UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND REGION
FIVE POST OFFICE SQUARE, SUITE 100, BOSTON, MA 02109

October 1, 2020

Bruce Thompson
de maximis, inc.
200 Day Hill Road, Suite 200
Windsor, CT 06095

Re: Approval of *Implementation Plans* for Remedial Design Work

Nuclear Metals, Inc. Superfund Site

Dear Mr. Thompson:

EPA, in consultation with the Massachusetts Department of Environmental Protection, has completed its review of the following *Implementation Plans* for Remedial Design activities at the Nuclear Metals Superfund Site:

- *Site-Wide Soils and Sediments Cooling Pond, Sphagnum Bog, Septic Field And Landfill Excavation Evaluations Implementation Plan (PDI SSS-4 and PDI HB-4)*, revised September 2020.
- *Site-Wide Soils and Sediments Depleted Uranium Penetrator Investigations Implementation Plan (PDI SSS-2)*, revised September 2020.
- *Site-Wide Soils and Sediments Soil and Sediment Sampling Implementation Plan (PDI SSS-1 and SSS-3)*, revised September 2020.
- *Holding Basin Investigations Drilling and Sampling Implementation Plan (PDI HB-1, HB-2, and SSS-5)*, revised September 2020.
- *Treatability Study Sample Collection and Holding Basin Geotechnical Boring Implementation Plan*, revised September 2020.
- *Implementation Plan for Drilling and Pump Testing in Bedrock*, dated August 2020.

EPA provided comments on these Implementation Plans in a letter dated September 7, 2020. EPA finds that all necessary revisions have been made, and therefore approves the Implementation Plans.

If there is any conflict between the Performance Standards as stated in the Implementation Plans and the Performance Standards as stated in the Consent Decree (CD) and statement of work (SOW), the CD and SOW shall control.

Please do not hesitate to contact me at (617) 918-1339 or at smith.christopher@epa.gov should you have any questions in this regard.

Sincerely,

Christopher Smith
Project Manager

Response To Comments

de maximis, inc.
200 Day Hill Road
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(860) 298-0541
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September 18, 2020

Mr. Christopher Smith
Remedial Project Manager
EPA Region 1
5 Post Office Square, Suite 100
Mail Code OSRR 07-4
Boston, MA 02109-3912

Subject: Nuclear Metals, Inc. Superfund Site, Concord, Massachusetts
Remedial Design Work Plan – Implementation Plans
Responses to Comments and Revised Implementation Plans

Dear Mr. Smith:

Enclosed for your review and approval are Responses to Comments (RTC) received from EPA on the Implementation Plans dated September 7, 2020.

Please let me know if you have any questions.

Sincerely,

Bruce Thompson

Attachment – Responses to Comments

cc: Garry Waldeck, MassDEP
Settling Defendants
Mark Kelley, PE, Haley & Aldrich, Inc.
Carl Elder, PE, Geosyntec Consultants

Responses to Comments on Implementation Plans dated September 7, 2020

Cooling Pond, Sphagnum Bog, Septic Field and Landfill Excavation Evaluations Implementation Plan

Section 2.1, Paragraph 2: Typo, change "determine" to "determined."

Section 2.2, Paragraph 2: Remove reference to the “Overall” drilling implementation plan.

Section 2.2. Paragraph 3: Update the dates of these RDWP documents to revised/approved dates.

Section 3.1, last Paragraph: Change "Up to 2 rounds" to "Up to 4 rounds" based on response to EPA's comment discussing capturing seasonable variability (Appendix A, comment 28)

Section 3.3, First Bullet: Correct typo "can be access safely."

Response: Comments have been addressed.

Depleted Uranium Penetrator Investigation

Overall: No specifics are provided on how the top 6 inches of soil will be scraped back. Additional details are needed (e.g., how will excavation be performed, will equipment not be allowed to travel over excavated sections, how will the depth of excavation be confirmed to be 6 inches, etc.)

Overall: By calculation, approximately 3,000 cubic yards of material will be excavated. No information is provided on how samples will be collected (frequency, composite of multiple points, etc.). Additionally, a plan is needed for if soils do not pass PRGs and are not suitable for use as backfill. For example, PAHs may exceed PRGs in areas of soil that are adjacent to asphalt parking areas and subject to runoff.

Response: Comments have been addressed.

Soil and Sediment Sampling Implementation Plan

Section 1: Update the dates of the RDWP documents to match revised/approved dates.

Section 2.2, Paragraph 2: Remove reference to “Overall” drilling implementation plan.

Section 4.2, Paragraph 2: Consistent with the response to EPA's comments on Appendix A of the RDWP, correct the depth intervals listed so that the missing depths are included (EPA Appendix A Comment #25).

Response: Comments have been addressed.

Holding Basin Investigations Drilling and Sampling Implementation Plan

Section 2.2, Paragraph 2: Update the dates of the RDWP documents to match revised/approved dates.

Response: Comments have been addressed.

Treatability Study Sample Collection and Holding Basin Geotechnical Boring Implementation Plan

The only mention of a how a drill rig would be mobilized into the Holding Basin is presented in Section 1.1, item 5.

The driller will mobilize the drilling rig into the HB via the ramp along the southeastern slope of the basin (or propose other means for approval). This ramp has historically been used to mobilize drilling equipment in and out of the basin, and it is expected that mats (ex. Mabey mats) will need to be placed to provide additional traction for the drilling rig and protect the liner along the ramp. If the driller determines that drilling equipment cannot be safely driven into the HB via the ramp, the project team will explore other means, such as using a crane to lift and place the drilling rig in the HB.

More detail appears to be needed, including but not limited to: an evaluation of whether of this “ramp” remains sufficient to mobilize equipment in and out of the basin, more detail regarding how equipment and personnel would actually move in and out of the basin during operations, and more specifics regarding how a crane would be used if necessary.

Response: Comments have been addressed.

Implementation Plan For Drilling and Pump Testing in Bedrock

No comments

Response: Noted.

Final Implementation Plans

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REPORT ON

RD PRE-DESIGN INVESTIGATIONS – NMI SITE
SITE-WIDE SOILS AND SEDIMENTS
COOLING POND, SPHAGNUM BOG, SEPTIC FIELD AND LANDFILL EXCAVATION EVALUATIONS IMPLEMENTATION PLAN (PDI SSS-4 AND PDI HB-4)
CONCORD, MASSACHUSETTS

by
Haley & Aldrich, Inc.
Boston, Massachusetts

for
de maximis, inc.

File No. 131884-003
September 2020

Table of Contents

1. Objectives and Scope

The Pre-Design Investigation (PDI) activity for site-wide soils and sediments (SSS) will investigate the characteristics of the Cooling Pond, the Sphagnum Bog, the Landfill, and the Gabion Wall. The results of PDI SSS-4 will be used to design the remedial excavations at each area. Sediment within the Cooling Pond and Bog are also being evaluated for geotechnical properties in order to conduct the appropriate slope stability analyses as outline in PDI HB-4.

The objectives for performing the testing described in this PDI are as follows:

- Assess the potential for and delineate the limits of buried debris within the remedial excavation areas at the Landfill and within the former septic fields.
- Evaluate the slope stability of several areas proposed for remedial excavation areas and of the Gabion Wall.
- Evaluate the groundwater-surface water interaction and groundwater-sediment relationship at the Cooling Pond.
- Characterize and inventory existing wetland conditions at the Sphagnum Bog and Cooling Pond.
- Complete six transects with up to three probes each within the Cooling Pond, and Five transects within the bog, and three transects down slope of Holding Basin and bog.

The results of these investigations will provide the data for PDI SSS-4 and PDI HB-4. The data and subsequent analysis will support the design of remedial excavations and inform the wetland restoration requirements following the remedial excavations.

The scope of work for this PDI includes a geophysical survey, collection of field data to support the slope stability analysis, and collection of field data on shallow geology along site slopes, sediment and groundwater chemistry at the Cooling Pond, and information on the inventory and limits of existing wetland conditions at the Cooling Pond and Sphagnum Bog.

2. General Procedures

The following procedures will be considered for all proposed sampling for PDI SSS-4, related to general access, processing and post-sampling activities.

2.1 ACCESS

PDI SSS-4 will be conducted within several site areas and AOIs, and across varying field conditions, some of which will be challenging to access. Conditions at sampling locations include the following: within sphagnum bog wetland areas, within wetlands with soft sediment present, or in standing water including ponds with deeper water present.

Prior to sampling, each proposed sampling location will be located using a hand-held GPS unit or by scaling off known existing features, and each location will be reviewed for access and general field condition considerations. Pre-decontaminated ("clean") or new sampling equipment, supplies, glassware, etc. will be mobilized to each AOI or sampling location, either carried by hand or transported using a wagon sled or using a field vehicle depending on accessibility. Routes to proposed sampling locations will be reviewed to follow general project guidelines related to different zones to be established at the site (eg. Contaminated Soil Zone, Contaminant Reduction Zone, etc.). Actual routes and paths through wooded areas will be determined to most safely access each sampling location, with the least disturbance to the surrounding area. Although some limited clearing has been conducted at the site, additional clearing of branches, brush, leaves, etc. may be necessary to access the locations and to create individual sampling areas may be necessary. Disturbance to surficial soils will be limited.

If there are sensitive areas where less surficial soil disturbance will be necessary due to the nature of contamination in the area (e.g. sphagnum bog), access and other general procedures may be adjusted per location specific conditions and requirements.

2.2 SAMPLE PROCESSING

At each land-based soil sample location, polyethylene sheeting will be placed to create a small, dedicated area to temporarily stage sampling equipment and supplies, and to process the soil samples. For sediment samples collected in wet areas (within or adjacent to wetlands, or in pond), sediment samples are anticipated to be collected at the sample locations, then transported to a safe location at a dry area for processing. For groundwater or surface water sampling from piezometers installed where water or soft sediment is present at the surface, equipment may be transported and staged on a floating sled or bin. If piezometers are located where enough standing water is present which prevent safe access by foot, a boat may be used to access piezometer locations and to collect/process samples.

Details related to soil borings (if required) are discussed in the Drilling Implementation Plan, separate from this Implementation Plan. Small sample processing areas will be constructed at each drilling/sampling location to process soil samples collected by the drilling rigs.

Refer to the applicable project-Field Sampling Plan (FSP) (Appendix I of the Remedial Design Work Plan, *de maximis,* September 2020), the Standard Operating Procedures (SOPs) located as Appendix I 1 of the FSP , and Quality Assurance Project Plan (QAPP) (Appendix G of the Remedial Design Work Plan, *de maximis,* September 2020) for further details related to sample processing, glassware, preservation, chains of custody, decontamination, and field documentation requirements and procedures for the sample collection activities.

2.3 FOLLOWING PROCESSING

After sample processing is completed, the dedicated sampling equipment will be bagged for disposal and the remaining equipment will be decontaminated prior to reuse. Refer to the Investigative Derived Waste (IDW) Handling and Storage (SOP NMI-005) and Field and Heavy Equipment Decontamination Procedures (SOP NMI-007) Standard Operating Procedures (SOPs)for additional details related to those items.

Following completion of the sampling, the completed piezometer, soil and sediment sampling, or sphagnum bog peat probing locations will be captured with a hand-held GPS unit. Completed sediment and soil sample locations will be marked with a flag or wood stake with flagging attached. Subsequently, all completed piezometer, probing and sampling locations will be surveyed by a professional land surveyor. The elevation of the reference mark on the piezometers will also be determined by the surveyor. Markers will be labeled with the sample location name.

At the end of the sampling day, all soil and sediment samples collected will be screened by the onsite Radiological Laboratory to determine the concentration and total radioactivity prior to shipment. Gamma spectroscopy will be used to identify the isotope and assign activity present in each sample. The samples will be grouped to comply with Department of Transportation (DOT) and International Air Transport Association (IATA) guidelines. This data will also be provided to the receiving laboratory for approval prior to shipment.

3. Implementation Procedures: Cooling Water Recharge Pond (AOI4) Piezometer Install, Groundwater and Sediment Characterization

3.1 PIEZOMETER INSTALLATION

Up to 12 piezometers will be installed by hand in couplets of two within the Cooling Pond to evaluate shallow and deeper hydrogeologic conditions within the sediment and shallow underlying sand material present at the Pond. At each of the six proposed couplet location, one shallow piezometer will be installed with the screened section within the soft, organic sediment layer, and a second piezometer with the screen in the deeper sand layer underlying the soft sediment.

Although the RDWP indicates piezometer screens depths of 3 ft for the shallow and 6-ft for the deeper locations and that piezometers will have a 6-in long screen present, these were only estimates; actual screen lengths, intervals and depths will be determined in the field after actual thickness of sediment and depth to the sand layer are established at each of the proposed couplet location. Piezometers will be constructed and installed as follows:

- The piezometers will consist of the Solinst® Model 615 screened drive-point piezometer heads driven to proposed groundwater sampling depths which will be attached to a steel riser pipe extending to the surface. The ¾ in. diameter stainless steel drive point heads will have either a 6-in or a 1 ft long 50 mesh screened section and will be connected to ¾ in. diameter galvanized riser pipe. Prior to installation, a section of 5/8 in. OD HDPE tubing will be attached to the piezometer head which will run through the riser pipe to the surface. At the end of the steel riser pipe, a ¾ in. threaded to slip PVC coupling will be attached, and an approximate 12 in. long, ¾ in. diameter PVC section with removable cap will installed onto the coupling at the end of the piezometer system. The HDPE tubing will extend into the PVC pipe section and will be access by removing the pipe from the riser at the coupling. The PVC pipe at the end of the system will scored for venting and a reference point will be marked on the PVC coupling for elevation and groundwater level measurements.
- Piezometer systems will be driven to the appropriate depth using a handheld, manual slide hammer and a Solinst manual drive head assembly which allows the piezometer to be installed while the HDPE tubing is in place.
- Following installation of the piezometer, approximately 6 inches of bentonite chips will be placed around the base of the piezometers to isolate potential cross communication of groundwater and surface water.
- During and following installation of the piezometer system, the following information will be collected and recorded:
  - Depth of water,
  - Depth of soft sediment,
  - Depth of surface water from reference point on piezometer,
  - Depth to pond bottom from reference on piezometer, and
  - Depth installed below sand layer.
- A length of ½ in. OD HDPE tubing will be affixed on the side of the steel riser pipe on the piezometer, with the intake end placed approximately one half the depth of the surface water

to facilitate future surface water sampling. The other (surface) end of the tubing will either be run to the shoreline, coiled and strapped to a nearby structure, or will be coiled at the piezometer location above the surface water level.

Up to 4 rounds of head measurements will be collected from the 12 piezometers. Information on head differentials between the shallow and deep sediment wells will inform our understanding of the interaction between groundwater and surface water.

3.2 GROUNDWATER AND SURFACE WATER SAMPLING

Up to 12 groundwater samples will be collected from the Cooling Pond - one sample collected from each newly installed piezometer. Groundwater quality data will be used in conjunction with head measurements and sediment quality data to evaluate the potential for contaminants to transport between sediment and groundwater. One discrete surface water sample will be collected from the center of the Pond during the groundwater sampling round.

Sampling will be performed using low-flow methodology as outlined in the EPA Low-Stress (Low-Flow) Standard Operating Procedure EQASOP-GW4, as summarized in NMI-GW-010 SOP. At the piezometer locations, groundwater sampling equipment will be connected to the existing HDPE tubing permanently affixed to the piezometer head. In general, during low-flow purging a multi-parameter meter will be used to measure pH, specific conductivity, turbidity, dissolved oxygen, oxidation reduction potential (ORP) and temperature. Readings will be collected at 5-minute intervals and recorded on field logs. Once parameters are stable with turbidity reduced to an acceptable level, groundwater samples will be collected into laboratory provided glassware. Due to the nature of piezometers installed within cohesive material such as sediment, and that short screened sections will be installed within the piezometers (6-in or 1-ft), strict conformance of the low-flow sampling operating procedures discussed above may not be possible. If so, sampling procedures will be evaluated on a case-by-case basis.

Field instruments will be inspected and calibrated at the beginning of each day and checked during field activities to verify performance. Instrument specific calibration procedures will be performed in accordance with the instrument manufacturer's requirements.

Groundwater samples will be submitted to a National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory for analysis of chlorinated volatile organic compounds (CVOCs), uranium, copper and total organic carbon (TOC). Uranium is the primary contaminant of concern in groundwater at the Cooling Pond. The addition of copper, chlorinated VOCs, and TOC data will be used to calculate the sorption from groundwater to sediment.

The surface water sample location will be as close to the center of the pond, within the center of the water column to collect a representative sample of surface water during the groundwater sampling event. Similar sampling procedures as the groundwater sampling described above will be implemented. The surface water sample will also be tested for the same parameters as the groundwater.

3.3 SEDIMENT SAMPLING

Up to 12 sediment samples will be collected at the locations of the proposed piezometers within the footprint of the Cooling Water Recharge Pond (AOI 4). Sediment samples will be collected from the approximate depth intervals where the well screens are installed at each piezometer within the couplet;

one sample from within the soft, organic sediment layer, and a second from the deeper sand layer underlying the soft sediment. Sediment sampling techniques will vary and be chosen depending on field conditions at time of sampling (depth of water, distance to shoreline, sediment types, etc.) and depending on depth intervals of sediment samples required, as follows:

- If sample locations greater than 1 ft in depth can be accessed safely on foot, a number of sediment sampling techniques may be used, including the following:

    a. If sediment is soft and loosely compacted consisting of a cohesive organic soil (silt), a Lexan® or polycarbonate approximate 2 or 3 in. ID tube sampling tube will used for sediment sample collection, as follows:

        - The depth of water and location will be documented and recorded. The appropriate length of coring tube will be selected so that it could be driven into the sediment through the water column to the maximum depth of sampling.
        - For the initial attempt, the sample tube will pushed manually into the sediment to the bottom of the deepest sample interval depth. A cap would then be placed on the top of the tube and the tube then extracted with a sediment core collected within the tube. If the sediment material appears to be loose and may release from the bottom of the coring tube, a cap will be affixed to the bottom of the core prior to lifting it out of the water.

    If the collected sediment is falls out the bottom of the coring tube and sample cannot be recovered, the sampling tube will be fitted with a sliding rubber piston to maintain suction in the tube while advancing the sampler, which better prevent softs sediment from escaping the coring tube during extraction.

        - Prior to advancing the core, a piston is placed into the sample tube and the seals will be checked to ensure a tight fit. The piston will be placed approximately 1-ft above the bottom of the sample tube.
        - The sample core tube will be lowered through the water column to the measured depth of the bottom. The line attached to the piston will be secured to allow the polycarbonate tube to slide past the piston as the tube is pushed into the sediment – the piston remains in place and does not move while the core tube advances into the sediment.
        - The tube is then pushed manually into the sediment until the bottom of the deepest sample interval depth or refusal.
        - The coring tube will then be pulled out of the sediment and lifted through the water column. As the bottom of the polycarbonate tube approached the water surface, a cap will be affixed to the bottom of the core prior to lifting the sample out of the water. After placing the bottom cap, the core will be positioned upright. Standing water preset above the piston will drained, the tube will be trimmed, the piston removed, and if necessary, another cap will be placed on the top of the tube.
        - Location ID, orientation, and total penetration depth will be recorded on the top cap. Cores will be transferred to the onshore work area in an upright position

- Once the cores are transferred to the processing area, they will be left undisturbed momentarily to allow settling of suspended solids.
- After the standing water above the sediment was visibly clear, holes will be drilled into the core tube to drain excess water above the sediment core. After the water is drained, the cores will be placed horizontally to allow for logging and processing.
- Prior to processing the cores, additional aluminum foil or polyethylene sheeting will be placed on top of the work surface to prevent cross-contamination. If needed to access sediment from within the core tube, electric sheers will be used to cut open the core tube. Total recovery will be measured and the core will be the logged and photographed.
- Prior to collecting the sediment samples from the core tube, the cores will be segregated into sample intervals representative of depth intervals required for sampling. The sample intervals will be based on recovery and the entire core will assumed to compact uniformly. (For example, if the core recovery was 75% of the total penetration, the top 6 inches of the sediment layer will be assumed to be the top 4.5 inches of sediment recovered in the core.) After calculating sample intervals based on recovery, cores will be sectioned and the sediment sampled.

b. If sediment is densely compacted or consists of a coarser sand and gravel (rather than cohesive organic material), and if the sediment can be removed to the maximum depth required without the cored hole collapsing prior to reaching that depth, a hand auger will be used.

c. If sediment is densely compacted or consists of a coarser sand and gravel and the sediment <u>cannot</u> be removed to the maximum depth required without the cored hole collapsing, the following will be attempted:

- The 0-1 ft surface sediment sample will be collected either by hand using a hand auger or trowel. If the conditions do not allow collection by hand auger or trowel, an open-ended plastic cylinder will be driven into the ground surface to an approximate depth of 1 ft, which would isolate the sample area from surrounding loose wetland soils and preventing surface water from entering the excavation area. The sample was collected from inside the cylinder using a hand trowel.
- After the initial surficial sample interval is collected, a 4 in. diameter section of Schedule 40 PVC pipe will be hand driven to the maximum sampling depth. Installation of the PVC pipe drive pipe will prevent the borehole from collapsing and prevented surface water and loose sediments present around the area of excavation from mixing with the samples collected from the depth intervals. Sediment will be sampled by removing the material from within the drive pipe using a hand auger.

- If sample locations are present within several feet of standing water and cannot be accessed safely on foot, a boat may be needed to facilitate sampling. Again, actual sampling equipment and techniques will be dependent on standing water depth, sediment type and sample depths. Sampling equipment and techniques described above may be used from a boat to collect sediment samples.

- If sample locations cannot be collected using hand methods described above (hand auger, trowel, core tube, etc.) either by foot or from a boat, a direct push (Geoprobe) boring rig or a vibracore rig will be used to access and sample the sediment.

Sediment samples will be composited over either 6-in or 1-ft depth intervals in a stainless-steel bowl or disposable aluminum pan. The volume of collected material will be stirred to homogenize the sample and then placed in appropriate glassware for submission to the laboratory.

Samples are planned to be submitted for laboratory analysis of chlorinated volatile organic compounds (CVOCs), uranium, copper, and total organic carbon (TOC). If the laboratory determines that the sample has less than 30% solids, a new sample will be collected with a greater sample volume, as necessary. In the field, if it appears the sample is overly wet, additional sample volume will be collected and submitted to the laboratory.

4. Implementation Procedures: Bog and Septic Field Investigations

4.1 BOG SEDIMENT INVESTIGATIONS

Up to 6 shallow hand probes will be advanced within the sphagnum bog to gather data related to the thickness of the peat/sediment material present. Specific data will be collected on the thickness and depths of the two distinct peat layers present in the Bog (the acrotelm and catotelm), and to determine characteristics of underlying (non-peat) material.

Prior to sampling at the Bog, each proposed sampling location will be located and reviewed for access and general field condition considerations. Due to the sensitive nature of the sphagnum bog material, additional access considerations will be determined, such as using wooden planks or plywood as temporary walkways to the sampling locations to spread contact pressure of the foot traffic.

A variety of hand probing and peat material sampling equipment may be used during the proposed bog explorations. Actual methods and equipment will be determined according to actual field conditions, peat consistency, depth and density, but may consist of the following:

- Solid, cylinder metal probing rods
- Liner-type sediment corer/sampler (e.g. Wildco or AMS)
- Small diameter peat probe (e.g. Wildco or AMS)
- Hand auger

Solid probes will first be advanced into the sphagnum bog peat material to evaluate if material types can be determined without needing to collect physical peat samples. If not successful with simple probing, other liner/coring type equipment will be used to collect the peat material for observations. If additional peat material is required for collection (see torvane test section below), a hand auger may be used to collect bulk material for analysis.

Additionally, up to 6 torvane tests may be performed in the shallow hand probes to evaluate the shear strength of the bog sediments if the material is suitable for a torvane test. It is possible that the peat will be too fibrous to obtain in-situ measurements.

It is anticipated that there is a sandy deposit below the peat material. To the extent possible this material will be sampled for geotechnical testing. Grain size distribution and hydrometer tests will be run on this material if adequate sample is recovered. The purpose of this testing is to evaluate the type of material to estimate either published strength or correlate this material with soils collected from borings along the containment wall alignment. It may be necessary to install temporary sheeting along the outside edge of the sediment excavation to minimize impact to the bog while removing the contaminated sediment. The bog is too sensitive to mobilize typical drilling equipment to determine in-situ strength characteristics of this underlying material.

4.2 FORMER SEPTIC FIELD TEST PITS

Following the geophysical survey at the former septic field area, up to 4 test pits will be excavated to confirm the presence and limits of the subsurface structures identified in the GPR and EM surveys. Test pits will be excavated to depths of approximately 8 to 10 feet using a track-mounted excavator.

Up to one soil analytical sample will be collected from the test pits at the former septic field to confirm the limits of the septic field structures. Soil samples will be collected from either a side walls of the test pit excavation, or from material excavated and placed adjacent to the excavation using a hand-held excavation device such as a shovel or hand trowel. Sample will be composited from a representative depth interval in a stainless-steel bowl or disposable aluminum pan. The volume of collected material will be stirred to homogenize the sample and then placed in appropriate glassware for submission to the laboratory.

Samples are planned to be submitted for laboratory analysis of VOCs, PCBs, semi-volatiles (including, polycyclic aromatic hydrocarbons (PAHs) (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene), Metals (including arsenic, uranium, thorium, barium, chromium, cobalt, copper, iron, manganese, and molybdenum), Nitrate-N, and Nitrite-N.

5. Implementation Procedures: Non-sampling Field Work/Survey

5.1 GEOPHYSICAL SURVEY

Geophysical surveys will be completed in two areas of the site; within the landfill area and within the former septic system area north of the Cooling Pond. A geophysical survey was performed by MACTEC at the landfill in conjunction with the Remedial Investigation (RI) but was only performed within the limits of the fencing at the time of the survey and identified some anomalies which may have been due to the metal fencing. This PDI will confirm the results of a geophysical survey previously performed at the landfill documented in the RI report, and extend the survey to outside the limits of the fence. The fence will be removed, and some vegetation may need to be cleared prior to the survey.

The second geophysical survey will be performed within the former septic fields to confirm the limits of the septic fields, and to evaluate if there are other buried debris or associated structures in the area. The former septic field area is currently paved with a driveway and parking lot.

The surveys will be completed by establishing a 10-foot by 10-foot reference grid within each survey area to be marked using spray paint or flagging. Perpendicular nodes will also be laid out with a theodolite or fiberglass measuring tape throughout the survey areas.

At each location, two methodologies will be used in the geophysical survey. An electromagnetic (EM) survey will be used to evaluate for debris. The EM survey is capable of detecting metal debris at depths of approximately up to 8 feet. EM devices proposed to be used in the survey include Radiodetection Model 7100, Genoics EM61, or Genoics EM31. Conductivity is logged in 0.5-second increments as the operator traverses the grid and annotates the data files. A Ground Penetrating Radar (GPR) survey will also be used, which is capable of identifying subsurface structures in greater detail at depths of up to approximately 15 feet. GPR devices proposed to be used in the survey include GSSI Model SIR-2000 or SIR-4000, with a 200 or 400 MHz radar antenna.

In addition to the EM and GPR surveys at the landfill, a total-field magnetic profiling is planned to distinguish any anomalies caused by ferrous metal or non-ferrous metal objects. The total-field profiling is performed with a Geometrics model G-858 magnetometer, which records magnetic data values at 0.5 seconds as the operator traverses the 10-feet grid

5.2 WETLAND CHARACTERIZATION

This PDI will collect the information needed to characterize current conditions at the Cooling Pond and the Bog in order to design the wetland restoration plan following the remedial excavations in each area. This investigation includes compiling an inventory of plant species growing within the habitat zones, and delineation of resource areas and habitat types, including vegetated border areas, banks, and transitional zones which may be disturbed during remedial activities. Observations will be documented on the dominant and common species within each habitat zone and supporting figures and field notes will be annotated with current conditions.

The wetlands mapping and evaluation of the functions and values will be conducted as follows:

- Wetlands will be delineated according to the methodology required per 310 CMR 10.00 as described in *Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act* (MassDEP, 1995).
- Wetland functions and values will be assessed according to the methodology described in *The Highway Methodology Workbook Supplement: Wetland Functions and Values – A Descriptive Approach* (U.S. Army Corps of Engineers, New England District, September 1999).

Data from the bog sediment depths will be used with species inventory and delineation information collected in this activity to develop a final restoration approach, including soil specifications, planting plan, and related details.

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REPORT ON

RD PRE-DESIGN INVESTIGATIONS – NMI SITE
SITE-WIDE SOILS AND SEDIMENTS
DEPLETED URANIUM PENETRATOR INVESTIGATIONS
IMPLEMENTATION PLAN (PDI SSS-2)
CONCORD, MASSACHUSETTS

by
Haley & Aldrich, Inc.
Boston, Massachusetts

for
de maximis, inc.

File No.131884-003
September 2020

Table of Contents

1. Objectives and Scope

This Pre-Design Investigation (PDI) activity for site-wide soils and sediments (SSS) will evaluate the presence of depleted uranium (DU) in soil from DU penetrators and metal fragments. The scope of this investigation will be based on results of the prior Non-Time-Critical Removal Actions (NTCRAs), including verifying removals performed in the NTCRAs and further evaluating areas of concern identified in the NTCRAs. The results of PDI SSS-2 will be used to confirm prior removals of soil impacted by DU metal fragments and assess the presence of DU metal fragments in deeper soil (greater than 6 inches deep).

The objectives for this PDI are to evaluate the presence of DU penetrators and metal fragments at the site, remove any identified DU penetrators/metal fragments and associated impacted soil, and conduct delineation sampling at areas where DU penetrators/metal fragments were previously removed and from areas identified in this walkover survey.

The scope of work as follows:

- Perform DU gamma walkover survey of surficial soil to evaluate the presence of DU metal fragments.
- Excavate/scrape soil back to a depth of 6-inches and windrow the soil adjacent to the area exposed. Perform DU gamma walkover survey of deeper soil to evaluate the presence of DU metal fragments.
- Remove soil and DU fragments at any locations identified in shallow and deeper soil areas surveyed.
- Collect soil samples at previously remediated locations and newly excavated locations to confirm complete removal of DU penetrators/metal fragments and impacted soil to meet the Remedial Action Objectives (RAOs). Data collected will be used to delineate the limits of excavation necessary as part of the 30% Remedial Design (RD).

2. General Procedures

The following procedures will be considered for all proposed sampling for PDI SSS-2, related to general access, processing and post-sampling activities.

2.1 ACCESS

PDI SSS-2 will be conducted within several areas of site. Conditions at survey and sampling locations include the following: near the edge of parking areas, building exteriors, and the fence line, as well as along the edge of paved surfaces. One area of the DU penetrator survey extends from the edge of the paved surface down the slope toward the northern wetlands. The majority of the DU penetrator survey is along the fenceline and to the break in slope before it rises or drops off in elevation.

Prior to sampling, each proposed sampling location will be located using a hand-held GPS unit or by scaling off known existing features, and each location will be reviewed for access and general field condition considerations. Pre-decontaminated ("clean") or new sampling equipment, supplies, glassware, etc. will be mobilized to each survey or sampling location, either carried by hand or transported using a wagon sled or using a field vehicle depending on accessibility. Routes to proposed sampling locations will be reviewed to follow general project guidelines related to different zones to be established at the site (e.g., Contaminated Soil Zone, Contaminant Reduction Zone, etc.). Actual routes and paths will be determined to most safely access each sampling location, with least disturbance to the surrounding area. Although some limited clearing has been conducted at the site, additional clearing of branches, brush, leaves, etc. may be necessary to access the locations and to create individual sampling areas may be necessary. Disturbance to surficial soils will be limited.

If there are sensitive areas where less surficial soil disturbance will be necessary due to the nature of contamination in the area (e.g. sphagnum bog), access and other general procedures may be adjusted per location specific conditions and requirements.

2.2 SAMPLE PROCESSING

At each land-based soil sample location, polyethylene sheeting will be placed to create a small, dedicated area to temporarily stage sampling equipment and supplies, and to process the soil samples.

Refer to the applicable project-specific Standard Operating Procedures (SOPs) located as Appendix I 1 of the Field Sampling Plan (FSP) (Appendix I of the Remedial Design Work Plan, *de maximis,* September 2020), the (FSP) (Appendix I of the Remedial Design Work Plan, *de maximis,* September 2020) and Quality Assurance Project Plan (QAPP) (Appendix G of the Remedial Design Work Plan, *de maximis,* March 2020) for further details related to sample processing, glassware, preservation, chains of custody, decontamination, and field documentation requirements and procedures for the sample collection activities.

2.3 FOLLOWING PROCESSING

After sample processing is completed, the dedicated sampling equipment will be bagged for disposal and the remaining equipment will be decontaminated prior to reuse. Refer to the Investigative Derived Waste (IDW) Handling and Storage (SOP NMI-005) and Field and Heavy Equipment Decontamination

Procedures (SOP NMI-007) Standard Operating Procedures (SOPs)for additional details related to those items.

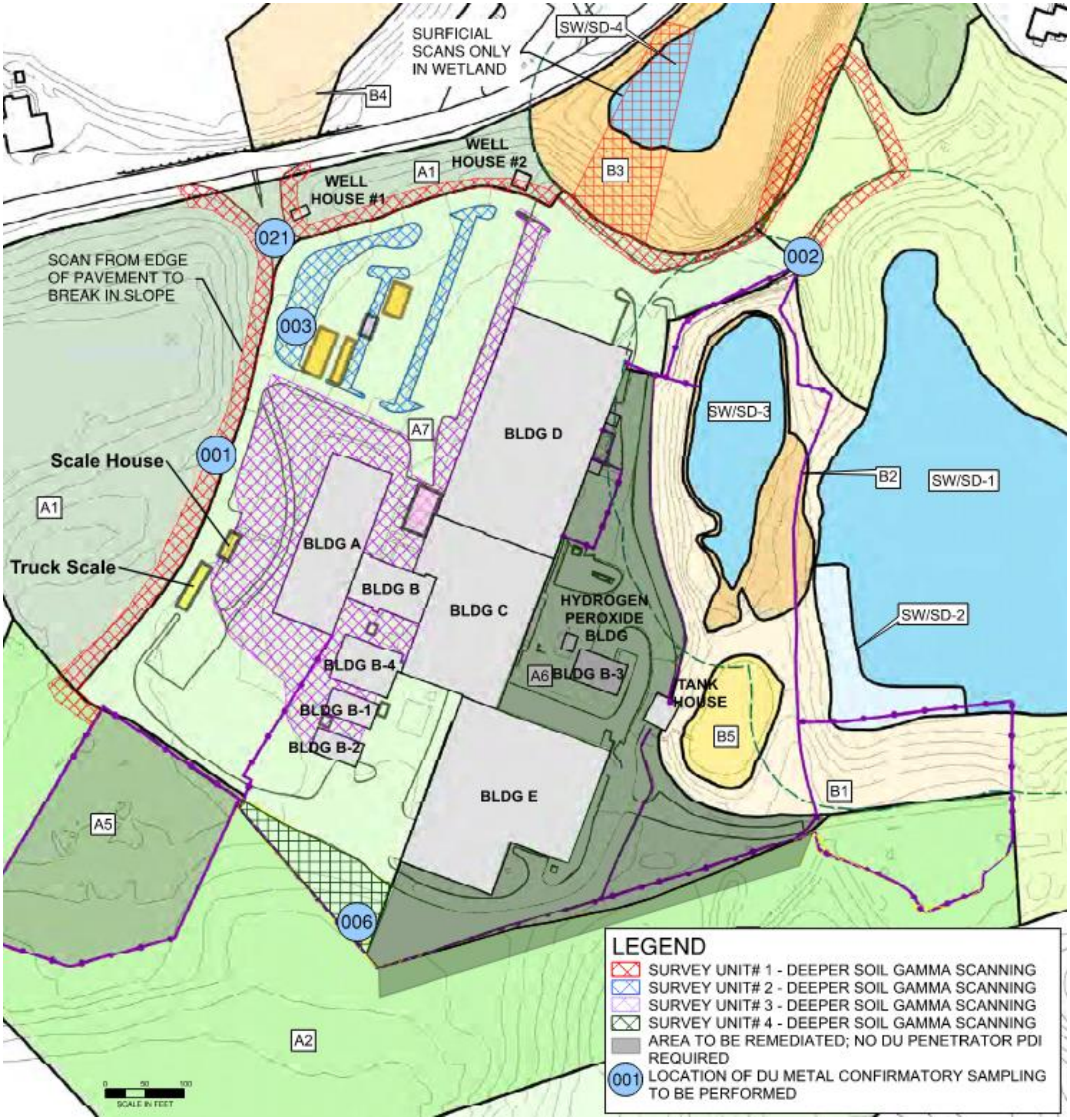
Following completion of the sampling, the completed soil sampling locations will be captured with a hand-held GPS unit. Completed soil sample locations will be marked with a flag or wood stake with flagging attached. Markers will be labeled with the sample location name.

At the end of the sampling day, soil samples collected will be provided to the site Radiation Safety Officer for screening prior to final packing and submittal to the analytical laboratory.

3. Implementation Procedures: DU Survey and Soil Characterization

3.1 DU GAMMA WALKOVER SURVEY

The DU Gamma Walkover survey is planned to be completed over approximately 17,100 square yards of the site where remedial excavations are not already planned. This area will be divided into 4 survey units (SU 1, 2, 3, and 4). Prior to completing the surveys, survey grids will be created for the survey units mentioned above and the areas will be grubbed/cleared to minimize interferences. Gamma walkover surveys will be performed one survey unit at a time. The Figure below shows the limits of DU Survey.



SURFICIAL
SCANS ONLY
IN WETLAND
SW/SD-4
B4
B3
WELL
HOUSE #2
A1
WELL
HOUSE #1
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SCAN FROM EDGE
OF PAVEMENT TO
BREAK IN SLOPE
003
SW/SD-3
A7
BLDG D
Scale House
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B2
SW/SD-1
A1
BLDG A
Truck Scale
BLDG B
BLDG C
HYDROGEN
PEROXIDE
BLDG
SW/SD-2
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A6
BLDG B-3
TANK
HOUSE
BLDG B-1
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LEGEND
SURVEY UNIT# 1 - DEEPER SOIL GAMMA SCANNING
SURVEY UNIT# 2 - DEEPER SOIL GAMMA SCANNING
SURVEY UNIT# 3 - DEEPER SOIL GAMMA SCANNING
SURVEY UNIT# 4 - DEEPER SOIL GAMMA SCANNING
AREA TO BE REMEDIATED; NO DU PENETRATOR PDI REQUIRED
001 LOCATION OF DU METAL CONFIRMATORY SAMPLING TO BE PERFORMED

If any elevated areas are identified during the gamma walkover survey, they will be marked (pin flag, stake, paint) and additional investigations will be performed only at those specific locations. Any areas with pin flags will have a 5 ft. zone cordoned off to be investigated with all other pin-flagged areas requiring hand digging or excavation to remove DU or impacted soil.

Once the first surficial scan is completed, the survey will continue by removing approximately 6 inches of soil from the areas previously scanned and identified as being within background limits. The 6-inches of soil will be excavated/scraped with a mini-excavator and will be temporarily windrowed adjacent to the area of removal. This will allow for the soil to be backfilled at the same location as it was removed. The excavator or other equipment will not be allowed within the areas exposed for the survey.

If any elevated areas are identified in the deeper zone, pin flags will be set and a 5-foot zone around the pin flag will be established. Soil windrowed within areas identified as being less than 3x instrument background will be backfilled. Each surficial and deeper pin-flagged areas will remain flagged for excavation and sampling, and will be cordoned off with caution tape to limit access.

The Gamma walkover surveys will be completed with a shielded 2x2 sodium iodide (NaI) detector coupled with a submeter accuracy GPS. Gamma walkover surveys will be performed by holding the NaI detector as close to the ground surface as possible (less than 4 inches from surface), moving it side-to-side while walking slowly (approximately 1 foot per second). Continue gamma walkover surveys in one direction until survey unit boundary has been reached, then turnaround and return, offset from the completed path to continue the walkover survey so that full coverage of the area is achieved. Repeat this survey process until the survey unit has been completed. Any elevated results will be initially evaluated by pausing over the location to determine if the elevated results are consistent. If not, then continue with gamma walkover surveys. If consistently elevated above the action level (3x instrument background), that location will be marked (pin flag, stake, paint) for additional investigations.

Gamma walkover surveys performed in this manner have a sensitivity of 56 pCi/g or total radioactivity of 3.3 uCi or approximately 10 g of DU metal at depth up to 6 inches in soil. Background will be established for each survey unit prior to gamma walkover survey and this background will be the basis for the action level in the survey unit. If there are significant changes to the soil type in a survey unit such that background changes, then a new background can be established for a portion of a survey unit.

3.2 INVESTIGATION OF ELEVATED NAI MEASUREMENTS

At each pin-flagged location with If elevated NaI measurements, the location will be recorded by GPS and the source of the elevated area will be investigated by hand digging in the area. Removed material will be screened with the NaI to determine if the source has been removed and/or identify it. The soil removed from the elevated area will be placed in a drum or roll-off. If the area continues to be elevated by NaI, but no metal fragments are apparent, the procedure described above will be performed, and an additional six inches of soil will be scraped back and the newly exposed ground surface scanned until no elevated NaI measurements are recorded.

If DU fragments are the source of the elevated NaI readings, the soil around the fragments will be removed (minimum of three feet diameter) and then scanning the newly exposed ground surface. The excavated soil removed from the areas with elevated gamma readings will be placed in drums or roll-offs depending on the volume removed. Each of these areas will have hand excavation and/or soil sieving will be conducted to retrieve and dispose of any DU penetrator/metal fragments. The soil surrounding the metal fragment(s) and any visibly impacted soil will be removed. The DU metal fragments will be drummed in 55-gallon drums. Soil removed will be either drummed or placed in a roll-off container, depending on the volume generated. It is expected that smaller volumes will be generated with this round of survey, so drums are expected to be adequate.

There is no planned stockpiling of soil as the goal is to only remove DU fragments and any soil touching the DU fragments from the site. In the event it makes sense to chase out an area now with DU fragments and impacted soil that may exceed a roll-off, then an area of the site will be set up to manage a soil stockpile.

The stockpile area will be set up on a paved area, with three-sides of jersey barriers and coir rolls will be laid across the opening of the stockpile area prior to leaving on a daily basis. If the stockpile remains for more than 1-week, it will be covered with polyethylene. If a soil stockpile is necessary. The stockpiled soil will be characterized by testing the site wide COCs for the material to be reused to backfill the surveyed area.

Soil sampling of the excavations will be performed as described in the Delineation Soil Sampling section below.

3.3 DELINEATION SOIL SAMPLING

A background soil sample will be collected from each Survey Unit area to correlate the gamma scanning instrument to analytical data to the extent possible. Background soil samples will be submitted for laboratory analysis of all site COCs, including uranium, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene), arsenic, and thorium.

Following collection of background samples, at each of the five (5) former DU penetrator/metal fragment soil removals performed during the NTCRA (001, 002, 003, 006, and 021), an initial gamma scan of the area will be conducted using a shielded 2x2 sodium iodide (NAI) detector. Following the scan and confirming background conditions, four discrete horizontal soil samples will be collected approximately 90 degrees from each other, each approximately 1 foot away from edge of the former soil removal area. A discrete vertical sample will also be collected at the bottom of the former removal area.

At each pin-flagged location that had material removed to achieve background with the NaI detector, soil samples will be collected. Horizontal surficial samples will be collected by advancing an approximate 3 to 4-in diameter stainless steel hand auger to 1-ft depth, or by manually hand excavating explorations using a shovel and/or hand trowel to a minimum dimension of approximately 6-in wide by 6-in long to 1-ft depth . Vertical soil samples will be collected to depths of 1-ft from the bottom of the removal area, composited from a minimum dimension of approximately 6-in wide by 6-in long.

Soil samples will be collected from the hand auger or from the side walls of the explorations, compositing the entire depth interval in a stainless-steel bowl or disposable aluminum pan. The volume of collected material will be stirred to homogenize the sample and then placed in appropriate glassware for submission to the laboratory.

Samples will be submitted for laboratory analysis of all site COCs, including uranium, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene), arsenic, and thorium.

Each area sampled will be restored by placing a non-woven geotextile on the small excavation and then backfilling with soil from the windrow or off-site fill. The area will be backfilled flush with grade and flagged.

If necessary, following review of the results from the sampling program described above, additional sampling may need to be performed to excavate the remaining DU penetrator/metal fragment impacted soil. The areas will be excavated to expose the geotextile and an additional 1 to 2 feet of soil horizontally from the impacted sidewall or an additional 6 inches vertically from the impacted bottom will be excavated, and then the newly exposed sidewall or bottom will be resampled for site COCs. Excavated soil will be placed in drums or roll-offs for future off-site management. The data collected will be used as part of the overall site wide soil delineation of the limits requiring excavation to meet the proposed cleanup levels (PCLs) summarized in the Record of Decision.

3.4 BACKFILLING AND SITE RESTORATION

Soil that was excavated and windrowed next to the survey area will be reused as backfill. This soil will be placed as closely to the original location as possible. Soil that is removed from elevated NaI readings will be placed in drums or a roll-off for off-site management. The small excavations needed to remove the DU fragments and the impacted soil will be backfilled with off-site material such as crushed stone or granular backfill placed on the geotextile. The surface treatments will also be restored to original surfaces.

If it is deemed necessary to stockpile soil this material will be tested for site COCs, and if the concentrations are below PCLs, the soil will be used as backfill to establish original grades. If soils exceed PCLs, the soil will be placed in roll-offs and managed off-site accordingly.

If it appears that more than 2-roll offs are necessary to manage the soil around the identified DU, this work may become part of the 30% RD. This work is intended to be Pre-Design work and the conclusion may be to extend the lateral and vertical extent of soil excavations along these areas of the proposed DU survey. As described above, the analytical data collected as part of this PDI will be used to delineate the limits of excavation shown in the 30% RD.

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REPORT ON

RD PRE-DESIGN INVESTIGATIONS – NMI SITE
SITE-WIDE SOILS AND SEDIMENTS
SOIL AND SEDIMENT SAMPLING IMPLEMENTATION PLAN
(PDI SSS-1 AND SSS-3)
CONCORD, MASSACHUSETTS

by
Haley & Aldrich, Inc.
Boston, Massachusetts

for
de maximis, inc.

File No. 131884-003
September 2020

Table of Contents

1. Objectives and Scope

The Pre-Design Investigation (PDI) activities for site-wide soils and sediments (SSS) will investigate the limits of chemical of concern (COC)-impacted soil and/or sediments (SSS-1), and the limits of site CoCs below the concrete slabs of the former buildings related to possible leaks from utilities (SSS-3). The results of PDI SSS-1 will be used to design the remedy to remove soil and/or sediments impacted by COC, while results of PDI SSS-3 will be used to design remedial investigations in conjunction with removal of the building slabs.

The objective of PDI SSS-1 is to define the horizontal and vertical extent of soil and/or sediment requiring remediation in several Areas of Interest (AOIs), including Areas A4 (AOI 9), A5 (AOI 8), and B2 (AOIs 2 and 4) due to the presence of PCBs, Area A6 (AOIs 7 and 11) due to the presence of depleted uranium, as well as PCBs.

The objective of PDI SSS-3 is to define the horizontal and vertical extent of contaminated soil below the former building slabs related to potential releases from floor drains, sumps, and subslab piping. The PDI includes collecting deeper subsurface soil at the four areas where significantly elevated uranium was identified during the NTCRA subslab investigation.

Details regarding the scope of work, including tables and figures for PDI SSS-1 and PDI SSS-3 were provided in the Remedial Design Work Plan - Appendix A Site-wide Soils and Sediment Pre-Design Investigation Work Plan, dated September 2020, in Attachments 1 and 3.

PDI INVESTIGATION	SITE AREA	PDI OBJECTIVES	PDI SCOPE
PDI-SSS-1	A4 (AOI 9) soil	PCBs and other COC delineation at northeast outfall area	Collect surface and shallow subsurface soil samples to refine delineation of COCs.
	A5 (AOI 8) soil	PCBs and other COC delineation at sweepings pile	Conduct borings to refine delineation of COCs.
	B2 (AOI 2 &4) soil	PCBs and other COC delineation within Cooling Pond Area	Collect surface and shallow subsurface samples to refine delineation of COCs.
PDI-SSS-3	Building footprints	Delineate uranium (based on subslab soil investigation performed as part of NTCRA)	Conduct borings through the existing floor slab to further evaluate the presence of COCs and to refine delineation of COCs for future excavation.

The procedures described below are augmented by the field sampling and laboratory procedures described in the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP). If applicable, work will be completed in accordance with the Health Physics Procedure (HPP) for Conduct of Radiological Work (HP-NMI-01). Additional references to standard operating procedures (SOPs) are added to specific work procedures listed below.

2. General Procedures

The following procedures will be considered for all proposed sampling for PDI SSS-1 and SSS-3, related to general access, sample processing and general post-sampling activities applicable to all proposed locations.

2.1 ACCESS

PDI SSS-1 will be conducted within several site areas and AOIs, and across varying field conditions, some of which will be challenging to access. Conditions at sampling locations include the following: wooded uplands, steeply sloped wooded areas, areas adjacent to wetland at the bottom of steep slopes or in wet wetland fringes, within wetlands with soft sediment present, and in standing water including ponds with deeper water present. Proposed explorations at the SSS-3 areas will be conducted from an existing concrete slab, directly accessible via existing paved roads at the site.

Prior to sampling, each proposed sampling location will be located using a hand-held GPS unit or by scaling off known existing features, and each location will be reviewed for access and general field condition considerations. For SSS-1 the majority of field locations where only shallow soil and sediment sampling is required are anticipated to be accessed on foot with hand-held equipment, typically in wooded areas. Pre-decontaminated ("clean") or new sampling equipment, supplies, glassware, etc. will be mobilized to each AOI or sampling location, either carried by hand, transported using a wagon or sled, or using a field vehicle depending on accessibility. Routes to proposed sampling locations will be reviewed to follow general project guidelines related to different zones to be established at the site (eg. Contaminated Soil Zone, Contaminant Reduction Zone, etc.) Actual routes and paths through wooded areas will be determine to most safely access each sampling location, with least disturbance to the surrounding area. Although some limited clearing has been conducted at the site, additional clearing of small trees, branches, brush, leaves, etc. may be necessary to access the locations and to create individual sampling areas. Disturbance to surficial soils will be limited.

If there are sensitive areas where less surficial soil disturbance will be necessary due to the nature of contamination in the area (such as the Sweepings Area), access and other general procedures may be adjusted per location specific conditions and requirements.

Prior to drilling at locations up-slope from the bog straw wattles or coir rolls will be available on-site as necessary to mitigate for potential erosion or runoff from the drilling area into the bog or other wetland area.

If applicable, all equipment and tools that will enter the restricted area and that might contact radioactive contaminated areas are subject to screening by an HP according to the Radiological Surveys HPP (HP-NMI-05 in the Field Sampling Plan [FSP], RDWP Appendix I) to determine if background levels of radiation exist on the equipment prior to exposure to on-site soils. Additionally, disposable barriers may be applied as directed by the on-site HP or RSO to prevent contaminating equipment and tools while in the restricted area. The driller and consultant personnel are asked to only bring tools and equipment into the restricted area that are deemed essential to complete the task because tools and equipment will be subject to screening by HP and RSO before leaving the restricted area and, depending on impacts and ability to decontaminate, may have to be disposed of if contaminated.

Before entering the restricted area, workers will review and sign the specific radiation work permit for drilling and soil sampling activities and don the required personal protective equipment (PPE) and monitoring equipment as specified in the radiation work permit and/or instructed by the RSO or HP. Prior to initiating work, the staff will consult with the HP and RSO to determine an approach for screening and transporting equipment to the decontamination area and back so that work can progress efficiently.

For locations where a drill rig is utilized, the driller will create an exclusion zone around the drill rig. The exclusion zone does not need to be a physical barrier and may be demarcated with traffic cones. Only the driller and driller's helper should enter the exclusion zone. Other field personnel may enter the zone only when invited and supervised by the driller.

2.2 SAMPLE PROCESSING

At each land-based soil sample location, polyethylene sheeting will be placed to create a small, dedicated area to temporarily stage sampling equipment and supplies, and to process the soil samples. For sediment samples collected in wet areas (within or adjacent to wetlands, or in pond), sediment is anticipated to be collected at the sample locations, then transported to a safe location at a dry, stable area for sample processing.

Small sample processing areas will be constructed at each drilling/sampling location to process soil samples collected by the drilling rigs.

Refer to the applicable project-specific Field Sampling Plan (FSP) (Appendix I of the Remedial Design Work Plan, *de maximis,* September 2020), the Standard Operating Procedures (SOPs) located as Appendix I 1 of the FSP , and Quality Assurance Project Plan (QAPP) (Appendix G of the Remedial Design Work Plan, *de maximis,* September 2020) for further details related to sample processing, glassware, preservation, chains of custody, decontamination, and field documentation requirements and procedures for sample collection activities.

For activities where a drill rig is used, after work areas and processes have been established, drilling will commence with continuous sampling. Soil cores will be extracted and carried to the logging area by the driller or the driller's helper. The boring will be advanced, and the soil cores will continue to be extracted until the final depth of the boring is reached. The driller may proceed faster than the field engineer or geologist, so cores might need to be staged in liners near the logging area; however, the driller should not begin advancing the next boring until approved by the field engineer or geologist. After a soil core has been set in the logging area, the core liner will be cut open and logged by the field engineer or geologist using the USCS and following the soil description SOP (NMI-S-006, in the FSP).

If appropriate, soils will be initially screened with a handheld radiation survey instrument to ensure radiation levels are at a level where the core is safe to handle as determined by the HP and approved by the on-site RSO. If the soil is deemed unsafe by the HP or RSO, other protocols will be followed as directed by the HP or RSO. If the soil is safe to handle without further controls, the soils will be logged by the field engineer or geologist and following the soil description SOP (NMI-S-006, in the FSP). If the soil is deemed unsafe by the HP or RSO, other protocols will be followed as directed by the HP or RSO.

After logging, the soil core will be screened again using the handheld radiation survey instrument by the HP, and the count rate per minute will be logged.

2.3 FOLLOWING PROCESSING

After sample processing is completed, the dedicated sampling equipment will be bagged for disposal and the remaining equipment will be decontaminated prior to reuse. Refer to the Investigative Derived Waste (IDW) Handling and Storage (SOP NMI-005) and Field and Heavy Equipment Decontamination Procedures (SOP NMI-007) Standard Operating Procedures (SOPs)for additional details related to those items.

Following completion of the sampling, the completed as-sampled locations will be captured with a hand-held GPS unit. Completed sample locations will be also be marked with a flag or wood stake with flagging attached. Subsequently, all completed soil and sediment sampling locations will be surveyed by a professional land surveyor. Markers will be labeled with the sample location name. Note that marking locations may not be possible if located in deep water areas.

At the end of the sampling day, all soil and sediment samples collected will be screened by the onsite Radiological Laboratory to determine the concentration and total radioactivity prior to shipment. Gamma spectroscopy will be used to identify the isotope and assign activity present in each sample. The samples will be grouped to comply with Department of Transportation (DOT) and International Air Transport Association (IATA) guidelines. This data will also be provided to the receiving laboratory for approval prior to shipment.

If applicable, each time staff or equipment leaves the restricted area, they must be screened out of the restricted area under the guidance of the HP following the Personnel Monitoring and Decontamination HPP (HP-NMI-06, in the FSP) and sign out of the specific radiation work permit. All waste and PPE generated during the field event should be bagged appropriately and will be handled and dispose of as directed by the RSO and described in the investigation derived waste (IDW) handling and storage SOP (NMI-5 in the FSP) and Radioactive Waste HPPs HP-NMI-19 and HP-NMI-27 in the FSP. If soil IDW is generated that can be placed back in the borehole, it will be handled and stored following the IDW handling and storage SOP (NMI-5 in the FSP) and Radioactive Waste HPPs HP-NMI-19 and HP-NMI-27 in the FSP.

Prior to equipment and tools being released from the NMI site, additional decontamination may be needed and screening with swab samples will be required as described in the Heavy Equipment Decontamination and Free Release HPP (HP-NMI-25) and determined by the on-site RSO.

3. Implementation Procedures: PDI SSS-1 – Remedial Excavation Soil Characterization

See below for specific details related to surficial and subsurface soil sampling and for sediment sampling procedures for SSS-1.

3.1 SURFICIAL SOIL SAMPLING

For surficial soil (0 to 1-ft), sampling is proposed to be completed using a hand auger or other hand-held excavation device such as a shovel or hand trowel. Although not anticipated, a direct push (Geoprobe) and/or hollow-stem auger drill rig may be necessary for surficial soil sampling depending on field conditions.

Samples will be collected by advancing an approximate 3 to 4-in diameter stainless steel hand auger to 1-ft depth, or by manually hand excavating explorations using a shovel and/or hand trowel to a minimum dimension of approximately 6-in wide by 6-in long to 1-ft depth. Soil samples will be collected from the hand auger or from the side walls of the explorations, compositing the entire 1-foot depth interval in a stainless-steel bowl or disposable aluminum pan. The volume of collected material will be stirred to homogenize the sample and then placed in appropriate glassware for submission to the laboratory. If soil samples are collected using direct push and/or hollow-stem auger drill, see section below for sampling details.

The surficial soil samples are planned to be submitted for laboratory analysis of PCBs, polycyclic aromatic hydrocarbons (PAHs) (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene), uranium, thorium, and arsenic.

3.2 SUBSURFACE SOIL SAMPLING

For deeper soil (greater than 1-foot depth), sampling is generally proposed to be completed by direct push (Geoprobe) and/or hollow-stem auger drill rig. Depending on field conditions, shallow subsurface samples (up to 2 feet) may be completed using a hand auger, shovel or hand trowel as was described above. Maximum depths of soil sampling for SSS-1 is anticipated to be 12-ft.

Sampling will likely be conducted using direct push methods via a Geoprobe® 6610DT rubber-track mounted direct push rig, or similar equivalent. Direct push explorations will be advanced in 5-ft intervals using 5-ft long Macro-Core® drill tooling with 1 7/8 in. I.D. Geoprobe® acetate liners, driven to the required depth below the ground surface (bgs). If a hollow-stem auger drill rig is used, explorations will be advanced in 2-ft intervals using 4-in diameter auger casing, with soil samples collected using 2-ft long split-spoon samplers. Upon retrieval of the liner core or split-spoon sampler, the sampler will be split or cut open for access to recovered soil.

Samples will then be collected by compositing soil from select depth intervals (generally on a 1 to 2 feet basis) in a stainless-steel bowl or aluminum pan. The volume of collected material will be stirred to homogenize the sample and then placed in appropriate glassware for submission to the laboratory.

Samples are planned to be submitted for laboratory analysis of PCBs, PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene), uranium, thorium, and arsenic.

The general drilling soil logging and sampling activities will be conducted in accordance with SOP NMI-S-004 – Drilling and NMI-S-006 – Soil Description. Additional procedures related to radiological screening of the soil cores and coordination with the HP and RSO are outlined above.

Excess soil cuttings not used for analytical soil samples will be containerized and transported to the storage drum containment area. Upon completion, explorations completed deeper than 2 ft depth will be tremie-grouted with bentonite to ground surface, and the ground surface will be restored or graded to approximate existing surrounding conditions.

3.3 SEDIMENT SAMPLING

Sediment sampling is planned In the Former Drum Burial Area (AOI 2) and the Cooling Water Recharge Pond (AOI 4). Sediment sampling techniques will vary and be chosen depending on field conditions at time of sampling (depth of water, distance to shoreline, sediment types, etc.) and depending on depth intervals of sediment samples required, as follows:

1. Where shallow sediment sampling locations are dry and/or can be safely accessed on foot with minimal standing water present, and where only surficial sediment samples are required (up to 1-ft depth), sampling will be completed using a hand auger or other hand-held excavation device such as a shovel or hand trowel.

2. If sample locations can be access safely on foot which need to be sampled greater than 1-ft depth, a number of sediment sampling techniques may be used, including the following:
    a. If sediment is soft and loosely compacted consisting of a cohesive organic soil (silt), a Lexan® or polycarbonate approximate 2 or 3 in. ID tube sampling tube will used for sediment sample collection, as follows
        - The depth of water and location will be documented and recorded. The appropriate length of coring tube will be selected so that it could be driven into the sediment through the water column to the maximum depth of sampling.
        - For the initial attempt, the sample tube will pushed manually into the sediment to the bottom of the deepest sample interval depth. A cap would then be placed on the top of the tube and the tube then extracted with a sediment core collected within the tube. If the sediment material appears to be loose and may release from the bottom of the coring tube, a cap will be affixed to the bottom of the core prior to lifting it out of the water.

    If the collected sediment is falls out the bottom of the coring tube and sample cannot be recovered, the sampling tube will be fitted with a sliding rubber piston to maintain suction in the tube while advancing the sampler, which better prevent softs sediment from escaping the coring tube during extraction.

        - Prior to advancing the core, a piston is placed into the sample tube and the seals will be checked to ensure a tight fit. The piston will be placed approximately 1-ft above the bottom of the sample tube.

- The sample core tube will be lowered through the water column to the measured depth of the bottom. The line attached to the piston will be secured to allow the polycarbonate tube to slide past the piston as the tube is pushed into the sediment – the piston remains in place and does not move while the core tube advances into the sediment.
- The tube is then pushed manually into the sediment until the bottom of the deepest sample interval depth or refusal.
- The coring tube will then be pulled out of the sediment and lifted through the water column. As the bottom of the polycarbonate tube approached the water surface, a cap will be affixed to the bottom of the core prior to lifting the sample out of the water. After placing the bottom cap, the core will be positioned upright. Standing water preset above the piston will drained, the tube will be trimmed, the piston removed, and if necessary, another cap will be placed on the top of the tube.
- Location ID, orientation, and total penetration depth will be recorded on the top cap. Cores will be transferred to the onshore work area in an upright position
- Once the cores are transferred to the processing area, they will be left undisturbed momentarily to allow settling of suspended solids.
- After the standing water above the sediment was visibly clear, holes will be drilled into the core tube to drain excess water above the sediment core. After the water is drained, the cores will be placed horizontally to allow for logging and processing.
- Prior to processing the cores, additional aluminum foil or polyethylene sheeting will be placed on top of the work surface to prevent cross-contamination. If needed to access sediment from within the core tube, electric sheers will be used to cut open the core tube. Total recovery will be measured and the core will be the logged and photographed.
- Prior to collecting the sediment samples from the core tube, the cores will be segregated into sample intervals representative of depth intervals required for sampling. The sample intervals will be based on recovery and the entire core will assumed to compact uniformly. (For example, if the core recovery was 75% of the total penetration, the top 6 inches of the sediment layer will be assumed to be the top 4.5 inches of sediment recovered in the core.) After calculating sample intervals based on recovery, cores will be sectioned and the sediment sampled.

b. If sediment is densely compacted or consists of a coarser sand and gravel (rather than cohesive organic material), and if the sediment can be removed to the maximum depth required without the cored hole collapsing prior to reaching that depth, a hand auger will be used.

c. If sediment is densely compacted or consists of a coarser sand and gravel and the sediment cannot be removed to the maximum depth required without the cored hole collapsing, the following will be attempted:

- The 0-1 ft surface sediment sample will be collected either by hand using a hand auger or trowel. If the conditions do not allow collection by hand auger or trowel, an open-ended plastic cylinder will be driven into the ground surface to an approximate depth of 1 ft, which would isolate the sample area from surrounding loose wetland soils and preventing surface water from entering the excavation area. The sample was collected from inside the cylinder using a hand trowel.

- After the initial surficial sample interval is collected, a 4 in. diameter section of Schedule 40 PVC pipe will be hand driven to the maximum sampling depth. Installation of the PVC pipe drive pipe will prevent the borehole from collapsing and prevented surface water and loose sediments present around the area of excavation from mixing with the samples collected from the depth intervals. Sediment will be sampled by removing the material from within the drive pipe using a hand auger.

3. If sample locations are present within several feet of standing water and cannot be accessed safely on foot, a boat may be needed to facilitate sampling. Again, actual sampling equipment and techniques will be dependent on standing water depth, sediment type and sample depths. Sampling equipment and techniques described above may be used from a boat to collect sediment samples.

4. If sample locations cannot be collected using hand methods described above (hand auger, trowel, core tube, etc.) either by foot or from a boat, a direct push (Geoprobe) boring rig or a vibracore rig will be used to access and sample the sediment.

Sediment samples will be composited over either 1 or 2-ft depth intervals in a stainless-steel bowl or disposable aluminum pan. The volume of collected material will be stirred to homogenize the sample and then placed in appropriate glassware for submission to the laboratory.

Samples are planned to be submitted for laboratory analysis of PCBs, PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene), uranium, thorium, arsenic, copper, lead, and mercury. If the laboratory determines that the sample has less than 30% solids, a new sample will be collected with a greater sample volume, as necessary. In the field, if it appears the sample is overly wet, additional sample volume will be collected and submitted to the laboratory.

4. Implementation Procedures: PDI SSS-3 – SUBSLAB Soil Characterization

4.1 CONCRETE CORING OF THE FORMER BUILDING SLABS

In order to facilitate collection of samples below the former building slabs without compromising the slab or disturbing the soil beneath, a concrete coring subcontractor will be employed to core through the existing slab. This will allow a drill rig to access the soil beneath the slab without damaging the drilling equipment or without the need to remove sections of concrete slab and disturb the soil beneath. It will also provide further detail about the thickness of the concrete slab at the specified locations.

The contractor will core through the concrete slab to create an approximately 4-inch diameter hole. The concrete core will be placed aside for appropriate disposal during future activities. If obstructions are encountered during the subsurface sampling phase, sampling locations may need to be moved which would require additional locations to be cored through the slab.

4.2 SUBSURFACE SAMPLING

Following slab coring, soil sampling is generally proposed to be completed at each location using a direct push (Geoprobe) and/or hollow-stem auger drill rig. Sampling will likely be conducted using direct push methods via a Geoprobe® 6610DT rubber-track mounted direct push rig, or similar equivalent. To minimize impact to the flexible membrane liner covering the slab, plywood or maybe mats will be used to protect the liner for transport of the drill rig onto the slab and from exploration to exploration location.

Explorations will be advanced in 5 ft intervals using 5 ft long Macro-Core® drill tooling with 1 7/8 in. I.D. Geoprobe® acetate liners, driven to the appropriate depth below the ground surface (bgs). Upon retrieval of the liner core, 2-ft composite soil samples will be collected from the following depth intervals: 4 to 6 feet, 6 to 8 feet, 8 to 10 feet, 10 to 12 feet, 12 to 14 feet, 14 to 16 feet, 16 to 18 feet, 18 to 20 feet, 20 to 22 feet, 22 to 24 feet, and 24 to 26 feet.

The general drilling soil logging and sampling activities will be conducted in accordance with SOP NMI-S-004 – Drilling and NMI-S-006 – Soil Description. Additional procedures related to radiological screening of the soil cores and coordination with the HP and RSO are outlined above.

Samples will be collected by compositing soil from select depth intervals in a stainless-steel bowl or aluminum pan. The volume of collected material will be stirred to homogenize the sample and then placed in appropriate glassware for submission to the laboratory.

Samples are planned to be submitted for laboratory analysis of uranium, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene), arsenic, and thorium.

Excess soil cuttings not used for analytical soil samples will be containerized and transported to the storage drum containment area. Upon completion, explorations will be tremie-grouted with a Portland cement and bentonite grout mix to ground surface. The flexible membrane liner will be patched following demobilization of the drilling equipment.

Geosyntec consultants

DRAFT

NUCLEAR METALS, INC. SUPERFUND SITE

CONCORD, MASSACHUSETTS

Treatability Study Sample Collection and Holding Basin Geotechnical Boring Implementation Plan

developed to support

Remedial Design Work Plan - Appendix C – Holding Basin Containment Pre-Design Investigation Work Plan

&

Remedial Design Work Plan - Appendix E – In Situ Sequestration Treatability Study Work Plan

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September 2020

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 PURPOSE

This implementation plan describes the steps and potential sequencing for collecting subgrade soils and groundwater samples for use in the in situ sequestration (ISS) treatability study (TS) as well as the collection of samples and subsurface data for the design of the Holding Basin (HB) containment wall and cap.

As outlined in Appendix C and Appendix E of the Remedial Design Work Plan (RDWP), the scope of work described in this implementation plan includes:

- Advancing a maximum of five soil borings into the unsaturated zone beneath the HB liner to collect soils for ISS TS;
- Advancing a maximum of five soil borings into the saturated zone beneath the HB liner to a maximum depth of 65 feet below ground surface (ft bgs) to collect soils for ISS TS;
- Advancing of a maximum of four geotechnical soil borings beneath the HB liner to evaluate soil characteristics for HB cap design;
- Installing one temporary well to collect a groundwater sample from the upper 10-feet of the saturated zone beneath the HB liner;
- Advancing a maximum of two soil borings into the saturated zone downgradient of the HB to collect soils for ISS TS; and
- Collect groundwater samples from three existing monitoring wells downgradient of the HB for ISS TS.

Soil cores from beneath the HB will be screened by a health physics technician (HP) with support from the site Radiation Safety Officer (RSO) for safety and suitability for the TS.

The site layout is shown on **Figure 1**. Soil borings SB-TS-01001 through SB-TS-01010 target soils with historically elevated uranium concentrations and are shown on Figure 2 of Appendix E of the RDWP along with the coordinates and target ISS TS sample collection depths at each of these locations. Geotechnical soil borings HA20-B101 through HA20-B104 are shown on Figure 1 of Appendix C of the RDWP. Both figures have been attached to this implementation plan as **Figure 2** and **Figure 3**, respectively.

Work performed in and downgradient of the HB will be completed in accordance with the Health Physics Procedure (HPP) for Conduct of Radiological Work (HP-NMI-01) at a minimum, with the Radiation Safety Officer's ability to increase protective measures as they see fit. Additional references to standard operating procedures (SOPs) are added to specific work procedures listed below.

1.1 Mobilization and Setup

This section describes the steps anticipated to mobilize personnel and equipment into the HB for the purpose of advancing the borings and collecting soil/groundwater samples.

1. All equipment and tools that will enter the restricted area and that might contact radioactive contaminated areas (e.g., drill rig and driller rods) are subject to entry screening by an HP according to the Radiological Surveys HPP (HP-NMI-05 in the Field Sampling Plan [FSP], RDWP Appendix I) to determine if background levels of radiation exist on the equipment prior to exposure to on-site soils. Additionally, disposable barriers may be applied as directed by the on-site HP or RSO to prevent contaminating equipment and tools while in the restricted area. The driller and consultant personnel are asked to only bring tools and equipment into the restricted area that are deemed essential to complete the task because tools and equipment will be subject to screening by a HP before leaving the restricted area and, depending on impacts and ability to decontaminate, may have to be disposed of if contaminated.

2. Before entering the restricted area, workers will review and sign the specific radiation work permit for drilling and sampling activities and don the required personal protective equipment (PPE) and monitoring equipment as specified in the radiation work permit and/or instructed by the RSO or HP.

3. Drilling locations shown on Figures 2 and 3 will be located by the field engineer or geologist using a handheld GPS unit such as a Trimble GeoExplorer. The field engineer or geologist will additionally establish a soil staging area and a soil logging area at a central location within the HB restricted area; suggested locations for these areas are shown in the Site Layout, (**Figure 1**).

4. Prior to initiating work, the driller will consult with the HP and RSO to determine an approach for screening and transporting equipment (e.g., drill rig and skid steer) in and out of the HB. A large decontamination area will be established outside of the HB for decontamination of equipment as it leaves the HB. The number of trips in and out of the HB will be minimalized to the extent possible. A small tools decontamination area will also be established within the HB for sampling and drilling equipment (i.e., casing). The suggested locations for these decontamination areas are shown in the Site Layout (**Figure 1**).

5. Equipment will be mobilized into the HB via the ramp along the southeastern slope of the basin that has historically been used to mobilize equipment in and out of the basin. The slope and stability of the ramp appears to remain sufficient for mobilization of the intended equipment however it will be further assessed (prior to mobilization) to determine the need for additional traction (i.e., crane matting or similar) to safely mobilize the equipment into the HB.

6. Immediately prior to mobilization, the existing liner along the ramp will be cut and folded over to expose the sub-liner soils. This will not only prevent damage to the exiting liner from the equipment tracks but will also provide additional traction for the equipment while

maneuvering on the ramp. Although the soils located directly under the existing liner should consist of non-radiologically impacted fill material, the HP and/or RSO will screen the pathway prior to use to ensure that no immediate radiological concerns are present in the soils prior to, and following mobilization down the ramp. Once all the equipment has been mobilized into the bottom of the HB, the liner will be folded back over and temporarily sealed with adhesive tape (e.g., 35 mm Eternabond roof repair tape or similar). This process will be repeated each time equipment is tracked up or down the ramp.

7. A temporary handrail/guide rope will be installed along the length of the ramp to allow for personnel to traverse in and out of the HB by foot. All personnel will mobilize in and out of the HB on top of the existing liner to avoid contact with any sub-liner soils. Personnel traversing up and/or down the ramp will limit the supplies and/or equipment being carried to ensure they can maintain three points of contact with the handrail/guide rope. Additional traction along the pedestrian accessway will be affixed to the liner (e.g., adhesive traction strips or similar) to provide extra traction for the personnel in an effort to avoid slip hazards associated with morning dew/frost and/or rain showers.

8. Once the equipment has been mobilized to the bottom of the HB, plywood or plastic mats will be used beneath equipment where necessary, except where tooling is advanced, to protect the liner from damage. Special care shall be used to have extra plywood or wooden blocks beneath any stabilizing feet or dozer blade on the drill rig. If damage to the existing liner is observed, the damaged areas will be temporarily sealed to prevent water infiltration beneath the liner. A berm will be constructed beneath the existing liner along the edges of the damaged area to divert water flow from collecting in the area where the penetration occurred. The penetration will then be temporarily sealed with adhesive tape (e.g., 35mm Eternabond roof repair tape or similar) and poly sheeting, as necessary. Following completion of the work, the liner will be repaired to prevent unwanted infiltration pathways.

9. Drilling should begin at the borings targeting the saturated zone with the first boring location at SB-TS-01004 as identified on **Figure 2**. SB-TS-01004 is selected as the first boring because it targets elevated uranium concentrations at a deep target sample depth, which will allow more subsamples to be collected and, therefore, help generate the correlation curve described in Section 1.2 below.

10. After setting up the drill rig at a boring location, the driller will create an exclusion zone around the drill rig. The exclusion zone does not need to be a physical barrier and may be demarcated with traffic cones. Only the driller and driller's helper should enter the exclusion zone. Other field personnel may enter the zone only when invited and supervised by the driller.

11. At the boring location, the plastic liner will be cleanly cut and peeled back to expose approximately 2 square feet (ft^2) of underlying soil. The liner should be cut back enough (i.e., larger than the boring diameter) so that it does not contact the drill tooling.

12. After work areas and processes have been established and the liner has been cleanly cut, drilling will commence with continuous sampling using a minimum 4-inch-diameter drill casing and following the sonic drilling approach outlined in SOP NMI-S-004 in the FSP.

All efforts will be made to avoid using water during drilling to avoid altering the ISS TS sample geochemistry. The four geotechnical soil borings shown on **Figure 3** will commence following completion of ISS TS sample collection at locations shown on **Figure 2**. Geotechnical soil borings will be advanced to a minimum of 10 feet into native material with the sonic drill rig used for collection of the ISS TS soil samples. Prior to commencing geotechnical soil borings, the drill-head will be equipped with an auto-hammer for driving split-spoon samplers to collect continuous standard penetration test (SPT) data. Any necessary modifications to the drill-head will be conducted in the HB in an effort to avoid excess mobilizations of the drill rig in and out of the HB and the associated decontamination.

13. Soil cores will be extracted and carried to the logging area by the driller or the driller's helper. The boring will be advanced and the soil cores will continue to be extracted until the bottom depth of the target sample interval has been reached. The driller may proceed faster than the field engineer or geologist, so cores might need to be staged in liners near the logging area; however, the driller should not begin advancing the next boring until approved by the field engineer or geologist. A table of the recommended order of drilling and ISS TS samples to be collected at each is attached (**Table 1**).

1.2 <u>Soil Logging and Sampling</u>

This section outlines soil logging and sampling methods to be used during drilling and sampling in the HB. The general drilling, soil logging and sampling activities will be conducted in accordance with SOP NMI-S-004 – Drilling and NMI-S-006 – Soil Description. Additional procedures related to radiological screening of the soil cores and coordination with the HP and RSO are outlined below.

ISS TS Sample Collection

1. In 2002, the United States Environmental Protection Agency (USEPA) placed approximately 6 feet of clean fill in the bottom of the HB to grade the bottom of the HB and allow an impermeable liner to gravity drain rainwater to a culvert at the northern end of the HB. Several unsaturated zone borings (**Figure 2** and **Table 1**) have target sampling intervals that begin at the base of fill (and top of the native soil); if more than 1 foot of fill is observed at the top of these target sample intervals, then the target sample interval described below will be shifted deeper to collect 10 feet of native soil.

2. After a soil core has been set in the logging area, the core liner will be cut open, and soils will be initially screened with a handheld radiation survey instrument to ensure radiation levels are at a level where the core is safe to handle as determined by the HP and approved by the RSO.

3. If the soil core is safe to handle without further controls, the soils in the core will be logged by the field engineer or geologist using the Unified Soil Classification System (USCS) and following the soil description SOP (NMI-S-006, in the FSP). If the soil is deemed unsafe by the HP or RSO, other protocols will be followed as directed by the HP or RSO.

4. After logging, the soil core will be screened again using the handheld radiation survey instrument by the HP, and the count rate per minute will be logged over the length of the core at approximately 1-foot intervals.

5. If the soil core was collected from above the target sample interval for a boring location (see **Figure 2** and **Table 1**), a maximum of one, 1-liter (L) subsample of soil will be collected every 5 feet from the portion of the core exhibiting the highest radiological activity and submitted to the on-site laboratory for analysis. The remaining soil will be labeled, set aside in the soil staging area, and covered until the on-site laboratory results are received.

6. While advancing the first boring, the subsamples submitted to the on-site laboratory will be evaluated to develop a correlation curve relating readings from the handheld radiation survey instrument to the uranium concentrations measured at the on-site laboratory. The correlation curve will range from a minimum concentration of approximately 10 milligrams per kilogram (mg/kg) to a maximum concentration of approximately 500 mg/kg. The correlation curve should consist of a minimum of five points distributed across the range. Using this curve, uranium concentration can be estimated from the count rate per minute measured using the handheld radiation survey instrument. Additional subsamples beyond what is described may be included to refine the correlation curve. The RSO and/or HP will be consulted in the field to help select additional samples for the curve.

7. The correlation curve will apply to an individual handheld radiation survey instrument and will be used to determine the field measurement by the instrument that corresponds to 100 mg/kg. Soil with a count rate per minute that correlates to a uranium concentration equal to or greater than 100 mg/kg will be considered to have an "elevated uranium value" that is desirable for the ISS TS samples.

8. If the soil core is from the 10-foot target sample interval (identified in **Figure 2** and **Table 1**), those portions of the sample interval with radiation activity levels greater than the elevated uranium value shall be divided into a maximum of five subsamples with no subsample consisting of less than 1-L of soil. Subsamples will consist of a continuous length of soil core. For the first boring, it may be necessary to first collect and analyze a subsample of soil from the target sample interval with the highest screened activity in order to develop the correlation curve described above.

9. If the soil core is from a 10-foot sample interval (identified in **Figure 2** and **Table 1**) and no portion of the target sample interval exhibits radiological activity above the elevated uranium value, then two subsamples, each at least 1-L in volume, should be collected from the two portions of the target sample interval exhibiting the highest radiological activity levels and be submitted to the on-site laboratory for analysis (total of four subsamples). The remaining soil will be labeled, set aside in the soil staging area, and covered until the on-site laboratory results are received.

10. Soil subsamples will be collected in zip-top plastic bags following the sonic drilling and sampling SOP (NMI-S-004, in the FSP). Using a new, clean pair of nitrile gloves, each

zip-top plastic bag containing the soil sample will then be placed into a second zip-top plastic bag, sealed, labeled appropriately (sample identification number, sample collection date, time of collection, and sampler initials), and placed into a sample cooler.

11. The sample cooler will then be screened out of the radiation contamination area by an HP and brought to the on-site radiation screening laboratory, where an aliquot of the sample will be analyzed for preliminary total uranium concentration. Following screening and preliminary sampling, soil samples will be sealed in zip-top plastic bags to limit unnecessary exposure to the atmosphere.

12. Once all preliminary uranium concentration data from the on-site laboratory for a completed boring has been received, unsampled staged soil cores may be returned to the borehole at the discretion of the field engineer or geologist, in a manner that returns soils to their approximate origin depth. At the end of each boring, all soil should be either returned to the borehole it was extracted from or double bagged, labeled, and stored in a secure location in accordance with Radioactive Material Receipt and Shipment HPP (HP-NMI-12 in the FSP).

13. Drill tooling will be decontaminated in between each boring in accordance with SOP NMI-007 in the FSP and as outlined below in Section 1.6.

Geotechnical Soil Collection

1. Soil samples collected from the geotechnical borings will be placed in jars and zip-top bags after sampling and logging the soil as described above in ISS TS Sample Collection Steps 2 through 4. Geotechnical soil samples will be submitted to a geotechnical laboratory for grain size distribution and hydrometer testing in accordance with methods outlined in Appendix C of the RDWP.
2. At the end of the sampling day, all soil and sediment samples collected will be screened by the onsite radiological laboratory in accordance with Radioactive Material Receipt and Shipment HPP (HP-NMI-12 in the FSP) to determine the concentration and total radioactivity prior to shipment to Advanced Terra Testing of Lakewood, Colorado.

1.3 Additional Borings and Treatability Study Samples within Holding Basin

This section describes the procedures and decision for screening and collecting samples for the ISS TS from additional borings within the HB to ensure adequate soil volume collection. The sample collection will continue as follows:

1. Three of the five soil borings for each sampling zone (i.e., unsaturated and saturated) have been marked as primary, and the remaining two have been marked as secondary (see **Figure 2**). Once the first soil boring is complete, the other two primary soil borings for the same sampling zone should be completed following the drilling and screening procedures outlined above. The suggested order for boring advancement and required sampling at each location is included in **Table 1**.

2. After receiving the on-site laboratory results for samples from the three primary borings from each sampling zone (unsaturated and saturated), the total volume of the subsamples with uranium concentrations greater than 100 mg/kg shall be calculated. If the total volume exceeds 30 L, those samples shall be submitted to the treatability testing laboratory as described below. Soils from the sampling zones will be mixed at the lab to create soil that is adequately contaminated for the treatability testing. The proportions of unsaturated and saturated soils used to create the mixed sample will be selected once concentrations in the samples are known.

3. If less than 30 L of soil with uranium concentration greater than 100 mg/kg have been collected, then additional borings shall be advanced at either the secondary locations or as step-outs from the primary borings as determined by the field engineer or geologist in consultation with the driller, HP, and RSO, as needed. This additional sampling shall follow the same procedure described above until a total of at least 30 L of soil with uranium concentrations greater than 100 mg/kg have been collected from each saturation zone.

4. Once collected, the samples will be labeled, placed in coolers with ice, and shipped under standard chain-of-custody procedures (described in NMI-001 and HP-NMI-12 of the FSP) to Hazen Research, Inc. (Hazen) of Golden, Colorado, the laboratory conducting the TS. Soil samples will be shipped to the laboratory under appropriate packing and shipping protocols as determined by the RSO and outlined in Radioactive Material Receipt and Shipment HPP (HP-NMI-12 in the FSP).

5. Each time staff or equipment leaves the restricted area, they must be screened out of the restricted area under the guidance of the HP following the Personnel Monitoring and Decontamination HPP (HP-NMI-06, in the FSP) and sign out of the specific radiation work permit.

1.4 Collection of Groundwater Sample from Holding Basin

This section describes the procedures for the collection of a groundwater sample from the shallow saturated zone (approximately upper 10-feet of the saturated overburden) using a temporary well or Push-Ahead sampler developed by Cascade Drilling (following SOP NMI-GW-006). The procedure below is the intended protocol for collecting this groundwater sample and has been discussed with the driller, but may have to be adjusted in the field if unforeseen challenges are encountered.

1. The shallow groundwater sample will be collected during advancement following completion of at least one soil boring from the saturated zone because this will inform the team about the depth to groundwater. This depth to water will be determined in the open borehole using a water level indicator tape and the stabilized reading will be recorded.

2. Prior to collecting the water sample, the low-flow sampling instruments (i.e., multiparameter sonde and turbidity meter) should be calibrated according to manufacturer directions and as described in SOP NMI-GW-010.

3. At the location where the groundwater sample is anticipated to be collected, the boring will be advanced as described in Section 1.2 and 1.3 to the recorded depth to water as determined in the first saturated soil boring (i.e., Step #1 above). Once at the anticipated depth to water, a water level indicator will be used to check if there is standing water in the drill rods. If no water is detected, the boring will be advanced an additional 2-feet and checked for water again with the indicator. This process will be repeated until water is detected or soil cores appear saturated.

4. Once water has been detected, the Push-Ahead system will be advanced 5 feet beyond the bottom of the casing per (SOP NMI-GW-006) or the boring will be advanced an additional 5 feet and a temporary well will be installed. If the 5-foot advancement below the water table will encroach into the target interval for a soil sample (see **Figure 2**), then the project team should be consulted to determine if the groundwater sample should be collected. The temporary well will be constructed of at least 2-inch diameter, schedule 40 PVC riser with a 2-foot 10-slot PVC screen. Once the temporary well has been installed, the casing will be pulled up 2 feet to expose the well screen.

5. After the temporary well or Push-Ahead system is in place, a decontaminated submersible pump (e.g., micro-bladder pump) will be lowered to the middle of the screened interval (approximately) and purging will begin. Prior to the sample collection, the temporary well screen or the Push-Ahead sampler will be purged until field parameters (temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, specific conductance and turbidity) stabilize consistent with low-flow groundwater sampling procedures SOP NMI-GW-010. Purge water should be containerized during pumping.

6. Groundwater samples will be collected for the following analyses:

   - VOCs via Method 8260
   - 1,4-dioxane via Method 8270SIM
   - SVOCs via Method 8270
   - Total and dissolved uranium with U^{235}/U^{238} speciation via Method 6020A ICP-MS
   - Total and Dissolved Metals via Method 6020A ICP-MS (Al, Sb, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Mo, Ni, Se, Ag, Tl, Th, V, Zn)
   - Nitrate/Nitrite via Method 353.2
   - Total Phosphorous via Method 365.1
   - Orthophosphate via Method SMP4500P-E
   - Dissolved Organic Carbon via Method 9060
   - Total and Dissolved Cations (As, Fe, Mn, Ca, Mg, Na, K) via Method 6020A ICP-MS
   - Anion (Sulfate, Fluoride, and Chloride) via Method 300
   - Carbonate and Bicarbonate Alkalinity via Method 310.1

7. Samples will be placed immediately on ice, screened for radioactive contamination by the HP or RSO as necessary, and packaged and shipped to GEL and Alpha Analytical laboratories under standard chain of custody procedures following SOP NMI-001.

8. After the groundwater sample has been collected, the temporary well or Push-Ahead sampler will be removed and the boring will be advanced to collect the saturated soil samples for the ISS TS as described in Section 1.2 and 1.3.

9. Purge water should be properly stored and handled in accordance with the IDW SOP NMI-005 and in consultation with the HP and RSO.

10. If groundwater recharge into the temporary well is too low to sample, the project team will be consulted to determine if groundwater should be collected as a grab sample, the well installed deeper, another well installed at another boring location, or a well installed at a new location within the HB.

1.5 Collection of Soil, Rock Matrix, and Groundwater Treatability Study Samples Outside Holding Basin

The sections below describe the collection of soil and groundwater samples for the treatability studies at locations outside of the HB.

1.5.1 Collection of Soil Samples

This section describes soil sampling activities to be performed for locations outside of the HB. The soil collection locations will target low-uranium-content soils and high-uranium-content soils. The borings will be advanced using sonic drilling methods and are presented on (**Figure 4**). Boring TS-SB-01 will be collected first and is located at the distal end of the uranium plume (near monitoring well couplet MW-S01 and MW-BS01) in the area of lower-uranium concentration soil. Boring TS-SB-02 will be collected second and is located directly downgradient of the HB near monitoring well MW-S24 in the area of higher-uranium concentration soil.

The following procedures should be used when collecting soil samples:

1. Boring locations will be located by the field engineer or geologist using a handheld GPS unit such as a Trimble GeoExplorer (**Figure 4**). The field engineer or geologist will additionally establish a soil staging area and a soil logging area near each location.

2. The driller will mobilize the sonic drill rig to the TS-SB-01 location and create an exclusion zone around the drill rig. The exclusion zone does not need to be a physical barrier and may be demarcated with traffic cones. Only the driller and driller's helper should enter the exclusion zone. Other field personnel may enter the zone only when invited and supervised by the driller.

3. After work areas and processes have been established, drilling will commence with continuous sampling using a minimum 4-inch-diameter drill casing and following the sonic drilling approach suggested in SOP NMI-S-004 in the FSP. All efforts will be made to avoid using water during drilling to avoid altering the sample geochemistry.

4. Soil cores will be extracted and carried to the logging area by the driller or the driller's helper. The boring will be advanced and the soil cores will continue to be extracted until

the final depth of the boring is reached. Each boring will be advanced to 20 feet below the water table (approximately 70 ft bgs).

5. After a soil core has been set in the logging area, the core liner will be cut open and logged by the field engineer or geologist using the USCS and following the soil description SOP (NMI-S-006, in the FSP).

6. During soil logging the depth to the water table (i.e., top of saturated soil) should be noted and soils to 20 feet below the water table will be collected in a large sample container such as 5-gallon bucket(s) or a larger plastic or steel drums.

7. After the top 20-feet of saturated soils have been collected, these soils will be mixed and a subsample will be containerized for shipment to the lab. A minimum of 45 liters of soil from TS-SB-01 will be collected for testing and a minimum of 6 liters of soil from TS-SB-02 will be collected for testing.

8. After completion of the boring, any remaining soil cores should be returned to the borehole or appropriately stored on-site as IDW.

9. Drill tooling will be decontaminated in between each boring in accordance with SOP NMI-007 in the FSP and as outlined below in Section 1.6.

10. Once collected, the samples will be labeled and placed in coolers with ice, as described in SOP NMI-001 of the FSP. Soil samples will then be shipped to Hazen laboratory under appropriate packing, chain of custody and shipping protocols as determined by the on-site RSO and outlined in Radioactive Material Receipt and Shipment HPP (HP-NMI-12 in the FSP).

1.5.2 Collection of Groundwater Samples

This section describes activities to be completed to collect groundwater samples for the ISS TS. The sample location selection and minimum volume needed to perform the analyses are described in Appendix E of the RDWP and summarized below:

- Section 3.2.2 – TS-ISS-1 – Overburden well MW-S30 – 67 liters;
- Section 4.2.2 – TS-ISS-2 - Overburden wells MW-S24 (626 liters) and MW-S30 (58 liters);
- Section 5.2.1 – TS-ISS-3 – Bedrock well GZW-10-2 or MW-BS03 (13 liters).

The wells above were selected for the samples based on historical concentrations, including the highest uranium concentration (MW-S24) and background uranium (MW-S30) in overburden and the highest uranium detections in bedrock in November 2019 (GZW-10-2 and MW-BS03). Groundwater collected from these wells will be used in column studies at the laboratory. The groundwater collection procedures are outlined in the steps below.

1. Each morning the low-flow sampling instruments (i.e., multiparameter sonde and turbidity meter) will be calibrated according to manufacturer directions and as described in SOP NMI-GW-010.

2. After calibration is completed, a decontaminated bladder pump will be deployed to the appropriate depth (approximately the middle of the well screen). Care will be taken to place the generator used to power the pump downwind of the well (if used) and the compressor and controller in an accessible location.

3. Low-flow sampling equipment will be set-up and purging will begin in accordance with low-flow protocols provided in SOP NMI-GW-010 of the FSP. The crucial parameters measured during purging and sampling are pH, DO, ORP, and specific conductance. Purge water should be stored in 5-gallon buckets during low-flow sampling.

3. After purging the necessary amount of water or meeting geochemical stability criteria, groundwater will be collected into appropriate containers, expected to be drums. Groundwater from each well will be pumped into separate sample drums using the submersible pump and running the tubing through a rubber seal on the opening to the drum and water will be discharged below the water surface in the drum to avoid aeration[1]. A small vent hole or tube will be used to allow displaced air to escape the drum.

6. The sample drums will be appropriately labeled and sent to Hazen for analysis of pH, ORP, Inorganic carbon (coulometry), and total uranium, calcium, phosphorous, arsenic, and iron (ICP-MS/ICP-OES) and use throughout the ISS TS.

1.5.3 Collection of Rock Matrix

Crushed rock matrix (i.e. rock cuttings) will be collected during air rotary drilling at open bedrock extraction wells BEW-1, BEW-2, and BEW-3 (Figure 5) for TS-ISS-3 – Amendment Selection for Bedrock Groundwater described in Section 5 of RDWP Appendix E. The cuttings will be collected from the air rotary cyclone discharge using a strainer. At each location, two 5-gallon buckets, each half-full of bedrock cuttings, will be collected from the borehole. The field staff will then fill the buckets to above the top of the cuttings using water produced from drilling (at the same interval as cutting are collected). These buckets will then be sealed, labeled and set aside for a potential bedrock treatability testing. Bedrock cuttings and water should be collected from an interval suspected of having water bearing fractures but no deeper than from the upper 20 feet of bedrock, if possible, as determined by observations during drilling. The observations of changes in the consistency, color, and volume of the cuttings and inspection of the rock cores, in conjunction with water produced during drilling and the driller's observations will be used to infer water-bearing fractures and zones of softer or less competent bedrock.

[1] In addition to the procedure described, the drums may be purged with argon gas before starting to fill. Argon is heavier than air and will displace air (containing oxygen) from the drums and ensure that there is an argon headspace above groundwater as the drum is filled and shipped. This is a common practice used by Geosyntec at bioremediation sites where it is important to maintain anaerobic conditions as groundwater is collected.

The buckets of bedrock cuttings will be shipped under standard chain-of-custody procedures (described in NMI-001 and HP-NMI-12 of the FSP) to Hazen.

1.6 Decontamination

Decontamination of drilling tools and sampling equipment will be completed, at a minimum, between each drilling location using procedures outlined in the Field and Heavy Equipment Decontamination SOP NMI-007 included in the FSP - RDWP Appendix I. Additional information specific to this implementation plan is provided below.

1.6.1 Decontamination of Sampling Equipment

For decontamination of smaller drilling tools or equipment that may come in direct contact with sampling aliquots (i.e., split-spoons, hand-augers, pumps etc.), a decontamination area will be established within the HB (**Figure 1**) in an effort to optimize drilling activities. A separate, centrally located decontamination area may be established at the Site to decontaminate used submersible pumps, drill roads and other heavy equipment as detailed below in Section 1.6.2. The HS and/or RSO will be consulted to determine if a pump needs to be screened for radiation contamination prior to leaving the well area.

Designated decontamination areas will consist of wash basins with secondary containment (i.e., polyethylene sheeting) and all washing fluids and solids will be contained and transferred to 55-gallon drums or fractionization tanks as IDW.

1.6.2 Decontamination of Oversized Equipment

For decontamination of larger drill tooling or equipment that generally come in less direct contact with the sampling aliquots (i.e., drilling rods/augers), a temporary decontamination pad will be used for decontamination following the completion of each boring. Prior to initiating drilling activities, the temporary decontamination pad will be constructed in a location accessible from the HB in an effort to avoid long mobilizations (i.e., within 500 ft, if possible) (see **Figure 1**). The decontamination pad(s) will consist of, at a minimum, a plastic-lined pad with elevated sides to contain decontamination fluids and will be wide enough to accommodate the drilling tools and equipment as well as the drill rig. The pad(s) will be sloped slightly and have a sump pump placed on the lower side to facilitate the collection and containerization of washing fluid and solids as IDW.

1.6.3 Decontamination within Restricted Areas

As outlined above, during mobilization and set up activities, the HS and/or RSO will determine if a drilling location is within a restricted area indicating a potential for radioactive contamination. Decontamination procedures will proceed as described in the above sections but also include additional wipe samples for radiation screening of the drilling tools and equipment to be collected prior to mobilization, throughout drilling activities, and/or at the end of all drilling activities as outlined in Health Physics Procedures (HPP) Radiological Surveys HP-NMI-05 and the Heavy Equipment Decontamination and Free Release HP-NMI-025 included in the FSP – RDWP Appendix I. Any wipe sampling or screening efforts will be performed by the RSO or HP, in coordination with *de maximis*. No equipment will be released from a restricted area without the consent of the HP and/or RSO.

2 DEMOBILIZATION

This section describes activities to be completed after soil samples for the treatability study have been collected.

1. After the saturated and unsaturated samples have been collected, boreholes should be abandoned by backfilling with residual soil from the borings and filling any remaining space with bentonite as described in the sonic drilling and sampling SOP (NMI-S-004, in the FSP).

2. After the boring has been filled, the cut liner will then be patched as outlined in #8 of Section 1.1 and subsequently repaired by a qualified geomembrane contractor using a comparable geomembrane to the existing HB liner and following manufacturer recommend guidelines. Any additional damage to the liner caused during sampling activities should be repaired in a similar manner to maintain and impermeable cap over the HB.

3. All waste and PPE generated during the field event should be bagged appropriately and will be handled and dispose of as directed by the RSO and described in the IDW handling and storage SOP (NMI-005 in the FSP) and Radioactive Waste HPPs HP-NMI-019 and HP-NMI-027 in the FSP. No soil waste is expected to be generated during this scope, however if soil IDW is generated due to borehole collapse or other reasons that limit the volume of soil that can be placed back in the borehole, it will be handled and stored following the above mentioned SOPs.

4. Prior to equipment and tools being released from the NMI site, additional decontamination may be needed and screening with swab samples may be required as described in the Heavy Equipment Decontamination and Free Release HPP (HP-NMI-025) and determined by the on-site RSO.

3 CLOSING

The procedures outlined here are proposed and anticipated with reliance on the historical data and expected contaminant distribution. The procedures may be adjusted in coordination with the HP, RSO, and project team (e.g., project managers, directors, and driller) based on conditions encountered in the field. Details related to the selection of samples and specific TS procedures are included in the TS Work Plan (Appendix E of the RDWP).

TABLE

Table 1
Holding Basing Treatability Study - Soil Sampling Plan
Nuclear Metals, Inc. Superfund Site
Concord, Massachusetts

Proposed Boring Sequence	Location-Specific Information		Total Boring Depth (ft bgs)	Depth Interval (ft bgs)	Samples
	Soil Boring ID	Type - Zone		Top - Bottom	
1	**SB-TS-01004** 464 - 1,317	Primary - Saturated mg/kg U	55	0 - TON (~6)	*No Samples*
				TON (~6) - 45	One 1-L sample at highest activity location per 5 ft.
				45 - 55	Maximum five (5) samples from soil with HRSI measured activity level that correlates to >100 mg/kg. Each sample taken from continuous interval with minimum volume 1-L .
2	**SB-TS-01005** 462 - 545	Primary - Saturated mg/kg U	57	0 - TON (~6)	*No Samples*
				TON (~6) - 47	One 1-L sample at highest activity location per 5 ft.
				47 - 57	Maximum five (5) samples from soil with HRSI measured activity level that correlates to >100 mg/kg. Each sample taken from continuous interval with minimum volume 1-L .
3	**SB-TS-01006** 106 - 391	Primary - Saturated mg/kg U	56	0 - TON (~6)	*No Samples*
				TON (~6) - 46	One 1-L sample at highest activity location per 5 ft.
				46 - 56	Maximum five (5) samples from soil with HRSI measured activity level that correlates to >100 mg/kg. Each sample taken from continuous interval with minimum volume 1-L .
4*	**SB-TS-01007** 686 - 1,188	Secondary - Unsaturated mg/kg U	23	0 - TON (~6)	*No Samples*
				TON (~6) - 13	One 1-L sample at highest activity location per 5 ft.
				13 - 23	Maximum five (5) samples from soil with HRSI measured activity level that correlates to >100 mg/kg. Each sample taken from continuous interval with minimum volume 1-L .
5*	**SB-TS-01008** 579 - 1,309	Secondary - Unsaturated mg/kg U	14	0 - TON (~6)	*No Samples*
				TON (~6) - 14	Maximum five (5) samples from soil with HRSI measured activity level that correlates to >100 mg/kg. Each sample taken from continuous interval with minimum volume 1-L .
6	**SB-TS-01001** 3,868 - 12,023	Primary - Unsaturated mg/kg U	18	0 - TON (~6)	*No Samples*
				TON (~6) - 8	One 1-L sample at highest activity location per 5 ft.
				8 - 18	Maximum five (5) samples from soil with HRSI measured activity level that correlates to >100 mg/kg. Each sample taken from continuous interval with minimum volume 1-L .
7	**SB-TS-01002** 1,150 - 2,740	Primary - Unsaturated mg/kg U	17	0 - TON (~6)	*No Samples*
				TON (~6) - 7	One 1-L sample at highest activity location per 5 ft.
				7 - 17	Maximum five (5) samples from soil with HRSI measured activity level that correlates to >100 mg/kg. Each sample taken from continuous interval with minimum volume 1-L .
8	**SB-TS-01003** 939 - 1,977	Primary - Unsaturated mg/kg U	16	0 - TON (~6)	*No Samples*
				TON (~6) - 16	Maximum five (5) samples from soil with HRSI measured activity level that correlates to >100 mg/kg. Each sample taken from continuous interval with minimum volume 1-L .
9*	**SB-TS-01009** 213 - 388	Secondary - Saturated mg/kg U	60	0 - TON (~6)	*No Samples*
				TON (~6) - 50	One 1-L sample at highest activity location per 5 ft.
				50 - 60	Maximum five (5) samples from soil with HRSI measured activity level that correlates to >100 mg/kg. Each sample taken from continuous interval with minimum volume 1-L .
10*	**SB-TS-01010** 272 - 1,096	Secondary - Saturated mg/kg U	36	0 - TON (~6)	*No Samples*
				TON (~6) - 26	One 1-L sample at highest activity location per 5 ft.
				26 - 36	Maximum five (5) samples from soil with HRSI measured activity level that correlates to >100 mg/kg. Each sample taken from continuous interval with minimum volume 1-L .

Notes:

1. Abbreviations: ft = feet, ft bgs = feet below ground surface; HRSI = handheld radiation survey instrument; TON = top of native soil; L = liter; mg/kg = milligram per kilogram; U = uranium.

2. * = if needed; if the primary borings do not yield >30 L of soil with uranium concentration >100 mg/kg per saturation zone additional soil should be collected either from a secondary boring or as a step-out from a primary boring at the discretion of the field engineer or geologist.

3. **Bold Depth Interval** = Target sample interval for elevated uranium concentration in soil.

FIGURES

Legend

- Septic Fields
- Wetlands
- Surface Water
- Site Boundary
- Depth to Bedrock Contour (dashed where inferred)
- Former Building Concrete Foundations
- Site Driveways and Equipment Access
- Soil Sample Transport Route to the On-Site Radiological Laboratory
- Proposed Equipment and Personal Radiation Screening Area
- Proposed Drilling Rig and Equipment Decontamination Area (Rig and Rods Casing)
- Proposed Small Sampling Tools Decontamination Area (i.e. split spoons, trowels, etc)
- Approximate Holding Basin Restricted Area (Flat Bottom of the Holding Basin)
- Approximate Holding Basin Support Area (Holding Basin and Area Near the Ramp)
- Proposed Holding Basin Egress Location (Existing Sloped Ramp)
- Proposed Soil Logging and Screening Area
- Proposed Soil Staging Area

Notes:
1. Areas and locations shown may be adjusted based on field access.

Site Layout

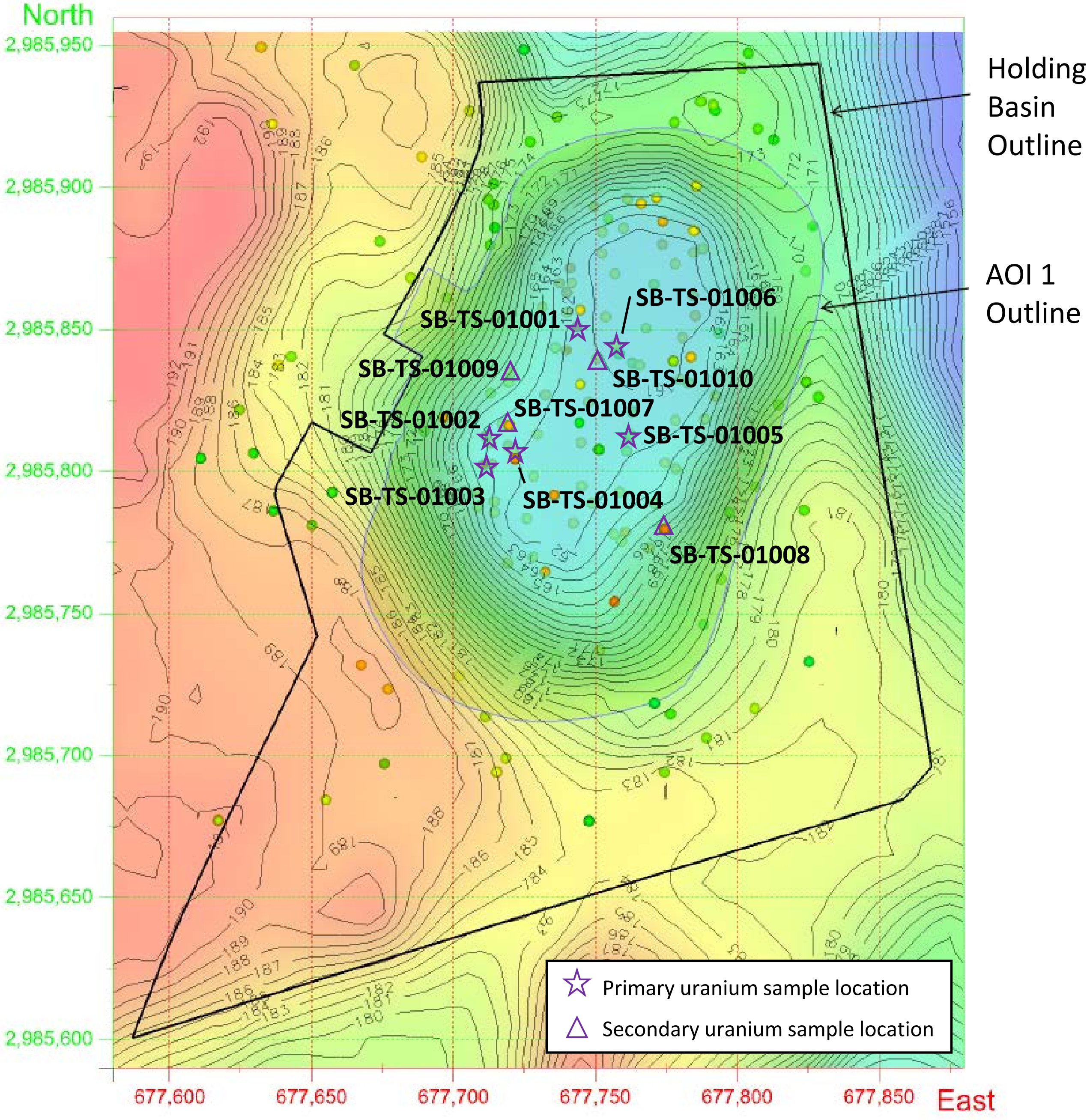
Nuclear Metals, Inc. Superfund Site
Concord, Massachusetts

Geosyntec consultants | de maximis, inc.

Acton, Massachusetts | July 2020

Figure 1

Q:\GISProjects\BR0090-NMISite\Projects\Updates_2020\Demaximis_Request\Figure 1 - Site Layout.mxd 7/24/2020 12:56:00 PM



Boring ID	Primary Boring	Easting	Northing	Sample Depth Interval (ft bgs)	Closest Historical Sample	
					Sample ID	Uranium Conc. Range (mg/kg)
Unsaturated						
SB-TS-01001	Y	677,743	2,985,851	8 – 18	SB-8	3,868 – 12,023
SB-TS-01002	Y	677,712	2,985,812	7 – 17	HB-308	1,150 – 2,740
SB-TS-01003	Y	677,714	2,985,803	6 – 16	SB-3	939 – 1,977
SB-TS-01007	N	677,717	2,985,817	13 – 23	HB-437	686 – 1,188
SB-TS-01008	N	677,775	2,985,780	4 – 14	SB-5	579 – 1,309
Saturated						
SB-TS-01004	Y	677,720	2,985,808	45 – 55	HB-439	464 – 1,317
SB-TS-01005	Y	677,762	2,985,812	47 – 57	HB-440	462 – 545
SB-TS-01006	Y	677,715	2,985,886	46 – 56	HB-441	106 – 391
SB-TS-01009	N	677,720	2,985,835	50 – 60	HB-503	213 – 388
SB-TS-01010	N	677,751	2,985,840	26 – 36	HB-423	272 – 1,096

1) Abbreviations: AOI = area of investigation; conc. = concentration; ft bgs = feet below ground surface; mg/kg = milligram per kilogram

2) Coordinates are in state plane

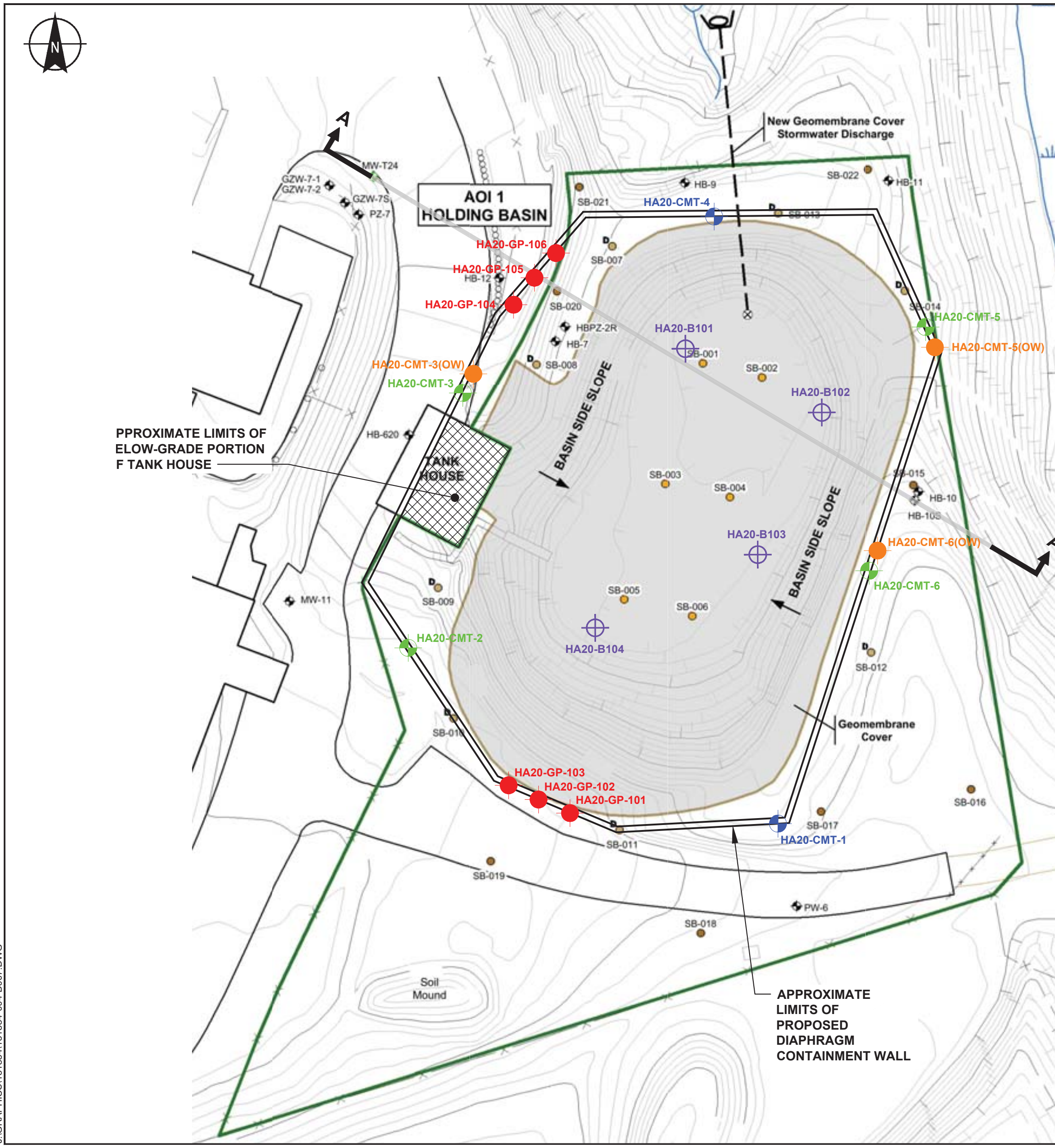
Geosyntec consultants

Acton, Massachusetts

Proposed Holding Basin Soil Boring Locations

ACTON, MASSACHUSETTS

PROJECT: BR0090 | FIGURE 2



LEGEND

HA20-CMT-1	PROPOSED HB-1 BORING (20 FT. INTO BEDROCK) - 3 CHANNEL CMT
HA20-CMT-2	PROPOSED HB-1 BORING (50 FT. INTO BEDROCK) - 3 CHANNEL CMT
HA20-CMT-3(OW)	PROPOSED 2-IN. OBSERVATION WELL
HA20-B101	PROPOSED HB-4 BORING (10 FT. INTO NATURAL MATERIAL)
HA20-GP-101	PROPOSED HB-2 GEOPHYSICS BOREHOLE (20 FT. INTO BEDROCK)
	DESIGNATION AND APPROXIMATE LOCATION OF SOIL BORING (SUB-BASIN)
	DESIGNATION AND APPROXIMATE LOCATION OF SOIL BORING (BASIN PERIMETER)
D	DESIGNATION AND APPROXIMATE LOCATION OF SOIL BORING (BASIN PERIMETER, TO BEDROCK)
	DESIGNATION AND APPROXIMATE LOCATION OF EXISTING WELL
	DESIGNATION AND APPROXIMATE LOCATION OF RI PROPOSED WELL
	APPROXIMATE LIMIT OF AOI 1 OUTLINE

NOTES

1. BASE PLAN TAKEN FROM REMEDIAL INVESTIGATION/ FEASIBILITY STUDY FIELD SAMPLING PLAN PREPARED BY MACTEC, INC. DATED 29 SEPTEMBER 2004.
2. CROSS SECTION TAKEN FROM FIGURE 3.4.2 OF REMEDIAL INVESTIGATION REPORT PREPARED BY GEOSYNTEC, DATED APRIL 2014.

0 40 80
SCALE IN FEET

HALEY ALDRICH

NUCLEAR METALS, INC.
2229 MAIN STREET
CONCORD, MASSACHUSETTS

PROPOSED SUBSURFACE EXPLORATION LOCATION PLAN - PDI HB-1

SCALE: AS SHOWN
MARCH 2020

FIGURE 3

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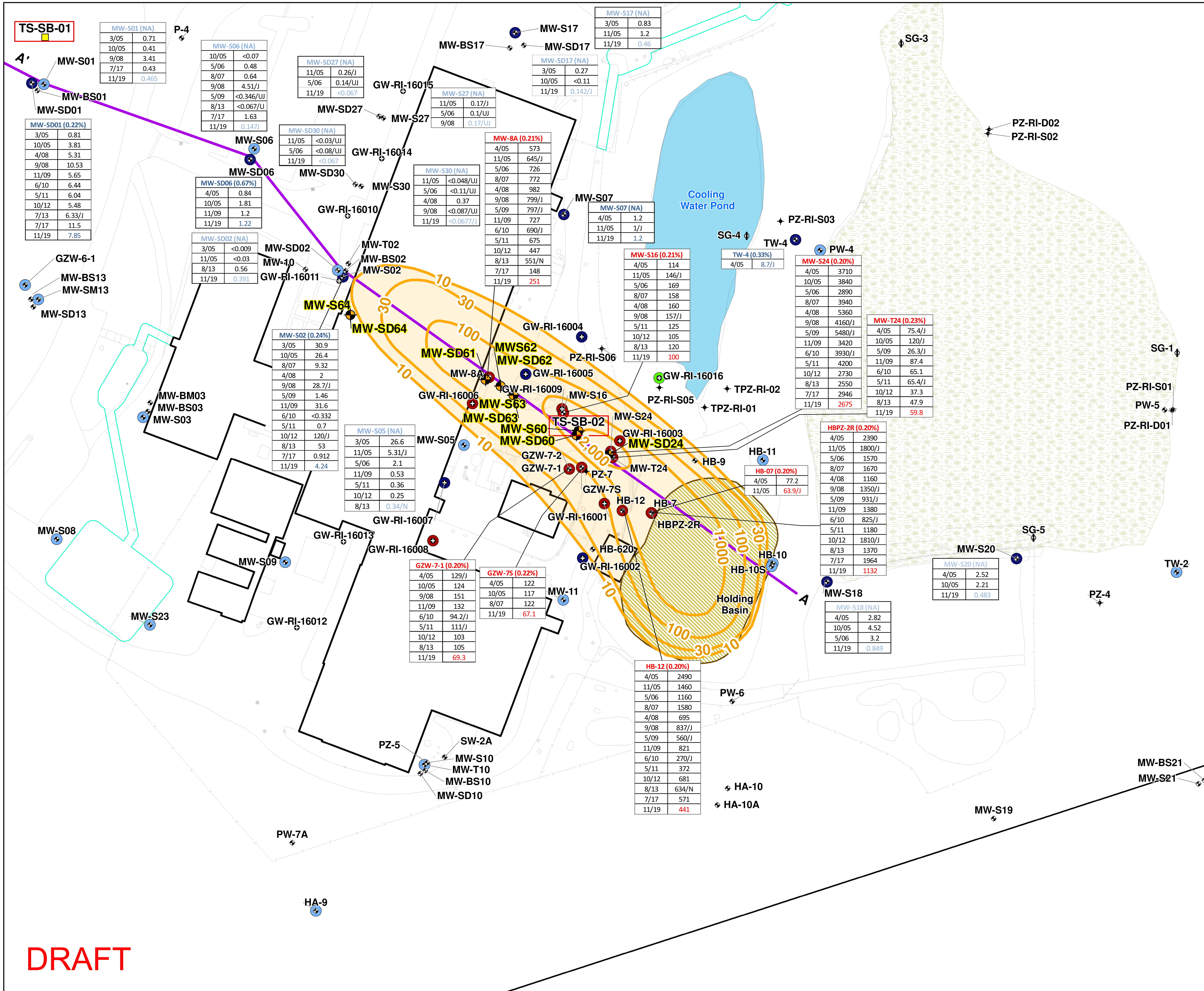


Legend

- Monitoring Well
- Piezometer
- Staff Gauge
- Groundwater Profiling Location
- Proposed Soil Sample Location
- Proposed Monitoring Well
- Holding Basin Source Control Area
- Septic Fields
- Wetlands
- Surface Water
- Uranium Contour in Overburden Groundwater, November 2019 (µg/L)
- Cross Section A-A"

Most Recent Total Uranium

- < 1 µg/L
- 1.01 - 10 µg/L
- 10.01 - 20 µg/L
- 20.01 - 30 µg/L
- > 30.01 µg/L MCL Exceedance in Overburden

Historical Total Uranium (µg/L)

HBPZ-2R (0.20%)	
Date	Total Uranium (µg/L)
8/13	1370
7/17	1964
11/19	1132

(0.21%) Represents the U-235% in the most recent sample data through November 2019

Notes:
1. Although concentrations shown are for total uranium, results shown are primarily depleted uranium (U-235% <0.6%).
2. Tabular summaries at wells downgradient of elevated total uranium are displayed for illustrative purposes only.
3. µg/L = micrograms per liter.
4. U = Not detected at or above the method detection limit shown.
5. J = Estimated value.
6. N = Indicates presumptive evidence of a compound. This flag is usually used for a tentatively identified compound, where the identification is based on a mass spectral library search.
7. Most Recent concentration text color within tabular summaries on figure coded by concentration ranges listed above.

Depleted Uranium in Overburden Groundwater - Data Through November 2019 and Proposed Monitoring Wells

Nuclear Metals Inc. Superfund Site
Concord, Massachusetts

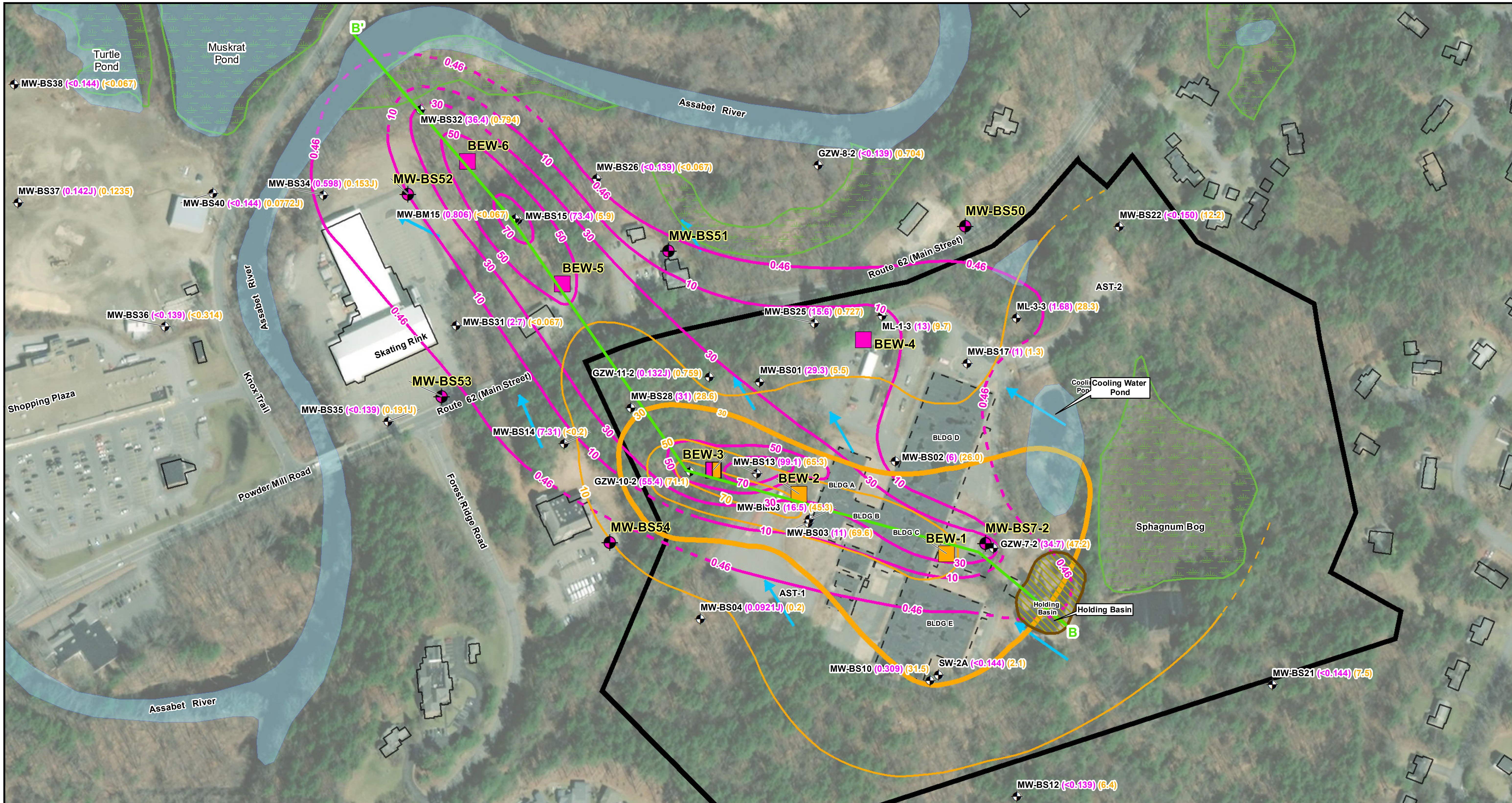
Feet
0 20 40 80 120 160

Geosyntec consultants
de maximis, inc.

Figure 4

Acton, Massachusetts

Q:\GIS\Projects\BR0090-NMI\Site\Projects\Updates_2020\Figure 2-5 Depleted Uranium in OB GW_v2.mxd



Legend

- Bedrock Monitoring Well
- Proposed Open Bedrock Well for Uranium Rebound Testing
- Proposed Open Bedrock Well for 1,4-Dioxane Rebound Testing
- Proposed Open Bedrock Well for 1,4-Dioxane and Uranium Rebound Testing
- Proposed Bedrock Monitoring Well
- Site Boundary
- Building Outline
- Former Building Concrete Foundation
- Bedrock Groundwater Flow Direction Inferred from November 2019 Groundwater Elevations
- Wetlands
- Surface Water
- Cross Section B-B'
- Uranium ISO Contour in Bedrock November 2019 (µg/L)
- Estimated Uranium ISO Concentration Contour in Bedrock November 2019 ug/L
- 1,4-Dioxane ISO Concentration Contour in Bedrock November 2019 (µg/L)
- Estimated 1,4-Dioxane ISO Concentration Contour in Bedrock November 2019 (µg/L)
- 0.57 1,4-Dioxane Concentrations November 2019 (µg/L)
- 76.9 Uranium Concentrations November 2019 (µg/L)

Note:
1. The uranium concentrations represent isotopically natural uranium.

DRAFT

N

0 220 Feet

Proposed Bedrock Wells for Uranium Rebound and 1,4-dioxane Delineation and Rebound Testing

Nuclear Metals, Inc. Superfund Site
Concord, Massachusetts

Geosyntec consultants | de maximis, inc. | Figure 5

Acton, Massachusetts | July 2020

Q:\GISProjects\BR0090-NMISite\Projects\Updates_2020\Figure 3-3 - Proposed Bedrock Wells for Uranium Rebound and 1,4-dioxane Delineation and Rebound Testing.mxd 7/15/2020 2:13:04 PM

****DRAFT****

NUCLEAR METALS, INC. SUPERFUND SITE
CONCORD, MASSACHUSETTS

Implementation Plan for Drilling and Pump Testing in Bedrock

developed to support

Remedial Design Work Plan - Pre-Design Investigation Work Plans for Uranium (RDWP Appendix B) and 1,4-Dioxane (RDWP Appendix D) in Bedrock Groundwater

Prepared for:

de maximis, inc.

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Prepared by:

Geosyntec consultants

289 Great Road, Suite #202
Acton, MA 01720
August 2020

Table of Contents

List of Figures

Attachments

1. PURPOSE

This plan includes implementation steps for the data acquisition and analysis activities related to bedrock drilling and testing described in the Remedial Design Work Plan (RDWP) sections:

- Appendix B (In Situ Sequestration, ISS), Section 3.0 Pre-Design Investigation Work Plan ISS-2 Pumping and Rebound Analysis for Uranium in Bedrock Groundwater, and
- Appendix D Pre-Design Investigation Work Plan for 1,4-Dioxane and VOCs in Bedrock Groundwater

This plan does not include steps for the portion of the ISS pilot testing in overburden also describe in RDWP, Appendix B. An implementation plan for overburden ISS testing will be submitted under separate cover following laboratory treatability testing to determine the preferred ISS additives.

As shown in Figure 2-7 of Appendix B, the 1,4-dioxane plume extends from the upgradient on-site areas near the Holding Basin to the downgradient areas north of Route 62 and south of the Assabet River. The uranium in bedrock plume is collocated with the 1,4-dioxane plume in the on-property portions of the 1,4-dioxane plume south and upgradient of Route 62.

Although the ISS-2 PDI focuses on the uranium concentrations in bedrock in the upgradient portion of the 1,4-dioxane plume (i.e., RDWP Appendix B) and the 1,4-dioxane and VOCs PDI focuses on the impacts in the downgradient areas of the Site (i.e., RDWP Appendix D), the initial approach and work components for each PDI are similar. Both include drilling, geophysics and test pumping of the bedrock groundwater. Thus, this implementation plan was developed to support an efficient execution of the work proposed in both work plans. Work described herein is intended to further define the distribution of uranium and 1,4-dioxane/VOCs in bedrock groundwater, assess the hydraulic properties of the bedrock aquifer, and collect data required to evaluate the feasibility of a pumping remedy. Additional references to Standard Operating Procedures (SOPs) are added to specific work procedures listed below.

1.1 Sequence of Work

It is proposed that five bedrock monitoring wells, designed to aid in further delineation of the 1,4-dioxane/VOC plume(s), are to be installed first and will serve as aquifer response monitoring locations during advancement of proposed open bedrock extraction wells (BEWs). This section describes the sequence of the work described in Section 3 of Appendix B and in Appendix D of the RDWP. These steps are listed below; a flowchart of the sequence is also presented on Figure 1.

Step 1. Installation of bedrock monitoring wells MW-50 through MW-54, and MW-BS7-2

Step 2. Installation of open bedrock extraction wells BEW-1 through BEW-6

Step 3. Geophysical logging and packer testing at BEW wells

Step 4. BEW well step testing

Step 5. BEW well pumping, effluent water quality and aquifer response monitoring

Step 6. Rebound monitoring and sampling

Step 7. Pumping and rebound data analysis and reporting.

The steps above outline the main components of the proposed work. Detailed procedures for each step are described in Section 2 below.

1.2 Mobilization and Setup

This section describes the steps to mobilize personnel and equipment to drilling locations for the purpose of advancing the borings and installing monitoring wells. A site plan with specific areas highlighted for personnel parking, driller equipment laydown and drilling location access, and equipment traffic patterns is presented on Figure 2.

1. As part of the pre-bid site walk, drillers have visited the site to get a general familiarity with site layout, access to/from various areas of the site, and have inspected drilling locations. Prior to initiating site work, the selected driller will also prepare a drilling implementation plan describing their approach to the work at each location (e.g., selected rig, Investigation Derived Waste [IDW] management, decontamination, etc.). The selected driller will also prepare an OSHA-compliant health and safety plan for their workers. Both of these plans will be reviewed by *de maximis*, Geosyntec and/or Haley & Aldrich.
2. Ahead of the drilling activities, *de maximis* will secure access agreements for the proposed boring locations located on neighboring properties. *de maximis* will also mark the limit of the drilling areas along public right of ways and ensure notification to Dig Safe so that subsurface utilities are marked and known ahead of the drilling. Kinder Morgan pipeline services may also need to be called to discuss procedures and provide access for drilling equipment over or near the gas pipeline running in the northeast to southwest direction and crossing Rt. 62 near the Valley Sports Arena.
3. Drilling locations will be located by the field engineer or geologist using a handheld GPS unit such as a Trimble GeoExplorer and a wooden stake will be placed at the location of the proposed borehole. For locations in pavement, spray paint will be used to mark the well location.
4. *de maximis*, through use of a subcontractor as needed, will clear trees and brush, and create temporary roadways for equipment to access drilling locations (e.g., BEW-4, 5 and 6). General access is shown on Figure 2. These paths will be adjusted as needed based on site conditions (e.g., to minimize removing large trees and/or to traverse more stable ground).
5. The drilling subcontractor will mobilize equipment and personnel to the site. On the first day of drilling, an extended tailgate meeting will occur where site-specific health & safety protocols are discussed, and chain of command/communication will be

covered. Drillers will then inspect the first, and potentially all, drilling location(s). At the drilling locations, the driller and the field engineer or geologist will assess access and review the Dig Safe markings to ensure that there are no subsurface or overhead utilities at the proposed drilling location. The driller will then mobilize and set up the drill rig and support vehicles at the first drilling location. The driller will demarcate the exclusion zone around the rig to keep unauthorized persons away from the area. The driller will stage drums and/or roll off container at the drilling location for the purpose of containerizing the IDW. The field engineer or geologist will establish a soil staging area and a soil logging area near the drilling rig for the purpose of logging soil cores and drill cuttings.

6. At the discretion of the Health Physicist (HP) and Remediation Safety Officer (RSO), restricted areas may be established around drilling locations described in this implementation plan to control the potential of radioactive contamination. Additional prescreening of soil cores by the HP with a portable radiation survey instrument may be required prior to handling. The HP and RSO will be consulted prior to commencing drilling, especially at BEW-1 and MW-BS7-2.

7. If a restricted area is established by the HP and/or RSO, all equipment and tools that will enter the restricted area (e.g., drill rig and driller rods) are subject to entry screening by an HP according to the Health Physics Procedure (HPP) for Radiological Surveys (HP-NMI-05 in the Field Sampling Plan [FSP] – RDWP Appendix I) to determine if background levels of radiation exist on the equipment prior to exposure to on-site soils. Additionally, disposable barriers may be applied as directed by the on-site HP or RSO to prevent contamination of the equipment and tools while in the restricted area. The driller and consultant personnel are asked to only bring tools and equipment deemed essential to complete the tasks into the restricted area. Nonessential tools and equipment mobilized into the restricted area are subject to screening by HP and RSO and may have to be disposed of if the HP/RSO determines that they have been contaminated and are not suitable for decontamination.

8. Prior to the commencement of open bedrock extraction well drilling, pressure transducers will be installed to monitor water levels in nearby monitoring wells. Transducer locations will be targeted for selected existing and newly installed bedrock monitoring wells (see Figure 3-4 and Table 3-2 of Appendix B of the RDWP). To monitor background groundwater levels, the transducers should be installed approximately one week prior to the start of bedrock drilling. Transducers will be installed using the Pressure Transducer Installation Log provided in Attachment A to Appendix B of the RDWP. Pressure transducers will be a non-vented type (e.g., Solinst Levelogger Model 3001 or equivalent), and their data will be barometrically compensated using ambient air pressure data collect by a Barologger (or similar) deployed at the Site.

1.3 Decontamination

Decontamination of drilling tools and sampling equipment will be completed, at a minimum, between each drilling location using procedures outlined in the Field and Heavy Equipment Decontamination SOP NMI-007 included in the FSP - RDWP Appendix I. Additional information specific to the Implementation Plan for Drilling and Pump Testing in Bedrock is provided below.

1.3.1 Decontamination of Sampling Equipment

For decontamination of smaller drilling tools or equipment that may come in direct contact with sampling aliquots (i.e., split-spoons, hand-augers, pumps etc.), a decontamination area will be established in close proximity of each drilling location in an effort to optimize drilling activities.

Designated decontamination areas will consist of wash basins with secondary containment (i.e., polyethylene sheeting) and all washing fluids and solids will be contained and transferred to 55-gallon drums or fractionization tanks as IDW.

1.3.2 Decontamination of Oversized Equipment

For decontamination of larger drill tooling or equipment that generally come in less direct contact with the sampling aliquots (i.e., drilling rods/augers), a temporary decontamination pad will be used for decontamination following completion of each drilling location. Prior to initiating drilling activities, temporary decontamination pad(s) will be constructed in locations accessible from each installation area in an effort to avoid long mobilizations (i.e., within 500 ft, if possible) from the drilling location. The decontamination pad(s) will consist of, at a minimum, a plastic-lined pad with elevated sides to contain decontamination fluids and will be wide enough to accommodate the drilling tools and equipment. The pad(s) will be sloped slightly and have a sump pump placed on the lower side to facilitate the collection and containerization of washing fluid and solids as IDW.

1.3.3 Decontamination within Restricted Areas

As outlined above, during mobilization and set up activities, the HS and/or RSO will determine if a drilling location is within a restricted area indicating a potential for radioactive contamination. Decontamination procedures will proceed as described in the above sections but also include additional wipe samples for radiation screening of the drilling tools and equipment to be collected prior to mobilization, throughout drilling activities, and/or at the end of all drilling activities as outlined in Health Physics Procedures (HPP) Radiological Surveys HP-NMI-05 and the Heavy Equipment Decontamination and Free Release HP-NMI-025 included in the FSP – RDWP Appendix I. Any wipe sampling or screening efforts will be performed by the RSO or HP, in coordination with *de maximis*.

Decontamination will be conducted following procedures as described above for both sampling equipment and oversized equipment. However, any temporary decontamination pad(s) that are anticipated to be used for equipment from within restricted areas will be constructed in a manner to allow for the drill rig to be driven onto the pad to allow for decontamination of the drill rig as well as any tools that may have come in contact with potential radioactive contamination.

No equipment will be released from a restricted area without the consent of the HP and/or RSO.

2. STEP 1 - NEW BEDROCK MONITORING WELL INSTALLATION

This section describes, the scope and procedures for:

1) installation of five new bedrock monitoring wells (MW-BS50 through MW-BS54) and BarCad® replacement bedrock monitoring well (MW-BS7-2);

2) development of the monitoring wells; and

3) collection of analytical samples from the monitoring wells.

The selection of locations and specific purpose of each bedrock monitoring well, and installation methods are described in RDWP Appendix B Section 3.4.2.3 and Appendix D Section 5. The proposed locations of these wells are shown on Figure 3-3 of Appendix B and Figure 7 of Appendix D. The proposed order of the monitoring well installation, based on locations expected to have the lowest to highest 1,4-dioxane and uranium concentrations, is listed below.:

1. MW-BS50,
2. MW-BS54,
3. MW-BS53,
4. MW-BS51,
5. MW-BS52, and
6. MW-BS7-2

MW-BS7-2 is a replacement for existing Barcad® well GZW-7-2 and is proposed to be installed last due to its proximity to the Holding Basin where residual uranium concentrations may be higher in overburden soils. The order wells are installed may be revised based on the status of access agreements, drill rig access, and field conditions.

Monitoring well boreholes will be advanced following the Soil and Rock Drilling SOP NMI-S-004, in the FSP. This approach, in summary, consists of the following:

1. The monitoring well boreholes will be advanced using Rotosonic drilling methods with a 4.75-inch diameter core barrel and 6-inch diameter override casing (or similar).
2. The boring will be advanced through the overburden and approximately 2 to 3 feet into competent bedrock as determined by the field engineer or geologist in coordination with the driller and project manager. Overburden soil cores will be continuously extracted and logged by the field geologist in accordance with Unified Soil Classification System following guidance in SOP NMI-S-006. After logging, soil cores will be containerized in labeled IDW drums as described in SOP NMI-005. The field engineer or geologist will additionally monitor and document drilling rates and water

losses if it is necessary for the driller to use water during drilling (e.g. to keep heaving sands from entering the sonic casing).

3. Once the override casing is properly seated approximately 2 to 3 feet into competent bedrock, the driller will retool the drilling rig and advance a 3.75-inch diameter (HQ) or 4.8-inch diameter (PQ) (or similar) bedrock borehole using wireline coring methods. During wireline coring, the field geologist will inspect the rock cores for rock type, fracture characteristics and weathering following the guidance in SOP NMI-S-006. Rock cores will be containerized in labeled drums per SOP NMI-005. Additionally, the field geologist will continue to monitor drilling rates and water loss will be tracked as a minimum volume to be removed during well development.
4. Wireline coring will advance to a depth of approximately 25 feet below the top of bedrock for the new monitoring wells and a depth of approximately 18 to 20 feet below top of bedrock for replacement well MW-BS7-2.
5. After reaching the final boring depth, the optimal well screen length and location within the bedrock may be adjusted by the field geologist in coordination with the driller and project manager based on the location(s) of water bearing fractures inferred from the rock cores and water loss to the formation observed during coring as a function of depth.
6. Monitoring wells will be installed following the guidance in SOP NMI-GW-003, in the FSP, and final construction recorded by the field engineer or geologist, including top and bottom of screen, top and bottom of filter pack, quantities of filter pack sand, choker sand, bentonite chips (if used), and bentonite powder and cement used in the cement/bentonite grout. The following describes the monitoring wells construction.

   - Bentonite chips or a mixture of bentonite chips and sand from the bottom of the borehole to approximately 1-foot below the proposed bottom depth of the well screen. The 1-foot internal between the top of the chips and the bottom of the well screen should be filled with #00 “choker sand” to prevent fines from the bentonite entering the well screen;
   - 5- or 10-foot long, 2-inch diameter, 10-slot Schedule 40 polyvinyl chloride (PVC) well screen (length and location determined based on location(s) of inferred water bearing fractures);
   - 2-inch diameter schedule 40 PVC riser from the top of the well screen to the ground surface;
   - Morie #0 sand filter pack placed from the bottom of the well screen to 2 feet above the top of the well screen;
   - One foot of choker sand (Morie #00) overlaying filter pack;
   - Three (3) feet of bentonite chip seal overlaying choker sand;
   - Tremied cement/bentonite grout mixture from the bentonite seal to the ground surface after the bentonite chip seal has sufficiently hydrated; and

- Flush-mount or standpipe protective casing to prevent surface water inundation and provide security

7. A minimum of 48 hours after installation of the well, the screened interval will be developed using a surge block equipped with a check valve (e.g., Waterra inertial pump) to flush the filter pack, and then the screened interval will be purged using a submersible pump. The screened interval will be considered developed when turbidity readings are below 5 NTUs or at least five screened interval volumes total of purge water have been removed (see SOP NMI-GW-002) in addition to the water lost to the formation during drilling. Purge water from the well will be containerized in labeled drums or fractionation tanks in accordance with SOP NMI-005.

8. After completing development of the five new monitoring wells (MW-BS50 through MW-BS54), the wells will be purged using and sampled using a low-flow, flow-through apparatus in accordance with sampling procedures outlined in in SOPs NMI-002, NMI-003, and NMI-GW-010. Samples will be collected for the following analytes and submitted to a certified analytical laboratory in accordance with chain of custody and sample shipping procedures listed in SOP NMI-010.

   - 1,4-dioxane via USEPA Method 8270 selected ion monitoring (SIM)
   - Volatile organic compounds (VOCs) via USPEA Method 8260
   - Total and dissolved uranium[1], arsenic, cobalt, manganese, and thorium via USEPA Method 6020A inductively coupled plasma – mass spectrometry (ICP-MS)

9. After completing development of the replacement monitoring wells (MW-BS7-2), MW-BS7-2 and the existing Barcad® well (GZW-7-2) will be sampled using a low-flow, flow-through apparatus in accordance with sampling procedures in SOPs NMI-002, NMI-003, and NMI-GW-010. Samples will be collected for the following analytes and submitted to a certified analytical laboratory in accordance with chain of custody and sample shipping procedures listed in SOP NMI-010:

   - 1,4-dioxane via USEPA Method 8270 SIM
   - Total uranium (U^{235}/U^{238}) using USEPA Method 6020A ICP-MS

10. It is anticipated that up to three co-sampling events will be needed to establish whether the results from MW-BS7-2 are comparable to GZW-7-2. If the results are comparable, well GZW-7-2 will cease to be used for monitoring and may be decommissioned in accordance with SOP NMI-GW-004.

11. Bedrock hydraulic conductivity testing will be considered for specific new monitoring well(s) that do not exhibit a hydraulic response to pumping from a nearby proposed extraction well(s). If obtaining the hydraulic conductivity estimates via well-point tests

[1] The total and dissolved analysis for uranium will include speciation for U-235 and U-238 isotopes.

is determined to be necessary, the slug testing will follow procedures outlined in SOP NMI-GW-019.

3. STEP 2 - BEDROCK EXTRACTION WELL INSTALLATION

This section describes, the scope and procedures for the installation and development of six new 6-inch diameter bedrock extraction wells (BEW-1 through BEW-6). The proposed location of these wells are shown on Figure 3-3 of Appendix B and Figure 7 of Appendix D of the RDWP.

The order of bedrock extraction well installation should start with BEW-6 and proceed sequentially to BEW-1 in order of increasing anticipated uranium concentration. This order may be revised based on access agreement status or drilling rig access or other field conditions.

The details regarding the selection of locations for the proposed wells, and descriptions of the specific work and oversight activities are provided in Section 3.4 of Appendix B and Section 5.2 of Appendix D. Additional description of the drilling methods and sampling activities that will be used are provided in SOP NMI-S-004. The advancement of open bedrock extraction wells through the overburden and into bedrock are summarized below. Final selection of drilling contractor will determine the method of well installation; the following sections summarize steps for each method, but selection of the method will be dependent on drilling contractor selection.

3.1 Overburden Drilling

1. Rotosonic, air rotary or dual rotary drilling will be used to advance casing through the overburden. The drilling method will be selected from the methods proposed by the drilling subcontractors in their proposals in response to the Request for Proposal (RFP) for drilling services prepared by *de maximis*. During drilling, the field engineer or geologist will monitor and document drilling rates and water losses and production.
2. If dual rotary drilling methods are used, the driller will advance, a minimum 6-inch diameter cased borehole through the overburden. The cuttings will be evacuated through the annular space between the drill string and casing using air supplied by an onboard or auxiliary compressor and directed into a cyclone suspended over drums or a roll-off container. The field engineer or geologist will collect cuttings coming from the cyclone using a strainer at approximately 5-foot increments and washed with potable water. A detailed description of the dual rotary drilling method and collection of cuttings for lithologic description is included in SOP NMI-S-004. When bedrock is first intercepted, the field geologist should collect cuttings more frequently (i.e. every 1 to 2 feet) to assist in evaluating the integrity of the shallow bedrock. The field geologist will monitor, inspect, and log drill cuttings for color, rock type, consistency, and rate to assess lithology changes following guidance in SOP NMI-S-006.
3. The driller will subsequently spin the outer dual rotary casing up to within 1 to 2 ft of the top of bedrock and pump a volume of cement bentonite grout equal to 1.5 times the volume required to fill the bedrock socket to the bottom of the borehole. Once the grout is placed in the bedrock socket, the driller will spin the outer casing back down to the

bottom of the borehole. The grout is intended to seal the bedrock borehole from the overburden and will be allowed to set overnight.

4. *Alternate equipment:* If rotosonic drilling methods are used, a 9-inch diameter core barrel and 10-inch diameter casing (or similar) will be advanced through the overburden several feet into bedrock. Once the bedrock is intercepted, the field geologist will pay close attention to the rock cuttings or cores to evaluate the integrity of the bedrock for the purpose of setting the permanent steel casing. After the bedrock socket is determined by the field geologist in coordination with the driller and project manager to be of sufficient integrity for the casing, the drilling will be suspended, and the driller will remove the drill string from the borehole. Overburden soil cores will be continuously extracted during the initial advancement of the borehole and logged by the field geologist following guidance presented in SOP NMI-S-006. The field geologist will inspect and log the cores for color, rock type, and consistency to assess lithology changes following guidance in SOP NMI-S-006. Soil cores will be containerized in labeled drums as described in SOP NMI-005. The driller will then likely proceed to install a 10-inch (or similar) diameter override casing and retrieve the 6-inch casing. After the 10-inch casing is seated into the bedrock, the driller will install a 6-inch permanent casing in the borehole and grout the annular space between the 6-inch permanent casing and the 10-inch override casing as the 10-inch casing is sequentially retrieved from the borehole.

5. Once the grout is determined to have cured, the driller will reconfigure the drill rig for air rotary or sonic drilling to advance a 6-inch borehole into the bedrock.

3.2 Bedrock Drilling

The bedrock boreholes will be advanced to target depths specified in Tables 3-1 of Appendix B and Table 1 of Appendix D through the permanent steel casing installed into bedrock. Although the bedrock boreholes can be advanced using sonic drilling methods, the preferred bedrock borehole advancement method for the open borehole extraction wells is air rotary which can be used in conjunction with water level monitoring at nearby wells to evaluate the connectivity between fractures that intercept the wells and the advanced borehole. If sonic drilling methods are used, the number and locations of pressure transducers installed to monitor water levels in the formation during drilling may be revised from the plan shown on Figure 3-4 of Appendix B and Figure 9 of Appendix D of the RDWP and the locations presented in Table 3-2 of Appendix B and Table 2 of Appendix D.

1. Prior to commencing air rotary drilling into the bedrock, transducers previously installed in nearby bedrock monitoring wells (see Table 3-2 of Appendix B and Table 2 of RDWP Appendix D) will be reprogrammed from a longer logging interval during the baseline monitoring period to a short logging interval (e.g., 1 or 5 seconds). The short logging interval will ensure that the time of the water level response can be correlated to the depth of the borehole being advanced.

2. Additionally, the field engineer or geologist will periodically measure the depth to water in the nearest deep overburden well. The water level will be monitored as the bedrock borehole is advanced to evaluate whether the grout seal remains intact during

drilling. If greater than 1 ft of water level rise/drop is observed in the overburden monitoring well, then drilling should be suspended, and the project manager contacted to determine the appropriate next steps.

3. During air rotary drilling, cuttings will be directed into a cyclone suspended over drums or a roll-off container or accumulated at the drilling location and transferred to drums. The field engineer or geologist will collect samples of the cuttings at approximately 5-foot increments. The cuttings will be logged following using procedures outlined in SOP NMI-S-006.

4. *Alternate Equipment:* If sonic drilling methods are used to advance the bedrock borehole, the bedrock core and/or rock fragments will be retrieved from the core barrel into plastic sleeves and placed in the logging area for the field geologist or engineer to inspect.

5. At locations BEW-1, BEW-2, and BEW-3 one 5-gallon bucket of bedrock cuttings from the borehole will be collected in a 5-gallon bucket, labeled and set aside for bedrock treatability testing (if required). Bedrock cutting should be collected from an interval suspected of having water bearing fractures, if possible, as determined by observations during drilling. The observations of changes in the consistency, color, and volume of the cuttings and inspection of the rock cores, in conjunction with the driller's observations will be used to infer water-bearing fractures and zones of softer or less competent bedrock.

6. If air rotary drilling methods are used, and fractures or fracture zones are intercepted during drilling, the drilling will be suspended and the fractures developed by air lifting (pumping compressed air down the drill string and through the drill bit to evacuate water, residual drill cuttings and fines). Development of the fractures should continue until the turbidity of water produced from the boring is low (e.g., <50 Nephelometric Turbidity Units [NTU]) and the water is clear to the naked eye or fails to be less turbid with ongoing development. After a fracture zone is developed or goes dry, drilling activities will resume. The field geologist will record the time and depth of each inferred water-bearing fracture intercepted during drilling as well as the volume of water purged.

7. After reaching the target borehole depth using either air rotary or sonic drilling methods, the entire length of the borehole will be developed by air lifting per SOP NMI-GW-002. The borehole development will continue until the turbidity of the generated water is low (e.g., <50 NTU), the water is clear to the naked eye, and, at a minimum, the volume of water generated exceeds any water lost to the formation during rotary drilling (if used). Development may cease if it no longer become less turbid with further development and the volume of water removed for development exceeds fluid lost during drilling.

8. The borehole will be left open with steel casing sealing the overburden. The driller will cut the steel casing approximately 1.5 to 2.5 ft above the ground surface, and the top of the casing will be leveled. The top will be marked or notched to identify a measuring point for all water level measurements at the well. The well will then be fitted with a

suitable slip-on cap or waterproof cap (e.g., Royer Locking Well Cap) on the top of the casing to reduce the potential for debris to enter the borehole and secured with a padlock (SOP NMI-GW-004).

9. The field engineer or geologist will record the well construction information for each bedrock extraction well following the guidance in SOP NMI-GW-003.
10. The open bedrock boreholes are intended to remain as open bedrock wells for the purpose of pumping and rebound testing. It is possible that the bedrock at the selected drilling location is highly fractured/weathered and will not support an open borehole. In this occurs a well screen will need to be installed to span discrete fractures or fracture zones. Bedrock instability alternatives are discussed in Section 3.4.8 of Appendix B and Section 5.3.4 of Appendix D.

4. STEP 3 – OPEN BOREHOLE TESTING

This section summarizes the open borehole testing to be conducted in open borehole bedrock wells. These work activities are detailed in Sections 3.4.6.1 and 3.4.6.2 of Appendix B and Sections 5.3.1 and 5.3.2 of Appendix D.

4.1 Borehole Geophysics

This section describes the borehole geophysics to be conducted at each of the open bedrock well (BEW-1 through 6) after installation and development. Borehole geophysical logging will be conducted to confirm the locations of fractures and/or fracture zones and identify water-bearing fractures in each monitoring well. A detailed description of the borehole logging including how each downhole tool will be used to evaluate the location and nature of the intercepted fractures is provided in Section 3.4.6.1 of Appendix B.

1. Geophysical logging will start no sooner than 48-hours after the completion of drilling and development and will be conducted by a qualified subcontractor.

2. The geophysical logging will include the caliper log, fluid temperature and resistivity, acoustic and optical televiewer, and heat pulse flow meter (HPFM) testing under ambient and pumping conditions. The borehole geophysical data will be used in conjunction with field observations during drilling (e.g., water production) to identify intervals with significant inflow/outflow.

3. The borehole data collected during geophysical logging will inform the selection of borehole intervals for packer testing and the construction of permanent monitoring well(s) within the boreholes, if required.

4. The small amounts of IDW water generated during the pumping associated with HPFM logging will be containerized in a steel 55-gallon drum (or other suitable container) and combined and managed with the IDW generated during drilling and well development.

The borehole data collected during the geophysical logging will be used to inform the selection of borehole intervals for packer testing. The results of the geophysical testing at each well and the proposed packer testing intervals will be reviewed and discussed with the project team.

4.2 Packer Testing and Contaminant Monitoring

1. The packer testing intervals in the newly installed open borehole extraction wells will be selected based on fractures and/or fracture zones identified during well installation and geophysical logging. The packer testing, including packer spacing, inflation pressures, and pumping procedures will follow those outlined in SOP NMI-GW-016. Packer testing will be conducted by a qualified subcontractor. Prior to starting packer testing, pressure transducers should be deployed (if not already) in nearby bedrock monitoring wells in which water level response was observed during drilling. Pressure transducers should be set to a short logging interval (e.g. 1-5 seconds) period to help assess whether there is a response, indicative of connectivity, when pumping individual intervals of the bedrock.

2. The packer testing intervals in the newly installed open borehole wells will be selected based on borehole geophysical data described in Section 4.1. Up to four discrete intervals per boring will be selected for packer testing.

3. The packer apparatus will consist of three pressure transducers that will monitor the water column pressure below, within, and above the zone isolated by packers. The isolated interval will be pumped with a submersible pump at low rates determined in the field (e.g., based on well development).

4. After inflation of packers and prior to pumping, the water level within the interval isolated by packers will be allowed to equilibrate to inform the static or ambient head in the fracture. Pressure data collected during pumping by the pressure transducer located in the isolated zone will be converted to drawdown and, in conjunction with the pumping rates, used to estimate the hydraulic conductivity of the fracture zone.

5. The discharge water from each interval will be monitored for field geochemical parameters using a flow-through apparatus (see SOP NMI-GW-010). The samples will be collected when (1) the field geochemical parameters stabilize to the low-flow criteria and a volume equivalent to at least three isolated interval borehole volumes are removed or (2) if the isolated interval is low yielding and the three volumes cannot be purged in a reasonable time frame, the samples will be collected after three hours of pumping.

6. Samples will be collected from the isolated intervals at all bedrock extraction wells and submitted to a certified laboratory for analysis of 1,4-dioxane via USEPA Method 8270SIM

7. The following additional samples will be collected from the following bedrock extraction wells based on historical MCL exceedances of metals and VOCs in their vicinity.

    - BEW-1 – arsenic, iron, manganese, cobalt, thorium, and uranium via USEPA Method 6020A ICP-MS

- BEW-2 – arsenic, iron, manganese, cobalt, thorium, and uranium via USEPA Method 6020A ICP-MS
- BEW-3 – arsenic, iron, and manganese, and uranium via USEPA Method 6020A ICP-MS
- BEW-4 – thorium via USEPA Method 6020A ICP-MS and VOCs via USEPA Method 8260
- BEW-5/BEW-6 – cobalt and manganese via USEPA Method 6020 ICP-MS and VOCs via USEPA Method 8260

8. After completion of packer testing at a well, data from pressure transducers in nearby wells will be downloaded and analyzed to evaluate the connectivity between the isolated interval and the specific well where the transducer was deployed.

5. STEP 4 - STEP TESTING

Step testing will be conducted to select a pumping rate for long-term pumping. The step testing will entail pumping the well at multiple rates, likely 3 rates, to evaluate a maximum safe yield for long-term pumping. The testing activities will follow SOP NMI-GW-017, and in summary will be as follows.

1. Testing should begin at BEW-6 and move sequentially upgradient to BEW-1 in order to start where uranium concentrations are expected to be lower and advance towards where they are expected to be higher to limit the possibility for cross contamination.

2. A submersible pump, such as Grundfos SP-10S05-9 (0.5 HP motor) or equivalent, will be lowered into the well and suspended approximately 5 - 10 ft above the bottom of the well. Information for potential pumps to use for testing is included in Appendix A; the pump selected for testing will depend on the expected yield, pump availability, etc. Tubing from the pump should run up the well and across the ground surface where it will connect to a test panel having a flow totalizer, a flowmeter, pressure gauge(s), a flow control valve and a sampling port. The outlet from the control panel will be piped to a fractionation tank, tote or 55-gallon drums to store water from the step test.

3. A pressure transducer will be installed in a stilling well within the open borehole to monitor drawdown during step testing. The pressure transducer should be set to log pressure at a rate of (approximately) every 10 seconds to capture the drawdown curve during each step. A laptop of field computer may remain connected to the transducer so that the water level in the well can be monitored in real time while also recording the data onto the transducer's internal memory. Manual water level measurements will also be taken periodically during the testing to confirm the water levels recorded by the transducer.

4. The testing will start at a low pumping rate (e.g., 0.5–1 gpm) followed by successively higher pump rates. Pumping rates will be selected based on the amount of drawdown observed at the first pumping step and/or well production during development. The flow rate should be monitored closely, especially at the start of a new pumping rate as drawdown may cause the flowrate to slow; the flow control valve will need to be adjusted to maintain a near constant flow rate during each step.

5. Each pumping step should continue until the drawdown stabilizes and quasi steady-state is achieved before moving to the next pumping rate. The water level in the well should not be allowed to approach the depth of the pump. The target pumping duration for each step will be one-hour.

6. It is anticipated that for each step the pumping rate will be doubled (e.g., 1 gpm, 2 gpm, 4 gpm). The field team leader will select the pumping rates in coordination with the project manager. At the end of each step the next flow rate will be tested immediately, without turning off the pump. The test will be completed when at least three pumping rates have been tested. The pressure transducer data may be downloaded and reviewed between each successive step.

7. After pumping is completed at a given location and the pump is turned off, the pressure transducer will remain in the well and continue recording while the water level in the well recovers to static. Data from the step test, including recovery, will then be downloaded.

   Following the completion of the testing at each location, the submersible pump, transducer(s) and the water level meter will be removed from the well(s) and decontaminated following procedures presented in SOP NMI-007.

6. STEP 5 - BEDROCK EXTRACTION WELL PUMPING, EFFLUENT WATER QUALITY AND AQUIFER RESPONSE MONITORING

As described in Section 3.5.2 of Appendix B, the duration of pumping, the quantity of water generated and the amount of uranium and 1,4-dioxane mass removed during pumping is impossible to predict because the yield of the proposed bedrock extraction wells and porosity of the bedrock aquifer are not known. However, uranium and 1,4-dioxane mass removal as a result of pumping can be evaluated by monitoring the extraction well effluent concentrations during pumping.

A decision whether to pump the wells in tandem or one at a time will depend on the yield of the newly installed wells, ability to manage pumped water and other logistics. For instance, if the yield for a test well is high, then it is likely that pumping from a single well will impact a sizeable area of the bedrock, which is desirable. If the yield is low, pumping at two wells simultaneously will likely be manageable in terms of generated water and will reduce the time to complete the hydraulic testing.

It is anticipated that the extraction will be first initiated at the bedrock extraction wells located on the NMI property (BEW-1 through 4) and later conducted in the downgradient area at BEW-5 and BEW-6. This proposed sequence will avoid working through logistics and details of the well testing on stakeholder's property when pumping at the downgradient skating rink or other downgradient properties. This sequence also avoids any potential delays due to access issues.

6.1 Constant Rate Extraction Design and Monitoring

The constant rate extraction tests will follow SOP NMI-GW-018. The extraction rate at each bedrock well will be selected based on the results from the step tests and generally follow the steps below.

1. Approximately one week prior to the start of the constant rate extraction test, pressure transducers will be deployed in multiple monitoring wells shown on Figure 3-4 of Appendix B of the RDWP. These transducers will monitor background bedrock groundwater levels and then groundwater levels during pumping. Transducer installation will be documented using the Pressure Transducer Installation Log (attachment B to Appendix B of the RDWP). Pressure transducers should be non-vented and set to log measurements at 5–10-minute intervals. Transducers should be synchronized to take measurements simultaneously.

2. A barometric pressure transducer (i.e., barologger or equivalent) should be deployed at the Site at the same time as the transducers and set to log atmospheric pressure at the same times as the deployed pressure transducers.

3. A rain gauge (i.e., Onset bucket gauge or equivalent) will be deployed when the pressure transducers are installed and used to measure precipitation during the background period and pump tests.

4. Ahead of testing, a series of fractionation tanks will be mobilized to the Site to containerize groundwater generated as part of the pumping. The number of fractionation tanks needed will be further refined as the anticipated amounts of water generated are better understood from step testing.

5. A submersible pump will be installed in each bedrock extraction well for the test. Pumps may be placed at the elevation coinciding with significant water-bearing fractures inferred from geophysical logging or below the fracture. If a significant water-bearing fracture was not identified during geophysical logging, the pump will be set to a depth where at least 70% of the water column is above the pump to reduce the risk of the pump running dry. Because of the potential for a long pumping duration, it is preferable that the pump is connected to the electric grid rather than a portable generator, however, a portable generator may need to be used in the off-site locations such as BEW-5 and BEW-6. Geosyntec will work in coordination with *de maximis* to provide the most reliable electric feed to each location.

6. A non-vented type pressure transducer will be set 5 feet above the submersible pump in a 1-inch PVC stilling well at each of the bedrock extraction wells. The transducer should be programmed to record water level measurements at 5–10-minute intervals simultaneously with the pressure transducers installed in the monitoring wells.

7. Tubing from the pump will run up the well, out of the well and across the ground surface to a test panel. Test panels are expected to be located in a central location (i.e., a location that can be reached by several wells) and near the primary and secondary fractionation

tanks. Extracted groundwater will pass through a test panel having the following components:

- a backflow preventer (i.e., check valve)
- a sampling port
- a mechanical or digital flowmeter
- a mechanical or electronic totalizer
- a globe or gate valve for flow adjustment

A photograph of the test panel (partially assembled) is below. The manifold will be mounted to plywood and either be free standing or attached to the wall of a temporary shed mobilized to the field for testing.

Water from the test panel will discharge via hose into a primary fractionation tank. Periodically, water from the primary tank will be pumped through a filter system and into secondary fractionation tanks. Filtration is expected to consist of bag filters and ion-exchange resins to remove sediment and uranium, respectively. For some wells, ion-exchange resin may be unnecessary; the need for ion exchange resin will be determined from analytical results for samples collected during packer testing or from the primary tank. Water from secondary fractionation tanks will periodically be transferred into tanker trucks and transported off-site for disposal or further treated by the NTCRA treatment system. The water will be managed as further described in the investigation derived waste (IDW) Section 6.2.

8. Immediately prior to pumping, a round of manual depth-to-water measurements will be collected in wells with pressure transducers and additional bedrock wells in the area.

9. Pumping will be initiated at a rate determined by the step test and the valving on the control panel will be adjusted to maintain the desired flow rate. Field staff will monitor the flowrate during the initial startup as drawdown in the well may cause the flowrate to decrease and the control valve may need to be adjusted.

10. During pumping, manual depth-to-water measurements will be collected in the wells instrumented with transducers every 12 hours for comparison to the pressure transducer readings. Also during pumping, field staff will record flow rates and total flow. Initially these measurements will be recorded more frequently (e.g., hourly) but they can be recorded less frequently (but not less than daily) once the head in the well reaches a near constant elevation.

11. For the first week of pumping, field technicians will monitor changes in the water level and specific capacity of each extraction well on a 24-hour schedule to eliminate the potential for the water level to drop below the pump intake. Before the pump is shut down, a final round of depth-to-water measurements will be collected in the wells with pressure transducers and any additional bedrock wells in the area that were measured prior to the start of pumping.

12. The water quality of the extracted groundwater will be monitored for the parameters listed below and samples will be collected in accordance with Table 3-3 of Appendix B and Table 3 of Appendix D of the RDWP.

    - Field parameters (e.g., temperature, pH, dissolved oxygen, ORP, specific conductance, and turbidity) – collected every 6 hours until the end of the pumping period.

    - Analytical samples at all extraction wells – collected at the start of pumping, every 12 hours for up to 7 days, and every 48 hours after 7 days and until pumping is terminated.

        - 1,4-dioxane via EPA Method 8270 SIM

    - Additional samples based on MCL exceedances of metals in the vicinity of specific bedrock extraction wells with the frequency presented in Table 3.3 of Appendix B and Table 3 of Appendix D

        - BEW-1 – arsenic, iron, manganese, cobalt, thorium, and uranium via USEPA Method 6020A ICP-MS

- o BEW-2 – arsenic, iron, manganese, cobalt, thorium, and uranium via USEPA Method 6020A ICP-MS
- o BEW-3 – arsenic, iron, manganese, and uranium via USEPA Method 6020A ICP-MS
- o BEW-4 – thorium via USEPA Method 6020A ICP-MS and VOCs via USEPA Method 8260
- o BEW-5/6 – cobalt and manganese, and via USEPA Method 6020 ICP-MS and VOCs via USEPA Method 8260

13. Analytical samples will be shipped to the laboratory under chain of custody following SOP NMI-001. Samples collected at the start of pumping, after 3.5 days, after 7 days, and at the end-of-pumping will be analyzed initially and all other samples held by the lab. In the event that the results from one of the analyzed samples appear anomalous or the concentrations in the three analyzed samples vary by 10% or more, one or more of the held samples may be analyzed.

14. Following a week of pumping on a 24-hour schedule, the team may select to continue pumping during working hours (e.g., 8 hours per day) and turn off the pumps during nonworking hours.

15. At the end of a pumping period and before the pump is turned off, a final round of manual depth-to-water measurements will be conducted at the bedrock monitoring well with pressure transducers as well as at any wells measured prior to starting pumping.

16. Pressure transducers will continue to monitor bedrock groundwater levels for at least a week after pumping ceases to capture the recovery period.

17. After the recovery period has been captured, the transducers will be pulled, decontaminated following SOP NMI-007and the data downloaded.

6.2 Investigative Derived Waste Management

The management of IDW generated as part of the work described herein is discussed below. IDW Management will be performed in accordance with the procedures listed in the IDW Management SOP (NMI-005) accompanying this plan.

6.2.1 Drill Cuttings

IDW generated during drilling activities will be containerized into drums or a roll-off container depending on the selected final drilling method. At each drilling location, the driller will set up a plastic-lined drilling pad. The sides of the pad will be elevated to contain the cuttings generated during drilling. Cuttings mixed with water will be first collected into drums or totes. Water from these can be decanted and transferred into a fractionation tank(s) staged on-site. IDW water generated during open borehole drilling and/or development may contain lesser amounts of solids and can be handled using the same methods. The liquid in the fractionation tanks may be sampled for laboratory analysis presented in Section 3.4.5 of Appendix B prior to off-site disposal.

6.2.2 Bedrock Well Extraction Effluent

The extracted groundwater will initially be discharged to a primary holding tank. This water will be periodically transferred to a series of secondary fractionation tanks through a combination of bag filters and ion-exchange resins for uranium pre-treatment (if needed). Pre-treated and post-treated water will be sampled for analytes presented in section 3.4.5 of Appendix B and the corresponding Section 5.4 in Appendix D. Following the review of analytical results, the water will be transported for off-site disposal by an authorized treatment provider or transported and treated at the NTCRA groundwater treatment system.

7. STEP 6 - REBOUND SAMPLING AND ANALYSIS

After completion of the constant rate pumping program, groundwater samples will be collected from the extraction wells to monitor for the rebound of contaminant concentrations as described in Section 3.5.4 of Appendix B. A detailed sequence of rebound sampling is presented below.

1. Groundwater samples will be collected 1, 2 and 21 days following the termination of pumping. Additional recovery samples may be collected beyond 21 days if the pumping and post-pumping data suggest that longer-term monitoring would be beneficial to the rebound evaluation. Samples will be collected according to Table 3-3 of Appendix B and Table 3 of Appendix D using a bladder pump lowered to the same depth as the submersible pump intake.

    - Field parameters (e.g., temperature, pH, dissolved oxygen, ORP, specific conductance, and turbidity).

    - Analytical samples for 1,4-dioane via EPA Method 8270 SIM will be collected at all bedrock extraction wells. Additional samples based on MCL exceedances of metals in the vicinity of specific bedrock extraction wells at the frequency outlined in Appendix B Table 3-3 and Appendix D Table 3.

        - BEW-1 – arsenic, iron, manganese, cobalt, thorium, and uranium via USEPA Method 6020A ICP-MS
        - BEW-2 – arsenic, iron, manganese, cobalt, thorium, and uranium via USEPA Method 6020A ICP-MS
        - BEW-3 – arsenic, iron, manganese, and uranium via USEPA Method 6020A ICP-MS
        - BEW-4 – thorium via USEPA Method 6020A ICP-MS
        - BEW-5 – cobalt and manganese via USEPA Method 6020 ICP-MS
        - BEW-6 – cobalt and manganese via USEPA Method 6020 ICP-MS

2. Analytical samples will be shipped to the laboratory under chain of custody following SOP NMI-001.

8. STEP 7 – PUMPING AND REBOUND DATA ANALYSIS

Pumping and rebound data analysis will be conducted following the completion of extraction and rebound testing. The proposed data evaluation is described in Appendix B Section 3.5.8 and Appendix D Section 6.2.9. A description of how the rebound results will be used to evaluate the feasibility of pumping for bedrock groundwater remedy is presented in Section 3.6 of Appendix B and Section 7 of Appendix D.

9. CLOSING

The procedures outlined here are proposed and anticipated with reliance on the historical data and known contaminant distribution. The procedures and sequence may be adjusted in coordination with the project team, HP and RSO based on conditions observed in the field.

FIGURES

Implementation Step	Main Work Activities	Field Oversight and Monitoring Activities	Work Plan References Appendix B/Appendix D
1	**Install Bedrock Monitoring Wells** MW-BS50, MW-BS54, MW-BS53, MW-BS51, MW-BS52 , and MW-BS7-2	Soil and Rock Core Logging and Description Tracking of Drilling Water Lost to Formation Monitoring Well Design and Construction	Section 3.4.2/Section 5.1
2	**Install Bedrock Extraction Wells** BEW-6, BEW-5, BEW-4, BEW-3, BEW-2, BEW-1	Soil and Rock Core/Cuttings Logging and Description Tracking of Drilling Water Lost to Formation Water Level Monitoring in Nearby Wells	Section 3.4.2, 3.4.3/Section 5.2
3	**Geophysical and Packer Testing Program** BEW-6, BEW-5, BEW-4, BEW-3, BEW-2, BEW-1	Geophysical Log Evaluation for Water Bearing Fractures Selection of Intervals for Packer Testing Water Level and Water Quality Monitoring	Section 3.4.6/Section 5.3
4	**Bedrock Extraction Well Step Testing** BEW-6, BEW-5, BEW-4, BEW-3, BEW-2, BEW-1	Submersible Pump Installation Step Testing Water Level Monitoring	Section 3.5.1/Section 6.1
5	**Bedrock Extraction Well Pumping, Water Level and Quality Monitoring** BEW-6, BEW-5, BEW-4, BEW-3, BEW-2, BEW-1	Bedrock Well Pumping and Effluent Sampling Effluent Pre-Treatment and Management Water Level Monitoring in Nearby Wells	Section 3.5.2/Section 6.2
6	**Rebound Monitoring and Water Quality Sampling** BEW-6, BEW-5, BEW-4, BEW-3, BEW-2, BEW-1	Bedrock Well Sampling	Section 3.5.2/Section 6.2.5
7	**Pumping and Rebound Data Analysis and Reporting**		

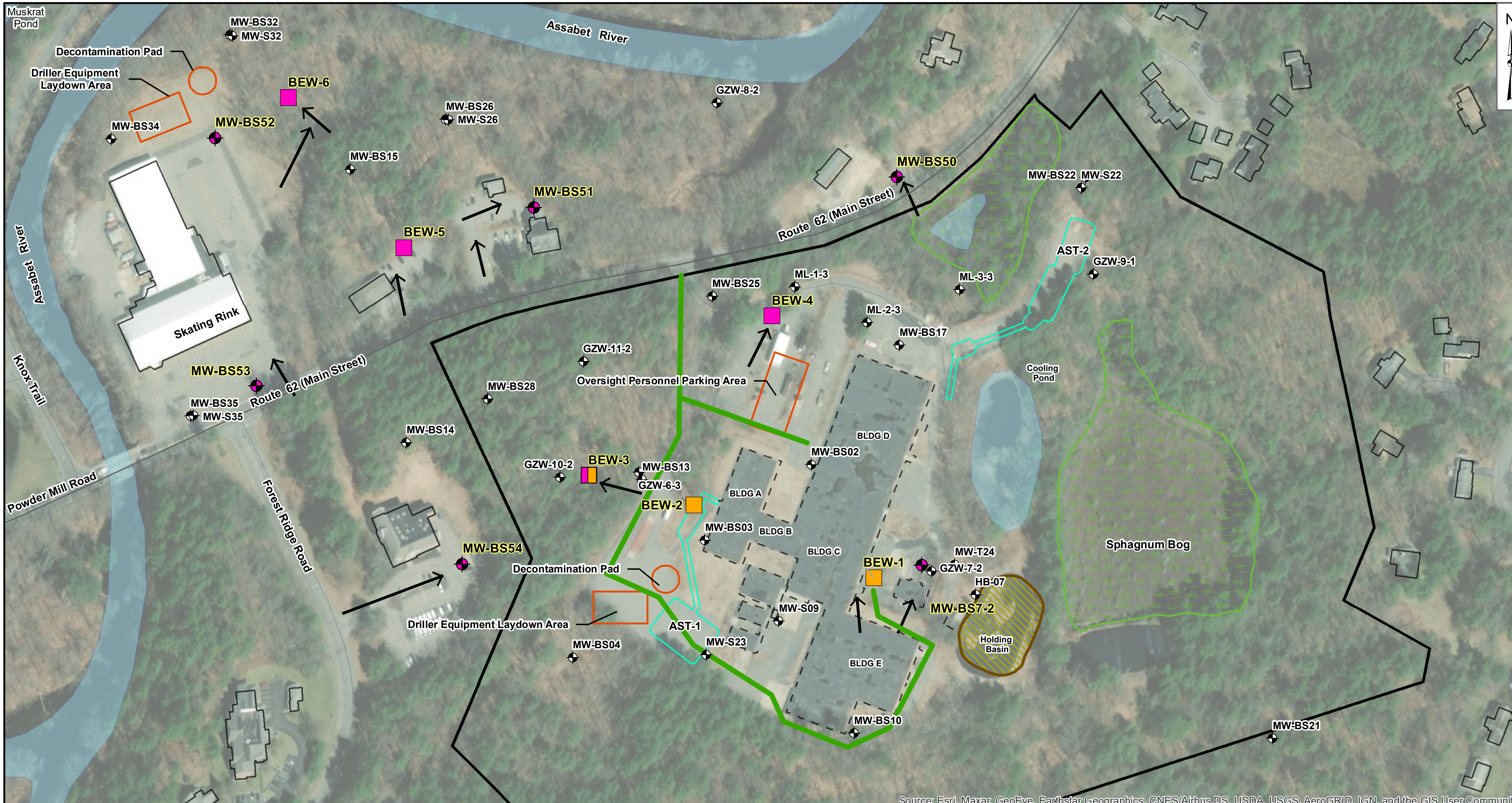
RDWP Appendix B and D Implementation Sequence

Nuclear Metals Inc Superfund Site
Concord Massachusetts

Geosyntec consultants

Acton, MA | June 2020

Figure 1



Legend

- Monitoring Well
- Proposed Bedrock Monitoring Well
- Proposed Open Bedrock Well for Uranium Rebound Testing
- Proposed Open Bedrock Well for 1,4-Dioxane Rebound Testing
- Proposed Open Bedrock Well for 1,4-Dioxane and Uranium Rebound Testing
- Septic Fields
- Wetlands
- Surface Water
- Site Boundary
- Depth to Bedrock Contour (dashed where inferred)
- Former Building Concrete Foundations
- Site Driveways and Equipment Access Areas
- Drilling Access Location

N

0 180 Feet

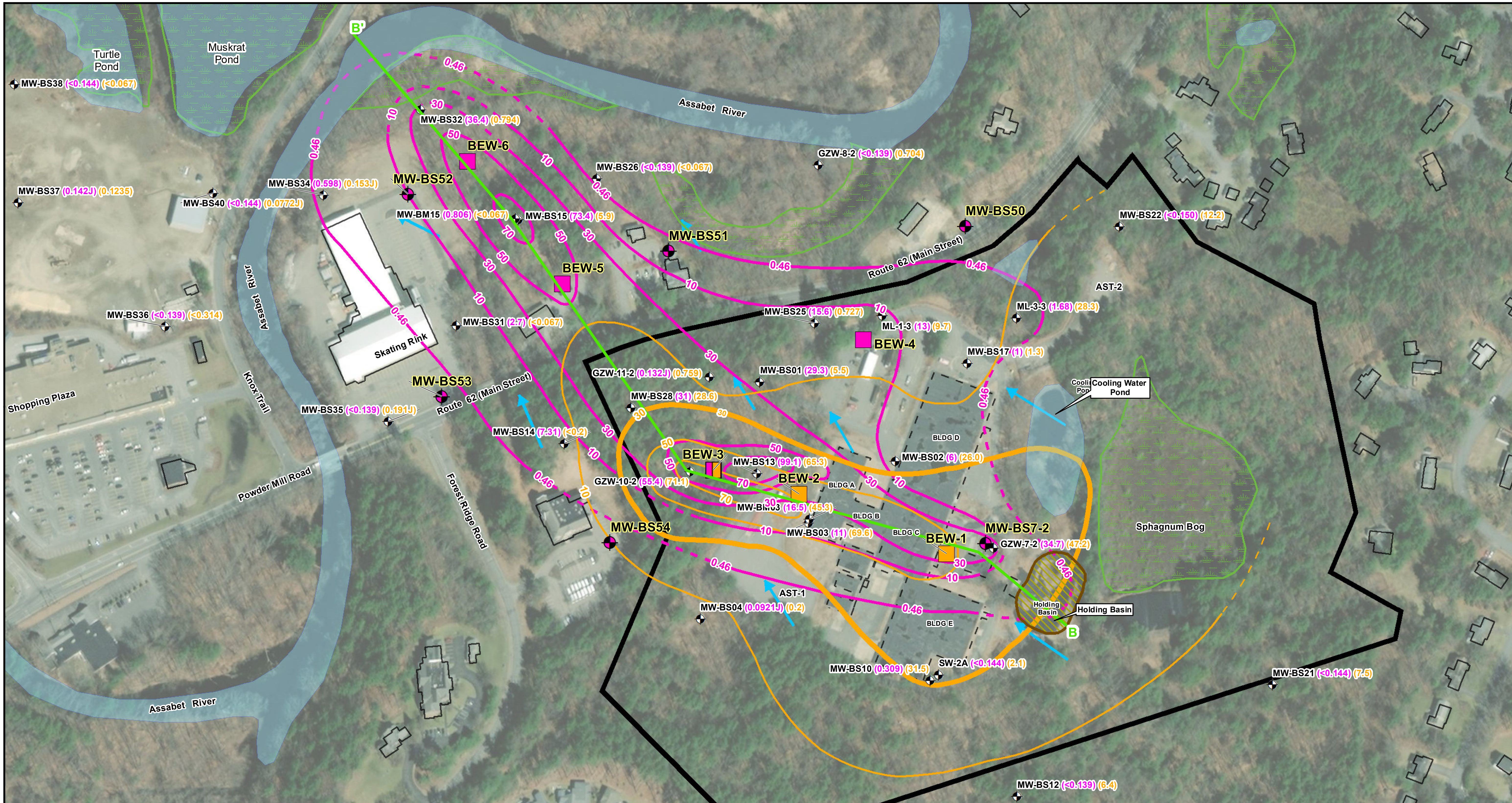
Bedrock Well Drilling and Site Logistics Plan

Nuclear Metals, Inc. Superfund Site
Concord, Massachusetts

Geosyntec consultants | de maximis, inc. | Figure 2

Acton, Massachusetts | July 2020

Q:\GISProjects\BR0090-NMISite\Projects\Updates_2020\Figure 1 - BR Well Drilling and Site Logistics Plan.mxd 7/15/2020 3:48:40 PM



Legend

Bedrock Monitoring Well	Site Boundary
Proposed Open Bedrock Well for Uranium Rebound Testing	Building Outline
Proposed Open Bedrock Well for 1,4-Dioxane Rebound Testing	Former Building Concrete Foundation
Proposed Open Bedrock Well for 1,4-Dioxane and Uranium Rebound Testing	Bedrock Groundwater Flow Direction Inferred from November 2019 Groundwater Elevations
Proposed Bedrock Monitoring Well	Wetlands
	Surface Water

Cross Section B-B'

Uranium ISO Contour in Bedrock November 2019 (µg/L)

Estimated Uranium ISO Concentration Contour in Bedrock November 2019 ug/L

1,4-Dioxane ISO Concentration Contour in Bedrock November 2019 (µg/L)

Estimated 1,4-Dioxane ISO Concentration Contour in Bedrock November 2019 (µg/L)

0.57 1,4-Dioxane Concentrations November 2019 (µg/L)

76.9 Uranium Concentrations November 2019 (µg/L)

Note:
1. The uranium concentrations represent isotopically natural uranium.

DRAFT

N

0 220 Feet

Proposed Bedrock Wells for Uranium Rebound and 1,4-dioxane Delineation and Rebound Testing

Nuclear Metals, Inc. Superfund Site
Concord, Massachusetts

Geosyntec consultants | de maximis, inc.

Acton, Massachusetts | July 2020

Figure 3

Q:\GISProjects\BR0090-NMISite\Projects\Updates_2020\Figure 3-3 - Proposed Bedrock Wells for Uranium Rebound and 1,4-dioxane Delineation and Rebound Testing.mxd 7/15/2020 2:13:04 PM

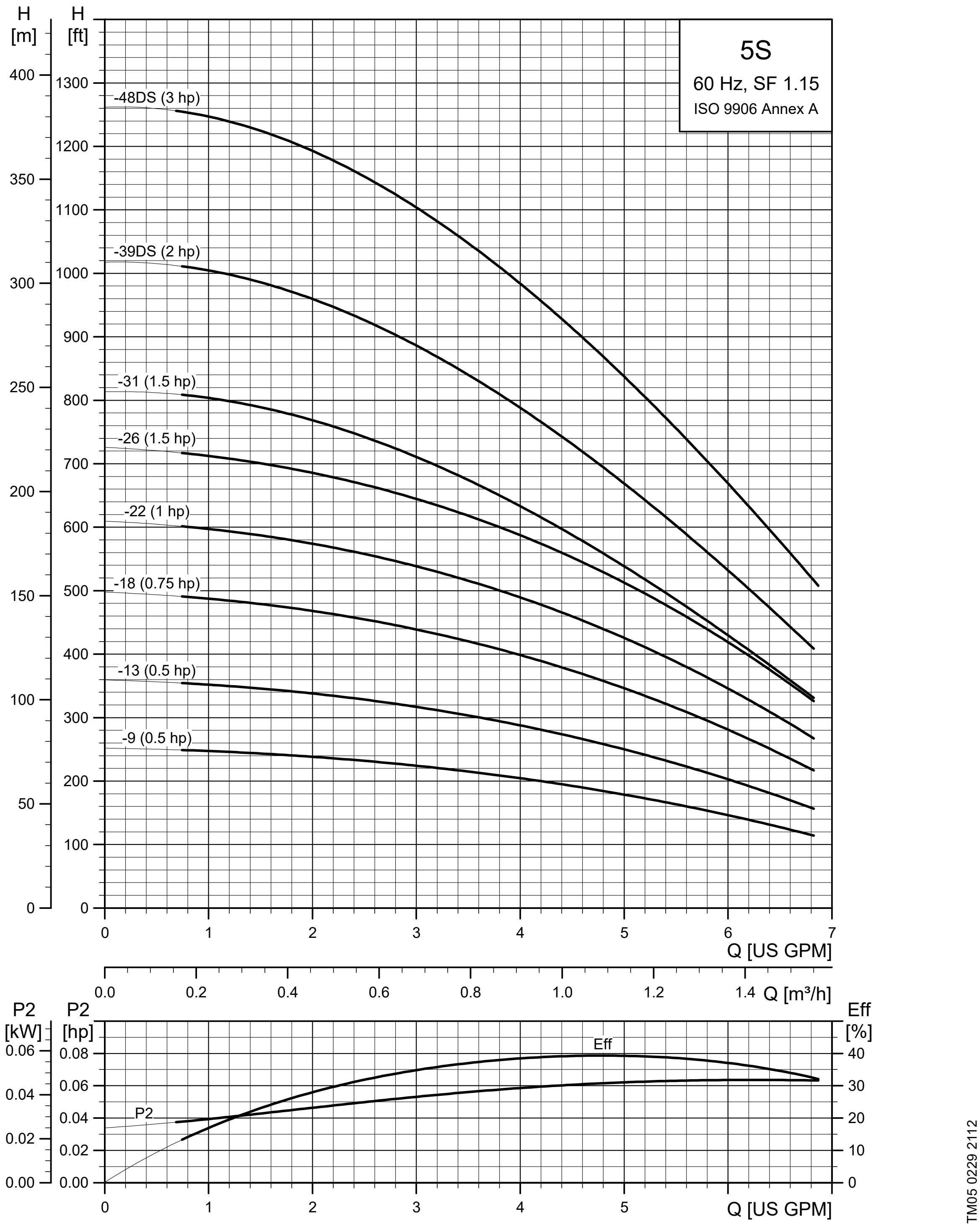
Attachment A

Grundfos Pump Curves

6. Curve charts and technical data

4" and larger wells

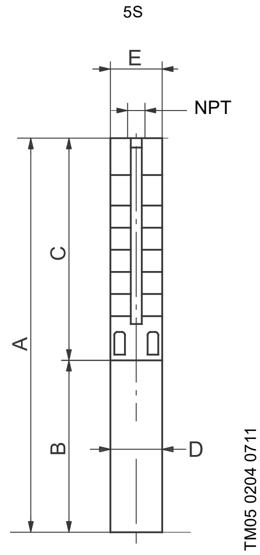
SP 5S (5 gpm)



4" and larger wells - continued

SP 5S (5 gpm) pump with 4" motor

Pump model	Nom. head [ft]	Motor					Dimensions [in (mm)]					Net weight (complete) [lb]
		Ph	Volts [V]	[Hp]		[rpm]	A	B	C	D	E	
5S, motor diameter 4-inch, 2-wire motor, 60 Hz - rated flow rate 5 gpm (1" NPT)												
5S05-9	184	1	230	0.5	■	3517	24.57 (624)	11.03 (280)	13.55 (344)	3.74 (95)	3.98 (101)	21.6
5S05-13	258	1	115	0.5	■	3360	27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.98 (101)	26.9
			230	0.5	■	3474	27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.98 (101)	26.1
5S07-18	357	1	230	0.75	■	3465	32.60 (828)	11.62 (295)	20.99 (533)	3.74 (95)	3.98 (101)	29.7
5S10-22	439	1	230	1	■	3400	36.50 (927)	12.21 (310)	24.30 (617)	3.74 (95)	3.98 (101)	32.4
5S15-26	529	1	230	1.5	■	3439	41.30 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.98 (101)	41.4
5S15-31	585	1	230	1.5	■	3410	47.21 (1199)	13.71 (348)	33.51 (851)	3.74 (95)	3.98 (101)	47.7
5S, motor diameter 4-inch, 3-wire motor, 60 Hz - rated flow rate 5 gpm (1" NPT)												
5S05-9	184	1	230	0.5	■	3450	24.57 (624)	11.03 (280)	13.55 (344)	3.74 (95)	3.98 (101)	22.5
5S05-13	258	1	115	0.5	■	3382	27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.98 (101)	26.9
			230	0.5	■	3352	27.88 (708)	11.03 (280)	16.86 (428)	3.74 (95)	3.98 (101)	25.2
5S07-18	357	1	230	0.75	■	3346	32.60 (828)	11.62 (295)	20.99 (533)	3.74 (95)	3.98 (101)	28.8
5S10-22	439	1	230	1	■	3379	36.50 (927)	12.21 (310)	24.30 (617)	3.74 (95)	3.98 (101)	32.4
5S15-26	529	1	230	1.5	■	3459	41.30 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.98 (101)	37.8
		3	230	1.5	■	3465	39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.98 (101)	38.7
			460	1.5	■	3465	39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.98 (101)	38.7
5S15-31	585	1	230	1.5	■	3423	47.21 (1199)	13.71 (348)	33.51 (851)	3.74 (95)	3.98 (101)	47.7
		3	230	1.5	■	3437	45.71 (1161)	12.21 (310)	33.51 (851)	3.74 (95)	3.98 (101)	45.0
			460	1.5	■	3437	45.71 (1161)	12.21 (310)	33.51 (851)	3.74 (95)	3.98 (101)	45.0
5S20-39DS	730	1	230	2	•	3428	59.61 (1514)	19.49 (495)	40.12 (1019)	3.74 (95)	4.25 (108)	57.6
		3	230	2	■	3426	53.82 (1367)	13.71 (348)	40.12 (1019)	3.74 (95)	4.25 (108)	54.0
			460	2	■	3426	53.82 (1367)	13.71 (348)	40.12 (1019)	3.74 (95)	4.25 (108)	54.0
5S30-48DS	909	1	230	3	•	3450	70.16 (1782)	22.60 (574)	47.56 (1208)	3.74 (95)	4.25 (108)	77.4
		3	208	3	•	3485	65.56 (1665)	18.00 (457)	47.56 (1208)	3.74 (95)	4.25 (108)	77.4
			230	3	•	3485	65.56 (1665)	18.00 (457)	47.56 (1208)	3.74 (95)	4.25 (108)	77.4
			460	3	•	3485	65.56 (1665)	18.00 (457)	47.56 (1208)	3.74 (95)	4.25 (108)	77.4



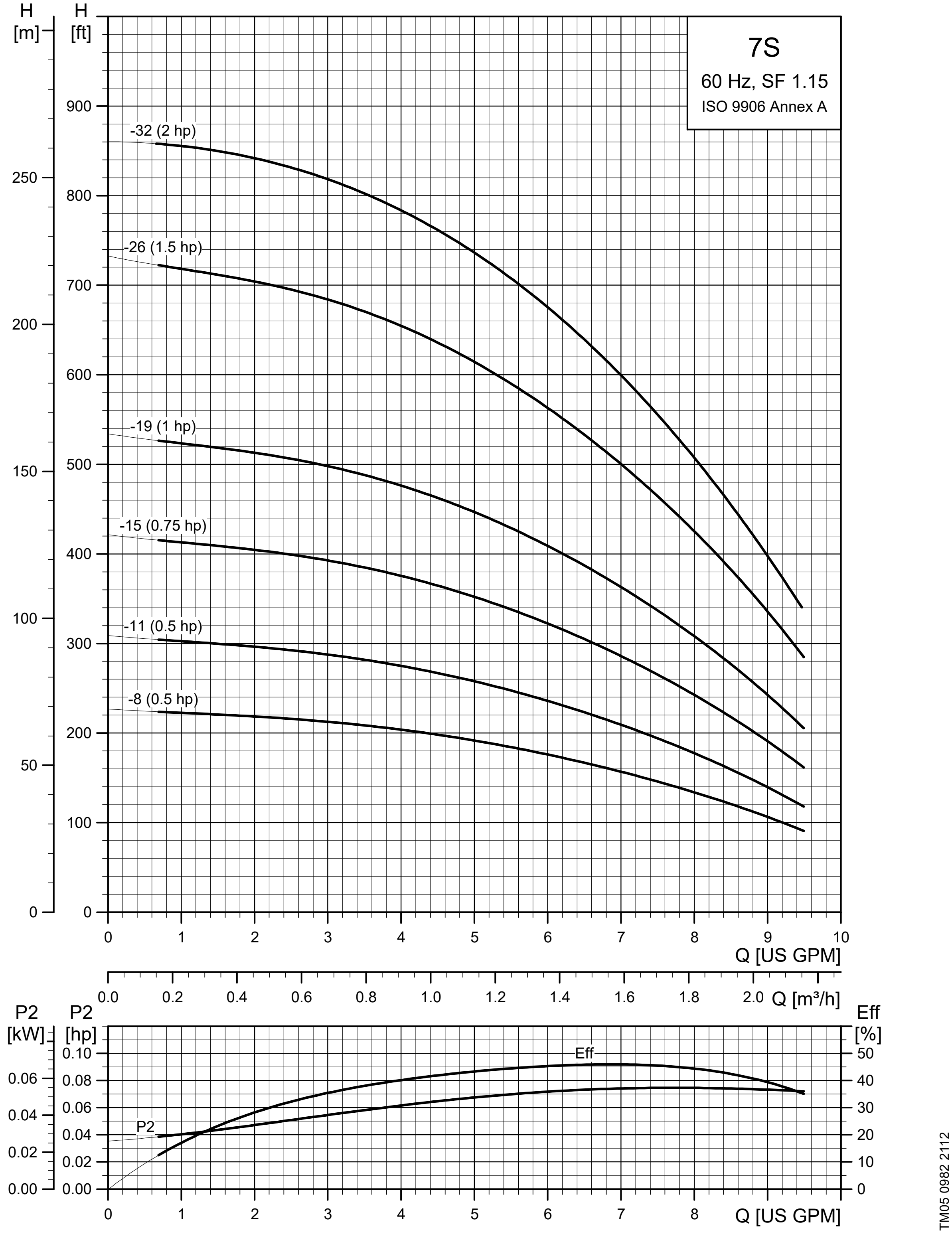
E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 1 - 1/2" NPT, 6" minimum well diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 ft (0.6 m).

- ■ MS 402 motor.
- • MS 4000 motor.

4" and larger wells - continued

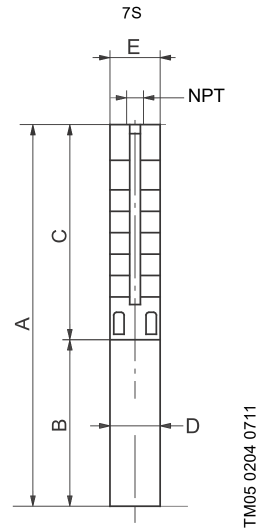
SP 7S (7 gpm)



4" and larger wells - continued

SP 7S (7 gpm) pump with 4" motor

Pump model	Nom. head [ft]	Motor Ph	Volts [V]	[Hp]		[rpm]	Dimensions [in (mm)] A	B	C	D	E	Net weight (complete) [lb]
7S, motor diameter 4-inch, 2-wire motor, 60 Hz - rated flow rate 7 gpm (1" NPT)												
7S05-8	164	1	230	.5	■	3512	23.75 (603)	11.03 (280)	12.72 (323)	3.74 (95)	3.98 (101)	21.6
7S05-11	222	1	115	.5	■	3359	26.23 (666)	11.03 (280)	15.20 (386)	3.74 (95)	3.98 (101)	29.7
			230	.5	■	3472	26.23 (666)	11.03 (280)	15.20 (386)	3.74 (95)	3.98 (101)	24.3
7S07-15	303	1	230	.75	■	3467	30.12 (765)	11.62 (295)	18.51 (470)	3.74 (95)	3.98 (101)	29.7
7S10-19	385	1	230	1	■	3394	34.02 (864)	12.21 (310)	21.82 (554)	3.74 (95)	3.98 (101)	32.4
7S15-26	525	1	230	1.5	■	3408	41.3 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.98 (101)	41.4
7S, motor diameter 4-inch, 3-wire motor, 60 Hz - rated flow rate 7 gpm (1" NPT)												
7S05-8	164	1	230	.5	■	3438	23.75 (603)	11.03 (280)	12.72 (323)	3.74 (95)	3.98 (101)	21.6
7S05-11	222	1	115	.5	■	3380	26.23 (666)	11.03 (280)	15.20 (386)	3.74 (95)	3.98 (101)	21.6
			230	.5	■	3349	26.23 (666)	11.03 (280)	15.20 (386)	3.74 (95)	3.98 (101)	30.6
7S07-15	303	1	230	.75	■	3349	30.12 (765)	11.62 (295)	18.51 (470)	3.74 (95)	3.98 (101)	27.9
7S10-19	385	1	230	1	■	3369	34.02 (864)	12.21 (310)	21.82 (554)	3.74 (95)	3.98 (101)	39.6
7S15-26	525	1	230	1.5	■	3419	41.30 (1049)	13.71 (348)	27.60 (701)	3.74 (95)	3.98 (101)	38.7
		3	230	1.5	■	3435	39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.98 (101)	38.7
			460	1.5	■	3435	39.81 (1011)	12.21 (310)	27.60 (701)	3.74 (95)	3.98 (101)	38.7
7S20-32	630	1	230	2	●	3590	52.05 (1322)	19.49 (495)	32.56 (827)	3.74 (95)	3.98 (101)	48.5
		3	230	2	■	3596	46.26 (1175)	13.71 (348)	32.56 (827)	3.74 (95)	3.98 (101)	48.5
			460	2	■	3596	46.26 (1175)	13.71 (348)	32.56 (827)	3.74 (95)	3.98 (101)	48.5



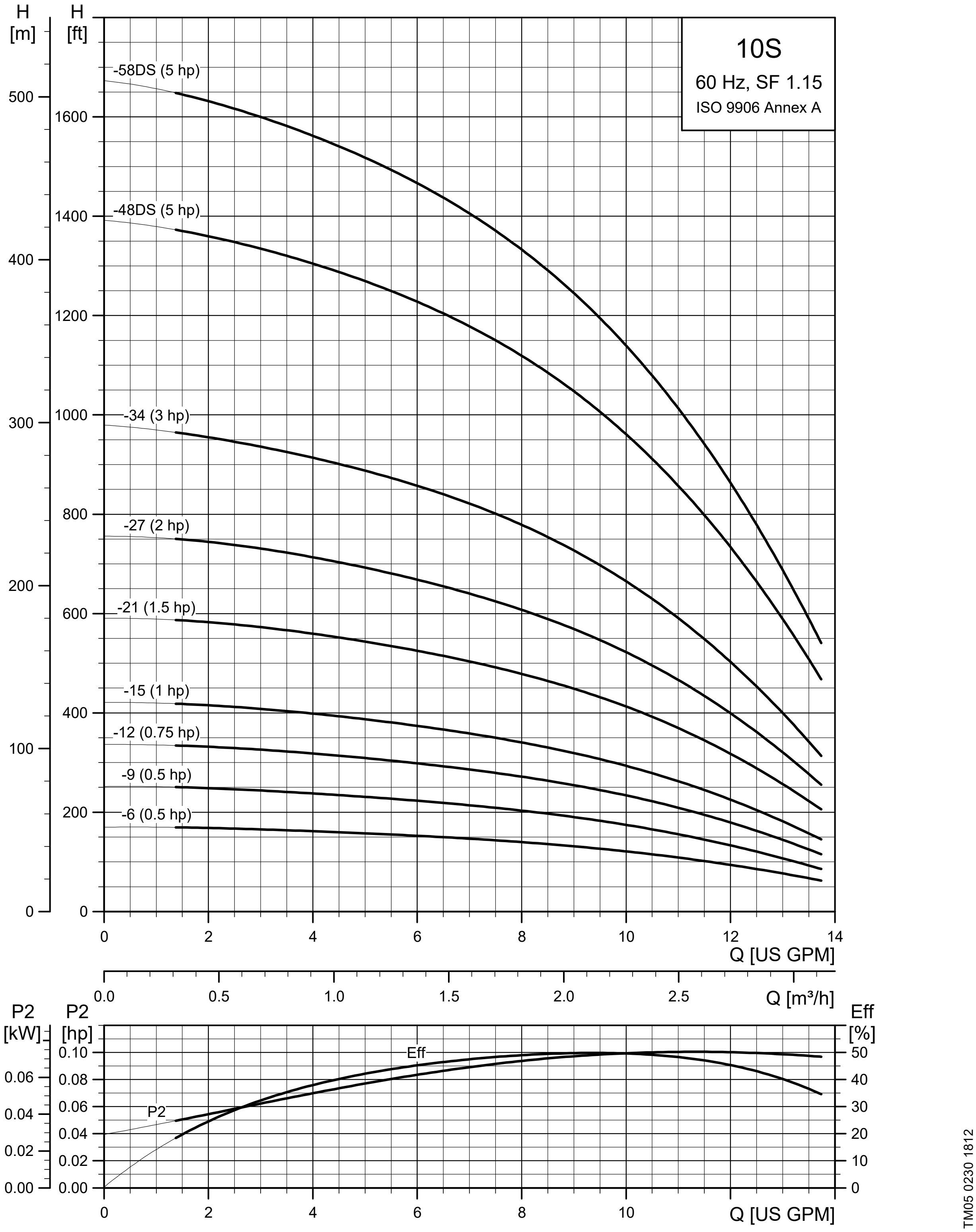
E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 1 - 1/2" NPT, 6" minimum well diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 ft (0.6 m).

- ■ MS 402 motor.
- ● MS 4000 motor.

4" and larger wells - continued

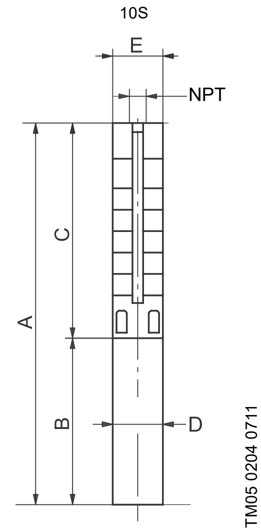
SP 10S (10 gpm)



4" and larger wells - continued

SP 10S (10 gpm) pump with 4" motor

Pump model	Nom. head [ft]	Motor Ph	Volts [V]	[Hp]		[rpm]	Dimensions [in (mm)] A	B	C	D	E	Net weight (complete) [lb]
10S, motor diameter 4-inch, 2-wire motor, 60 Hz - rated flow rate 10 gpm (1.25" NPT)												
10S05-6	126	1	230	.5	■	3454	22.05 (560)	10.99 (279)	11.07 (281)	3.74 (95)	3.98 (101)	20.7
10S05-9	185	1	115	.5	■	3336	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.98 (101)	24.3
			230	.5	■	3457	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.98 (101)	23.4
10S07-12	246	1	230	.75	■	3453	27.60 (701)	11.58 (294)	16.03 (407)	3.74 (95)	3.98 (101)	24.3
10S10-15	309	1	230	1	■	3382	30.67 (779)	12.17 (309)	18.51 (470)	3.74 (95)	3.98 (101)	29.7
10S15-21	433	1	230	1.5	■	3392	37.17 (944)	13.71 (348)	23.47 (596)	3.74 (95)	3.98 (101)	35.1
10S, motor diameter 4-inch, 3-wire motor, 60 Hz - rated flow rate 10 gpm (1.25" NPT)												
10S05-6	126	1	230	.5	■	3279	24.77 (629)	13.71 (348)	11.07 (281)	3.74 (95)	3.98 (101)	21.6
10S05-9	185	1	115	.5	■	3350	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.98 (101)	25.4
			230	.5	■	3313	24.53 (623)	10.99 (279)	13.55 (344)	3.74 (95)	3.98 (101)	24.3
10S07-12	246	1	230	.75	■	3320	27.60 (701)	11.58 (294)	16.03 (407)	3.74 (95)	3.98 (101)	28.8
10S10-15	309	1	230	1	■	3348	30.67 (779)	12.17 (309)	18.51 (470)	3.74 (95)	3.98 (101)	29.7
10S15-21	433	1	230	1.5	■	3398	37.17 (944)	13.71 (348)	23.47 (596)	3.74 (95)	3.98 (101)	35.1
		3	230	1.5	■	3419	35.63 (905)	12.17 (309)	23.47 (596)	3.74 (95)	3.98 (101)	32.4
			460	1.5	■	3419	35.63 (905)	12.17 (309)	23.47 (596)	3.74 (95)	3.98 (101)	36.0
10S20-27	554	1	230	2	●	3400	47.92 (1217)	19.49 (495)	28.43 (722)	3.74 (95)	3.98 (101)	45.9
		3	230	2	■	3399	42.13 (1070)	13.71 (348)	28.43 (722)	3.74 (95)	3.98 (101)	44.1
			460	2	■	3399	42.13 (1070)	13.71 (348)	28.43 (722)	3.74 (95)	3.98 (101)	44.1
10S30-34	716	1	230	3	●	3418	58.59 (1488)	22.6 (574)	35.99 (914)	3.74 (95)	3.98 (101)	81.9
		3	208	3	●	3465	53.98 (1371)	18.00 (457)	35.99 (914)	3.74 (95)	3.98 (101)	74.7
			230	3	●	3465	53.98 (1371)	18.00 (457)	35.99 (914)	3.74 (95)	3.98 (101)	74.7
			460	3	●	3465	53.98 (1371)	18.00 (457)	35.99 (914)	3.74 (95)	3.98 (101)	74.7
10S50-48DS	1020	1	230	5	●	3476	74.18 (1884)	26.62 (676)	47.56 (1208)	3.74 (95)	4.25 (108)	103.5
		3	208	5	●	3499	70.16 (1782)	22.60 (574)	47.56 (1208)	3.74 (95)	4.25 (108)	103.5
			230	5	●	3499	70.16 (1782)	22.60 (574)	47.56 (1208)	3.74 (95)	4.25 (108)	103.5
			460	5	●	3497	70.16 (1782)	22.60 (574)	47.56 (1208)	3.74 (95)	4.25 (108)	103.5
10S50-58DS	1225	1	230	5	●	3441	89.49 (2272)	26.62 (676)	62.88 (1597)	3.74 (95)	4.25 (108)	132.3
		3	208	5	●	3473	85.48 (2171)	22.60 (574)	62.88 (1597)	3.74 (95)	4.25 (108)	132.3
			230	5	●	3473	85.48 (2171)	22.60 (574)	62.88 (1597)	3.74 (95)	4.25 (108)	132.3
			460	5	●	3470	85.48 (2171)	22.60 (574)	62.88 (1597)	3.74 (95)	4.25 (108)	132.3



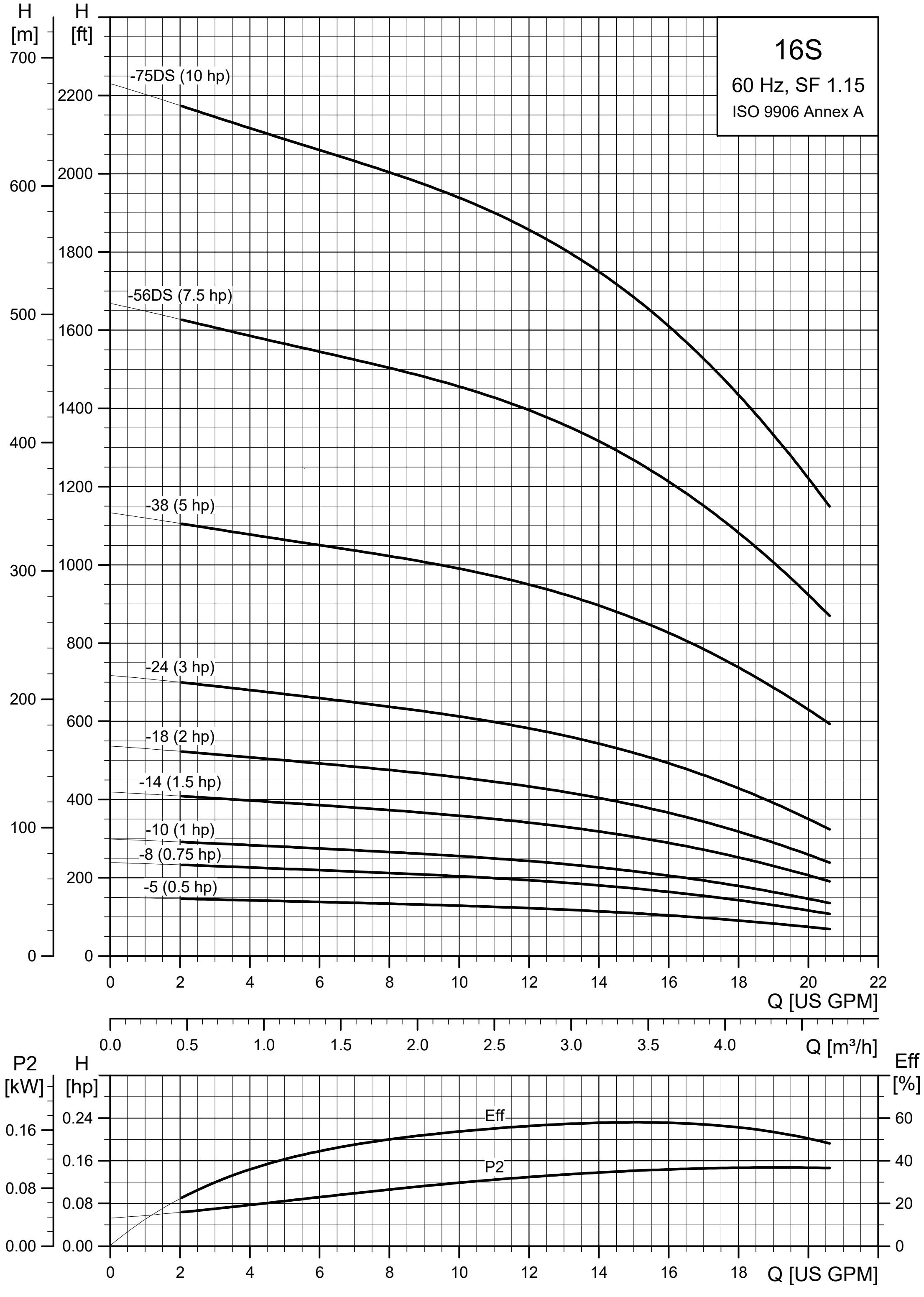
E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 1 - 1/2" NPT, 6" minimum well diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 ft (0.6 m).

- ■ MS 402 motor.
- ● MS 4000 motor.

4" and larger wells - continued

SP 16S (16 gpm)

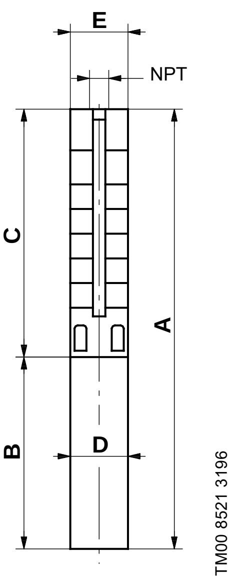


4" and larger wells - continued

SP 16S (16 gpm) pump with 4", 6" motors

Pump model	Nom. head [ft]	Motor Ph	Volts [V]	[Hp]		[rpm]	Dimensions [in (mm)] A	B	C	D	E	Net weight (complete) [lb]
16S, motor diameter 4-inch, 2-wire motor, 60 Hz - rated flow rate 16 gpm (1.25" NPT)												
16S05-5	112	1	115	.5	■	3391	21.26 (540)	11.03 (280)	10.24 (260)	3.74 (95)	3.98 (101)	21.6
			230	.5	■	3393	21.26 (540)	11.03 (280)	10.24 (260)	3.74 (95)	3.98 (101)	23.4
16S07-8	177	1	230	.75	■	3464	24.34 (618)	11.62 (295)	12.72 (323)	3.74 (95)	3.98 (101)	24.3
16S10-10	223	1	230	1	■	3394	26.58 (675)	12.21 (310)	14.38 (365)	3.74 (95)	3.98 (101)	27.9
16S15-14	313	1	230	1.5	■	3403	31.38 (797)	13.71 (348)	17.68 (449)	3.74 (95)	3.98 (101)	36.0
16S, motor diameter 4-inch, 3-wire motor, 60 Hz - rated flow rate 16 gpm (1.25" NPT)												
16S05-5	112	1	115	.5	■	3419	21.26 (540)	11.03 (280)	10.24 (260)	3.74 (95)	3.98 (101)	21.6
			230	.5	■	3396	21.26 (540)	11.03 (280)	10.24 (260)	3.74 (95)	3.98 (101)	21.6
16S07-8	177	1	230	.75	■	3343	24.34 (618)	11.62 (295)	12.72 (323)	3.74 (95)	3.98 (101)	27.0
16S10-10	223	1	230	1	■	3369	26.58 (675)	12.21 (310)	14.38 (365)	3.74 (95)	3.98 (101)	27.9
16S15-14	313	1	230	1.5	■	3414	31.38 (797)	13.71 (348)	17.68 (449)	3.74 (95)	3.98 (101)	32.4
		3	230	1.5	■	3430	29.89 (759)	12.21 (310)	17.68 (449)	3.74 (95)	3.98 (101)	28.8
			460	1.5	■	3430	29.89 (759)	12.21 (310)	17.68 (449)	3.74 (95)	3.98 (101)	28.8
16S20-18	397	1	230	2	●	3414	40.48 (1028)	19.49 (495)	20.99 (533)	3.74 (95)	3.98 (101)	36.0
		3	230	2	■	3413	34.69 (881)	13.71 (348)	20.99 (533)	3.74 (95)	3.98 (101)	36.0
			460	2	■	3413	34.69 (881)	13.71 (348)	20.99 (533)	3.74 (95)	3.98 (101)	36.0
16S30-24	533	1	230	3	●	3416	48.55 (1233)	22.60 (574)	25.95 (659)	3.74 (95)	3.98 (101)	62.1
		3	208	3	●	3464	43.94 (1116)	18.00 (457)	25.95 (659)	3.74 (95)	3.98 (101)	57.6
			230	3	●	3464	43.94 (1116)	18.00 (457)	25.95 (659)	3.74 (95)	3.98 (101)	57.6
			460	3	●	3464	43.94 (1116)	18.00 (457)	25.95 (659)	3.74 (95)	3.98 (101)	57.6
16S50-38	832	1	230	5	●	3449	65.91 (1674)	26.62 (676)	39.30 (998)	3.74 (95)	3.98 (101)	97.2
		3	208	5	●	3479	62.01 (1575)	22.72 (577)	39.30 (998)	3.74 (95)	3.98 (101)	90.0
			230	5	●	3479	62.01 (1575)	22.72 (577)	39.30 (998)	3.74 (95)	3.98 (101)	90.0
			460	5	●	3476	62.01 (1575)	22.72 (577)	39.30 (998)	3.74 (95)	3.98 (101)	90.0
SP 16S, motor diameter 6 inch, 60 Hz - rated flow rate 16 gpm (1.25" NPT)												
-	-	3	208	5	▲	3480	-	23.51 (597)	-	5.50 (139.5)	-	80.0
			230	5	▲	3510	-	23.51 (597)	-	5.50 (139.5)	-	80.0
			460	5	▲	3500	-	23.51 (597)	-	5.50 (139.5)	-	80.0
16S75-56DS	1224	3	208	7.5	▲	3478	92.28 (2344)	23.51 (597)	68.78 (1747)	5.63 (143)	5.51 (140)	165.1
			230	7.5	▲	3478	92.28 (2344)	23.51 (597)	68.78 (1747)	5.63 (143)	5.51 (140)	165.1
			460	7.5	▲	3491	92.28 (2344)	23.51 (597)	68.78 (1747)	5.63 (143)	5.51 (140)	165.1
16S100-75DS	1636	3	460	10	▲	3482	109.18 (2773)	24.69 (627)	84.49 (2146)	5.63 (143)	5.51 (140)	190.0

16S



E = Maximum diameter of pump including cable guard and motor.

Notes:
Control box is required for 3-wire, single-phase applications. Data does not include control box.
DS designation = Built into sleeve, 1 - 1/2" NPT, 6" minimum well diameter.
Performance conforms to ISO 9906. 1999 (E) Annex A. Minimum submergence is 2 ft (0.6 ft).

- ■ MS 402 motor.
- ● MS 4000 motor.
- ▲ MS 6000C motor.