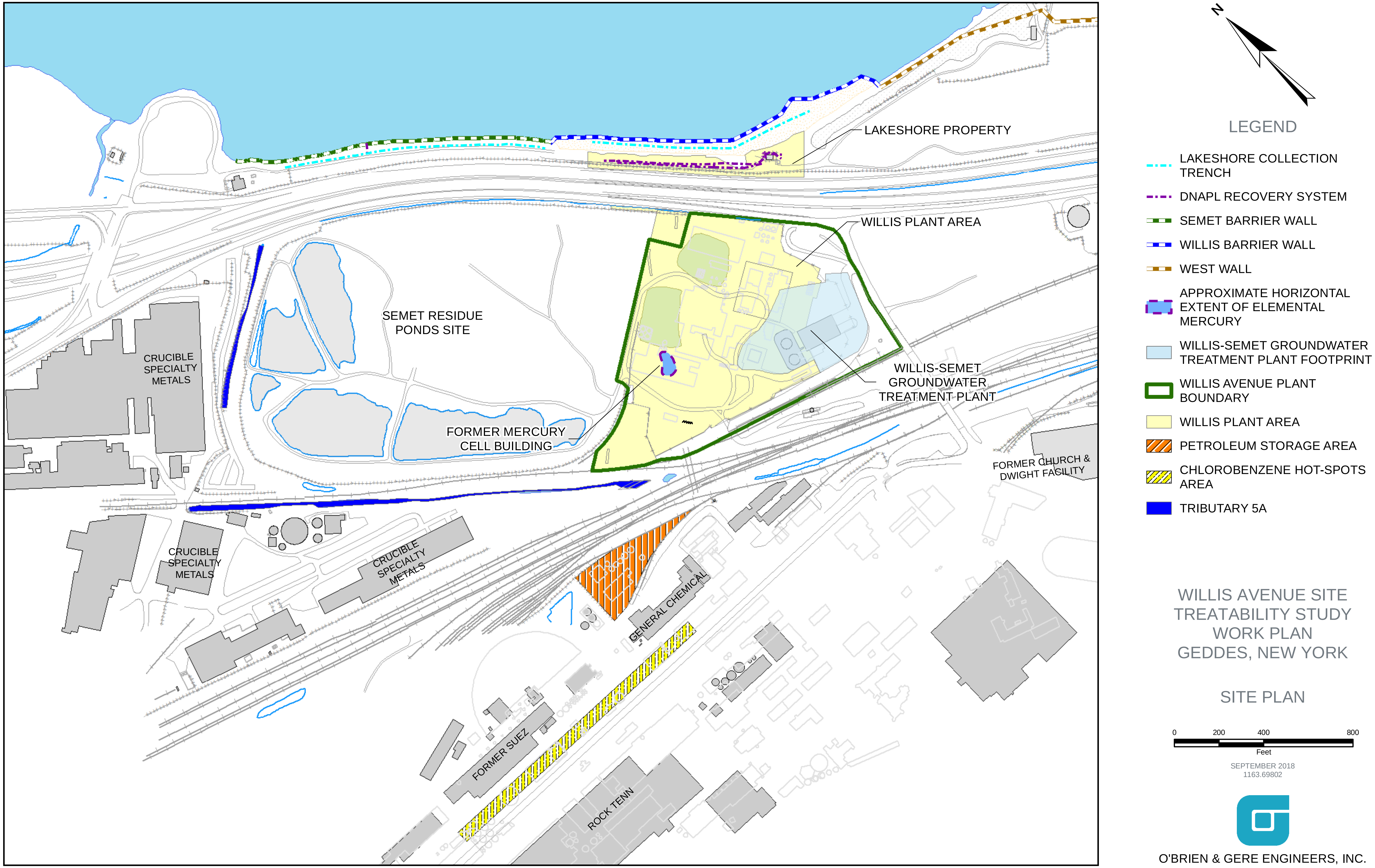

WILLIS AVENUE SITE
TREATABILITY STUDY
WORK PLAN
GEDDES, NEW YORK

SITE PLAN

SEPTEMBER 2018
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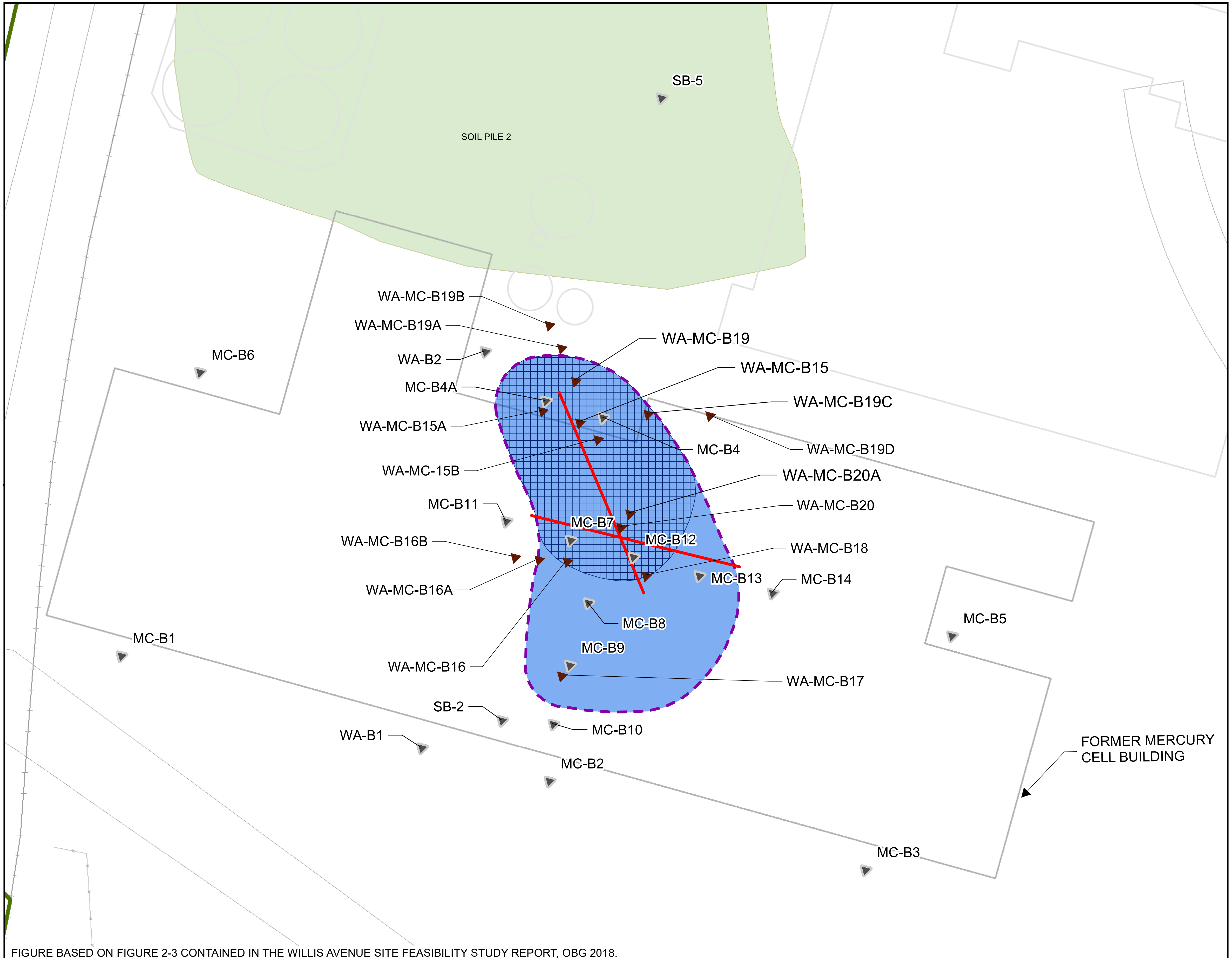

FIGURE BASED ON FIGURE 2-3 CONTAINED IN THE WILLIS AVENUE SITE FEASIBILITY STUDY REPORT, OBG 2018.

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LEGEND

- PROPOSED TEST PIT / TRENCH ALIGNMENT
- 2019 ISS BORINGS
- HISTORIC SOIL BORING
- APPROXIMATE HORIZONTAL EXTENT OF ELEMENTAL MERCURY
- ELEMENTAL MERCURY PRESENT 0-15 FT (~2,650 SF)
- ELEMENTAL MERCURY PRESENT 0-32 FT (~2,850 SF)
- BUILDING SLAB
- WILLIS AVENUE PLANT BOUNDARY

WILLIS AVENUE SITE
TREATABILITY STUDY
WORK PLAN
GEDDES, NEW YORK

WILLIS PLANT AREA
HORIZONTAL EXTENT
OF ELEMENTAL MERCURY

0 15 30 60
Feet

MARCH 2019
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