RECLAMATION FILL PLAN

FAIRFAX PLANT
FOR
LUCK STONE CORPORATION

FAIRFAX PLANT, CENTREVILLE, VIRGINIA

July 16, 2020

HHNT
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I. EXECUTIVE SUMMARY

Luck Stone Corporation (Luck Stone) owns and operates an existing stone quarry on approximately 210.25 acres located on Lee Highway (Route 29) about three (3) miles west of Centreville in Fairfax County, Virginia. The property is surrounded primarily by residential land zoned R-C to the north, east and south, and by industrial land zoned I-6 to the west. The facility has been owned by Luck Stone since 1938 and has been used for stone quarrying since the 1920s. Quarrying has been conducted in two pits – the “North Pit” and the “South Pit”. While mineral reserves are still available in and around the North Pit, Luck Stone will soon cease mining efforts and plans to begin reclamation efforts in the North Pit in 2020. Mining will continue in the South Pit for approximately 20 years at which time, similar reclamation efforts will begin.

In compliance with reclamation practices instituted by the Virginia Department of Mines Minerals and Energy (DMME), Luck Stone is required to restore the mine site to a safe and non-injurious state suitable for post-mine use. As leaving the exhausted pits to naturally fill up with water will result in an undesirable terrain with highwalls in excess of 125 feet and water depths of over 300 feet, Luck Stone intends to reclaim the exhausted mine site by importing and backfilling the pits with pre-approved Reclamation Fill in accordance with the standards and protocols set forth in this Reclamation Fill Plan. The final layout of the reclaimed pits will include gentle slopes (20% or less) that transition from the edge of the current highwall down towards ±20-acre lakes (see Drawing 7 included in Appendix 5 which illustrates the conceptual grading plans for the North Pit). There will be no exposed quarry high-walls left once the reclamation of the pits is complete. This will restore the site to a condition that is safe and suitable for future post-mine uses consistent with the current underlying R-C zone or a use otherwise permitted through the Fairfax County entitlement process. Reclamation Fill used to backfill the pits will be generated from specific, tested, and documented sources, and will include earthen and rock materials that have not been known to be exposed to, or mixed with, solid waste, petroleum products, or chemical contaminants. Only materials that meet these criteria and satisfy the testing criteria defined later in this document will be used as Reclamation Fill. To confirm this, Luck Stone will implement a monitoring system to confirm that all material arriving at the quarry meets the definition of Reclamation Fill as described in Section IV.A of this plan.

Luck Stone will require all Reclamation Fill generators to characterize the material and to complete and submit an initial Reclamation Fill Profile (Profile) for review and pre-approval prior to delivery of the Reclamation Fill to the quarry. Laboratory analyses performed by an accredited Virginia Environmental Laboratory, will be submitted with the Profile in accordance with Section IV.C. Upon receipt of a completed Profile, personnel responsible for the Luck Stone’s quarry reclamation operations will review the documents. Luck Stone personnel may also visit the site to visually assess the conditions of the source property and determine if fill from the source site, or from portions thereof, is approved for importation as Reclamation Fill.

Transporters of Reclamation Fill will be required to utilize a Luck Stone issued digital application which tracks the location and travel paths of each truck. Utilizing geo-fence technology at the source site and the Luck Stone Plant, only trucks which meet the parameters of the application (i.e. automatic confirmation of presence at source site, travel distance and travel time) will be accepted by the Luck Stone associate at the scale office.

Incoming material will be scrutinized in accordance with Section IV.E. of this Reclamation Plan before permission is granted to unload the material at the applicable location on the Luck Stone property. Random load inspections and soil testing of Reclamation Fill received will be conducted weekly for each source and type of Reclamation Fill as further described in Section IV.F.

Luck Stone will place Reclamation Fill being brought to the site in a controlled fashion consistent with the standard of care for geotechnical engineering and construction monitoring practices. During backfilling operations, the groundwater in the Reclamation Fill area will be controlled to provide an adequate amount of separation (about 15 to 20 feet) between the lowest level of the fill operations and the groundwater level. Erosion and dust control measures will also be implemented (see Sections V.D. and VI.D.). The lakes will have a liner to contain a permanent pool of water. The liner will consist of soils meeting the criteria for Reclamation Fill or geosynthetic materials that meet the Virginia Department of Environmental Quality (VDEQ) requirements for liners.

A Monitoring and Mitigation Plan (MMP) has been developed for the site and is included in Appendix 7 of this plan. The plan was developed to mitigate potential risks associated with the planned backfill and future use of the reclaimed mine, based on a risk assessment (see Section IX). The MMP provides details on the planned sampling locations, sampling methods, analytical parameters, and sampling intervals. As outlined within the MMP, sampling will occur prior to filling operations in an effort to establish background concentrations. Background monitoring will occur during eight separate events within a 12-month period and then monitoring would continue on a semi-annual basis throughout active filling operations at the site. The MMP also prescribes the measurement of water levels within the monitoring well network to enable assessment of trends in groundwater elevation fluctuation and groundwater flow direction. The facility's VPDES permitted outfall will also be sampled in accordance with permit requirements. Sample parameters for both groundwater and surface water will include select parameters similar to those that will be used for evaluation and acceptance of Reclamation Fill as outlined within Section IV.B of this Reclamation Plan. In the event that an independent professional engineer or geologist provides evidence that an off-site drinking water well has been impacted by reclamation activities, Luck Stone will evaluate the information submitted and prepare a response. The response may include conducting additional tests and studies, providing corrective measures for the drinking water well affected or, if applicable, objecting to the findings presented. Luck Stone will also review Reclamation Fill processes and make modifications as may be necessary. The Virginia Department of Environmental Quality would be notified, along with Fairfax County, of any confirmed results that exceed groundwater protection standards.

II. INTRODUCTION

Luck Stone Corporation (Luck Stone) owns and operates an existing stone quarry on approximately 210.25 acres located on Lee Highway (Route 29) about 3 miles west of Centreville in Fairfax County, Virginia. Luck Stone has retained Hodges, Harbin, Newberry and Tribble, Inc. (HHNT) and ECS Mid-Atlantic, LLC (ECS) to prepare a Mine Reclamation Plan that includes backfilling the existing quarries with clean earthen and rock materials (Reclamation Fill) with the ultimate purpose of leaving the site in a safe condition suitable for a post mine use.

The Luck Stone Fairfax Facility is located on both sides of Lee Highway, and generally west of Bull Run Post Office Road (Route 621), in the Centreville area of the Sully Magisterial District. The property is surrounded primarily by residential land zoned R-C to the north, east and south, and by industrial land zoned I-6 to the west. The facility has been owned by Luck Stone since 1938 and has been used for stone quarrying since the 1920s. Quarrying has been conducted in two pits – the “North Pit” and the “South Pit”. Mineral resources in the North and South Pits are expected to be exhausted within one (1) and twenty (20) years, respectively. Upon the exhaustion of mineral reserves, Luck Stone is proposing to begin the reclamation phase of its quarrying operation by backfilling the site with Reclamation Fill generated from specific, tested, and documented sources. Luck Stone will implement a monitoring system to ensure that all material arriving at the quarry to be used in the reclamation of the pits meets the definition of Reclamation Fill as described in Section IV.A of this plan. Upon the conclusion of reclamation efforts, the site will consist of two separate ± 20-acre lakes, surrounded by restored land previously utilized by mining activities.

Given that reclamation efforts in the North Pit will likely commence in 2020, this report addresses Luck Stone’s reclamation plan specifically for the North Pit. Once the reclamation of the South Pit becomes imminent, this plan will be amended as needed to include details specific to the South Pit.

This report includes the following sections:

- Section III discusses the need and benefits of the reclamation method proposed for the Luck Stone pits.
- Section IV discusses the quality of the material to be accepted for placement in the Pits and the processes to be put in place to confirm that this material meets the requirements set forth for Reclamation Fill.
- Sections V through VII describe the proposed filling operation in the North Pit, including dewatering requirements, fill placement methods, and placement of fill sequences.
- Sections VIII and IX provide background on the existing conditions of the North Pit and discuss the hydrogeologic setting and risk assessment.
- Section X describes the groundwater monitoring plan for the North Pit.
- Section XI describes the final reclamation condition and proposed land use for the North Pit.
- Section XII includes a list of references.
- Figures follow the text of the report.
- The appendices include the proposed forms, Sequence Drawings, Monitoring and Mitigation Plan, and other supporting documents referenced in this plan.

III. NEED FOR PROPOSED ACTIVITY/FILL

Quarry reclamation is an essential and necessary requirement for all mining operations. Upon the exhaustion of mineral reserves, the Virginia Department of Mines Minerals and Energy (DMME) requires the mine operator to restore the operational areas of the site to a safe and non-injurious state suitable for post-mine use. As a specific post-mine use has yet to be determined for the subject property, Luck Stone intends to reclaim the operational areas of the property in a manner which reduces the physical liabilities such as exposed highwalls and significant depths of water that would be present if these pits were left to naturalize in place. Luck Stone will import and place pre-approved Reclamation Fill to restore the operational areas of the mine site to a condition that is safe[1] and suitable for future post-mine uses consistent with the current underlying R-C zone or a use otherwise permitted through the entitlement process.

Given the size of the Luck Stone quarries, the pits (North and South) can provide up to 30 million cubic yards of storage for Reclamation Fill. It is estimated that the North Pit alone will provide storage capacity for up to 13 million cubic yards of Reclamation Fill. Based on estimated volumes of fill being delivered to a comparable operation in the northern Virginia area, discussions with local site development contractors, and other third-party research, Luck Stone personnel estimate an average of 700,000 cubic yards will be imported and placed in the North Pit each year. This volume is only an estimate and may fluctuate depending on the quantity and quality of the available material being generated from off-site sources. The filling of the pits will occur in a strategic process as described in Section VII of this plan. As part of the final phase of its reclamation efforts, Luck Stone also intends to construct lakes in the areas of the existing pits that have potential to be used for active and/or passive recreational purposes as part of a future post-mine use.

In conclusion, Luck Stone's proposed reclamation efforts will reduce the physical liabilities associated with an abandoned mine site. Returning the land to an environmentally sound and usable condition will greatly reduce the potential safety hazards for the residents of the nearby communities.

[1] Fatal falls from highwalls and drownings in deep waters are potential hazards associated with quarries abandoned in place that have not gone through restoration efforts similar to those proposed herein.

IV. RECLAMATION FILL

IV.A. Definition of Reclamation Fill

Reclamation Fill, for the purposes of the Luck Stone Fairfax Plant, will refer to natural (i.e. soil and rock) materials that are certified to meet the requirements of this plan. These requirements have been developed to be protective of the environment and human health. Reclamation Fill will include earthen and rock materials that have not been known to be exposed to, or mixed with, solid waste, petroleum products, or chemical contaminants. Only materials that meet these criteria and satisfy the testing requirements defined later in this document will be accepted on site and used as Reclamation Fill.

IV.B. Reclamation Fill Source Evaluation and Testing Requirements

IV.B.i. Source Evaluation and Testing Determination and Frequency

Luck Stone will conduct a due diligence review for each source of Reclamation Fill prior to acceptance at the Luck Stone Fairfax Quarry. A Phase I Environmental Site Assessment (ESA) report (if available) or similar documents/research will be provided by the generator with the initial Reclamation Fill Profile and Agreement (Profile) in accordance with Section IV.C, below. Luck Stone personnel, or a third-party qualified consultant, may visit the Reclamation Fill source location as necessary in-person and/or conduct a desktop study of historical use of the property to determine if there is evidence of a release of solid waste, petroleum products, or chemical contaminants.

Regardless of the due diligence review, Luck Stone will require all Reclamation Fill generators to characterize the material to meet the requirements set forth in this plan. A qualified environmental professional under the guidance/charge of a professional engineer or a professional geologist licensed in the Commonwealth of Virginia will be required to sample and conduct analytical testing on the Reclamation Fill material being considered for importation to the Luck Stone site. A grab soil sample representative of the Reclamation Fill to be brought to the site will be submitted for laboratory analysis of Column A Phase I Priority Analytes as shown in Appendix 4. Testing will be done at the source and the results will be included with the Profile submitted for review and approval by Luck Stone prior to transporting any Reclamation Fill to the Luck Stone site.

The acceptance application will include soil sampling results at a rate of one grab sample per source and per type of material from each source and one grab sample for every 3,000 cubic yards of Reclamation Fill per source and per type of material from each source. Following the initial application approval, the generator will be required to provide supplemental laboratory results at a rate of one grab sample per each additional 3,000 cubic yards of Reclamation Fill per source, per material type, or at any time that the material coming from the same source is visibly or obviously different from that initially approved for delivery to the site. The generator will be responsible for providing soil sampling results from the material in advance of planned fill delivery.

IV.B.ii. Testing Protocol

Grab samples will be collected at the rates identified above. Samples will be collected by a qualified third-party consultant in appropriate bottle ware and preserved with ice prior to being shipped to a contract laboratory accredited by the Virginia Environmental Laboratory Accreditation Program. Sampling and analytical methods will conform to the methods described in the U.S. Environmental Protection Agency's SW-846 document (EPA, July 2014).

IV.B.iii. Testing Responsibility

Analytical testing results will be submitted with the Profile for approval by Luck Stone prior to delivery. Luck Stone will have the right to request additional analytical testing from the generator for any reason.

As an additional level of quality control, Luck Stone will conduct its own appropriate laboratory testing of Reclamation Fill material, post-delivery, on samples obtained during a random load inspection or if noncompliant materials are suspected during unloading.

IV.B.iv. Testing Criteria

The results of analytical testing will be compared to the Groundwater Protection Screening Level (GWPS) criteria set forth in the Ecological and Groundwater Protection Soil Screening levels and provided in Appendix 4. Additionally, Luck Stone personnel will collect soil samples in and around the quarry and analyze for inorganic metals to develop a representative, background database for background metals concentrations in the existing soils onsite. These background metals concentrations, if higher than the GWPS, will be the determining criteria for Reclamation Fill acceptance and supersede the metals concentrations criteria identified within the tables and documentation provided in Appendix 4.

If any of the results exceed the limits specified in the Groundwater Protection Soil Screening Level criteria referenced above and exceed background inorganic metals concentrations, the fill will be deemed unfit for acceptance and the generator will be notified.

IV.C. Reclamation Fill Profile and Agreement Process

Luck Stone will require all Reclamation Fill generators to complete and submit an initial Reclamation Fill Profile and Agreement (Profile) for review and pre-approval prior to delivery of the Reclamation Fill to the quarry. The material characterization will be documented on the Profile. The Profile will include the following information:

- Generator name, address, contact information, and contractor license number;
- Description of Reclamation Fill to be shipped including source, estimated volume, physical characteristics;
- A Phase 1 ESA Report (if available), or similar due diligence documents, will be provided (per source);

- Analytical laboratory test results of the material at the source at a frequency as specified in Section IV.B.;
- Shipping method, transporter contact information, requested shipping dates, and expected volume per day;
- Confirmation that haulers will utilize the Luck Stone QuickHaul application (see Section IV.D);
- Location description and/or address, including facility name and owner, of the Reclamation Fill origination, if different from generator;
- Certification from the generator that the analytical laboratory test results are representative of all Reclamation Fill to be delivered to the quarry; will only come from the source property; is non-hazardous; and complies with the description indicated on the Profile; and
- Signed agreement that the generator will pay a pre-determined fee and promptly remove from the pits at his own expense, all material that is determined to be non-compliant.

Laboratory analyses performed by an accredited Virginia Environmental Laboratory will be submitted with the Profile. Upon receipt of a completed Profile, personnel responsible for the Luck Stone's quarry reclamation project will review the documents and may visit the source site as necessary to visually assess the conditions of the source property. If the Reclamation Fill is approved for acceptance, the Profile will be marked, "Approved", and the applicant will be notified to schedule delivery.

An example Reclamation Fill Profile is provided in Appendix 1. Each delivery to the quarry will be associated with a pre-approved Profile and Shipping Manifest. Deliveries without a pre-approved Profile will not be accepted. Luck Stone will keep all Reclamation Fill Profile records at the quarries or at their corporate offices for the life of the facility. Records may be kept in an electronic format.

IV.D. Transporters of Reclamation Fill Requirements

Transporters of Reclamation Fill will be required to utilize a Luck Stone issued digital application which tracks the location and travel paths of each truck. Utilizing geo-fence (or available equivalent) technology at the source site and the Luck Stone Plant, only trucks which meet the parameters of the application (i.e. automatic confirmation of presence at the source site, travel distance and travel time) will be accepted by the Luck Stone associate at the scale office. Screen shots of the Quickhaul App are provided in Appendix 2. Additional technology or other modes of electronic tracking devices/software may be implemented at Luck Stone's discretion. In rare instances, a paper ticket system may be utilized as an alternative or secondary means of tracking deliveries.

IV.E. Reclamation Fill Screening and Quality Management

Incoming material will be scrutinized before permission is granted to dispose of the material at the applicable location on the Luck Stone property. Upon the arrival to the Luck Stone site, the truck driver will enter the property and scale on the in-bound scale. At that time, the Luck Stone associate working within the scale house will perform a three-part delivery inspection prior to permitting the truck to proceed to the tipping location. First, the associate will confirm the truck ID is associated with a documented source and safety training has been completed by the driver. Secondly, utilizing Luck Stone's QuickHaul Application, the truck's origination and travel time will be confirmed with those which have been allotted for the subject source (See Appendix 2 for more information on the QuickHaul Application). Following the confirmation that the truck is part of an approved fleet and the vehicle came directly from an approved source, the associate will then perform a visual inspection of the material in the truck bed via overhead camera equipment installed on the scale. The Luck Stone associate will have the ability to deny any load if the delivery fails any part of the three-part inbound inspection. If the truck and load pass this inspection, the driver will proceed to the designated location outside the pit to unload the material for visual characterization and staging unless otherwise directed to deposit the load in an alternative location for random inspection and testing per Section IV.F. of this plan. Depending on a number of factors such as safety, ongoing mining operations and other restoration efforts on the property, the exact location of the Reclamation Fill staging area will vary. Luck Stone personnel, or their hired contractors and equipment, will transport the Reclamation Fill from the staging area located in the existing stockpile portion of the property, down to the reclamation area inside the pit. There it will be placed and compacted in accordance with the process described in Section V.C. of this Reclamation Plan.

Luck Stone may need to make adjustments to the Reclamation Fill staging, transport, placement, quality control, and/or testing protocols for Reclamation Fill to account for evolving conditions of the reclamation operation. However, any amendments to the quality control and/or testing protocols for Reclamation Fill resulting from evolving conditions not anticipated in this Plan will be submitted to the County for review and approval prior to implementation.

As a standard practice, non-compliant material will not be accepted at Luck Stone's Fairfax Plant. In some circumstances, de minimis amounts (5% or less) of organics (roots, branches, stumps, etc.) and inert material (pieces less than 6 inches in diameter of non-coated/non-painted concrete, blocks, or brick) may be present within the accepted Reclamation Fill. Luck Stone will have the right to reject loads with any level of non-compliant material. In the event these materials can be easily separated from the pile, the operator may do so prior to placement in the pit. Separated non-compliant material will be recycled or disposed of at an approved facility. Luck Stone will have the right to refuse future deliveries and terminate the Reclamation Fill agreement from sources and/or generators that deliver unacceptable levels (more than 5%) of non-compliant material.

In summary, the following procedures will be in place to ensure that only pre-approved Reclamation Fill will be accepted and placed on-site:

1. Initial soil characterization and Reclamation Fill Profile and Agreement has been completed and pre-approved (every source).
2. Source site visit and inspection performed by Luck Stone personnel or an assigned third-party consultant, as necessary.

3. In-bound inspections prior to disposing any material onsite:
    a. Confirmation of truck ID with safety training log (every load).
    b. Confirmation that truck came from a pre-approved source, within the allotted amount of mileage and time via the Luck Stone QuickHaul Application required for use by every driver (every load).
    c. Visual bed inspection via cameras (every load).
4. Random Load Inspections per Section IV.F.
5. Final visual inspection by trained equipment operator in the staging area prior to transporting the Reclamation Fill to the pit for placement and compaction in the pit (every load).
6. Hydrocarbon screening via a handheld Photoionization Detector (PID) will be conducted randomly and daily by a Luck Stone associate while reclamation efforts are taking place on the property. Testing locations will vary, but at a minimum, the active fill location(s) in the pit and recently placed material will be tested with the PID. A mini RAE 3000 or approved equal will be utilized for this activity. The readings will be documented on-site and available for review by interested parties.

Signage containing text similar to the messages below will be posted at Luck Stone's entrance:

> "Luck Stone Accepts Pre-Approved Reclamation Fill Only"
> "All Drivers are Required to Check in at In-Bound Scale for Inspection and Acceptance"
> "Safety Training is Required Prior to Entering the Mine Site"
> "Illegal Dumping will be Prosecuted to the Fullest Extent of the Law"

IV.F. Random Load Inspections

As an additional level of quality control, random load inspections and soil testing of Reclamation Fill received will be conducted weekly on samples of the material brought from each source. Upon arrival on the inbound scale, a Luck Stone associate will direct the driver to deposit his load in the designated area. The material will then be visually inspected by Luck Stone personnel for compliance with the standards set forth in the Reclamation Plan while the truck remains within the testing area.

Upon passing the visual inspection of the material during the random inspection, the driver will be permitted to leave the inspection area and Luck Stone will sample the unloaded material for analytical testing. One grab sample will be collected for the specified load and analyzed for the Column A Phase 1 Priority Analytes provided in Appendix 4.

If there is evidence of non-compliant material beyond what has been discussed in Section IV.E, i.e. construction debris, trash, solid waste, etc. Luck Stone will immediately load the material back on to the delivering truck and will escort it off the property. At that point, the generator will be notified, a rejection fee will be issued, and the details for the rejection will be documented. No additional material will be accepted from this source until the generator has submitted evidence that future loads will meet the requirements of this plan. If non-compliant fill material is identified from a source, a diligent effort will be made to assess the filled area of the pit where material from that source may have been recently placed based on operational records. The assessment would include the use of an excavator to enable soil screening and if elevated PID readings (readings over background levels) are encountered or visually suspect material identified, such material will be removed from the pit, staged onsite within a designated area, and a sample will be collected for laboratory analysis. If any of the inorganic metals results exceed the limits specified in Groundwater Protection Soil Screening Level criteria, but are observed below background levels, the fill will be considered acceptable. Any laboratory results documenting non-compliant material will be retested, and if the results are over the screenings level this will result in such material being removed from the site at the generator's expense. If a generator sends non-compliant material more than twice to the Luck Stone facility, Luck Stone will have the option to prohibit any further material from the pertinent source from being accepted regardless of further documentation and/or analytical testing provided by the generator. These rules will be included in the Reclamation Fill Profile and Agreement between Luck Stone and the generator.

Costs of properly managing the non-compliant fill will be borne by the generator as stated in the Reclamation Fill Profile and Agreement between Luck Stone and the generator.

An example Random Load Inspection Form is provided in Appendix 3. The random load inspections will be documented, and the records will be kept for the life of the facility. Records may be kept in an electronic format.

IV.G. DEQ Vetting & Written Confirmation

The specifics of this program will be submitted to the Solid Waste Program of the Virginia Department of Environmental Quality (VDEQ) for review via Fairfax County. Additional guidelines or correspondence from VDEQ related to the proposed reclamation efforts will be included in the final version of this document.

V. PREPARATION FOR FILL

V.A. Dewatering Requirements

ECS created a numerical groundwater model of the subject site in 2016 to assess on-site hydrogeologic conditions. The groundwater model was created using the MODFLOW-SURFACT code (produced by HydroGeologic, Inc.) within the Visual MODFLOW software interface (produced by Waterloo Hydrogeologic, Inc.). ECS used the groundwater model as part of the fill assessment evaluation to assess groundwater elevations and dewatering rates associated with five anticipated North Pit fill sequences. Model projections pertaining to North Pit dewatering rates are discussed in this section of the plan. Going forward, the groundwater model will be updated upon reaching the end of each fill sequence, although it will not be necessary to update the model upon reaching the end of fill sequence 5, as this would represent the end of pit filling.

The groundwater model's inputs, including grid layout, hydraulic properties, and boundary conditions, are described in detail in Section 6.0 of the Pit Filling Hydrogeologic Study, herein after referred to as the "Groundwater Modeling Report", which has been provided under separate cover. Information contained therein is considered confidential business information subject to an existing non-disclosure agreement (NDA). Figures 8-A, 8-B, 9, and 10 of the groundwater modeling report graphically depict model inputs. To summarize these inputs, the model consists of 12 layers, 137 rows, and 155 columns. Grid cell dimensions range from 80 feet by 89 feet at the subject site portion of the model to 632 feet by 702 feet at the outer portions of the model. The total thickness of the model is 850 feet. Assigned boundary conditions include a recharge boundary to represent infiltrated post-evapotranspiration precipitation, constant head boundaries to represent groundwater flux with regions outside the model domain, river boundaries to represent major streams, and drain boundaries to represent dewatering at the subject site and other quarries within the model domain.

ECS attempted to calibrate the groundwater model to two parameters: The North Pit's measured dewatering rate and groundwater levels measured at two observation wells that were available at the time of the model's creation in 2016. While the groundwater model was successfully calibrated to North Pit dewatering rates, groundwater levels were over-predicted by the model (i.e., model-predicted groundwater levels were higher than actual levels). The Groundwater Modeling Report documented difficulty calibrating the model to groundwater levels observed at the two observation wells located in proximity to the pit.

ECS compared model-predicted calibration groundwater levels to groundwater levels measured at the recently monitored seven observation wells (Table 1) and found that this over-prediction relationship still exists. In general, the model-predicted calibration values are approximately 60–150 feet higher than measured values, although the groundwater level measured at MW-3 in May of 2020 was within five feet of the model-predicted groundwater level. In addition to the reasons provided in the Groundwater Modeling Report, ECS believes that it was difficult to calibrate the model to both North Pit dewatering rates and groundwater levels due to the inherent limitations with constructing a three-dimensional groundwater model to represent a fractured bedrock system. Additionally, the wide range of groundwater elevations measured during the six monitoring events indicates that levels fluctuate greatly in response to North Pit dewatering and possibly other variables. Despite the limitations associated with the groundwater level calibration, ECS considers the groundwater model to be a useful tool in evaluating potential filling and pumping scenarios, especially since groundwater level and dewatering impacts will be reduced as pit filling advances.

Table 1: Summary of Monitoring Well Groundwater Level Measurements Collected from October 2019 to May 2020

Well Identification	Approximate Elevation of TOC[a] (feet amsl[b])	Measured Depth to Water (feet below TOC)		Estimated Groundwater Elevation (feet amsl)	
		Maximum	Minimum	Maximum	Minimum
PMW-A	292.4	346.95	336.65	-44.25	-54.55
PMW-B	290.5	354.99	295.91	-5.41	-64.49
PW-1	235.9	253.42	238.71	-2.81	-17.52
MW-2	242.6	271.35	259.93	-17.33	-28.75
MW-3	242.2	320.21	194.32	47.88	-78.01
MW-4	294.3	369.84	360.37	-66.07	-75.54
MW-5	297.7	368.10	342.50	-44.80	-70.40

[a]TOC = top of casing.
[b]amsl = above mean sea level.

The groundwater model was used to run simulations to predict dewatering rates at each of the four fill sequences when dewatering would occur. Each predictive simulation assumed that groundwater elevations in the North Pit would need to be maintained a sufficient distance below the fill sequence elevation to provide sufficient geotechnical stability (see Section V.E). For example, the groundwater level maintained for Fill Sequence 1 was assumed to be -20 feet amsl, since the lowest elevation at the bottom of the temporary pond would be 0 feet amsl. Based on this 20-foot separation distance, North Pit groundwater dewatering elevations were modeled as -20 feet amsl (Fill Sequence 1), 70 feet amsl (Fill Sequence 2), 130 feet amsl (Fill Sequence 3), 156 feet amsl (Fill Sequence 4), and at final non-dewatering condition (Fill Sequence 5). South Pit dewatering was also simulated as part of this assessment. Based on anticipated South Pit depths at each of the fill sequences, a groundwater dewatering elevation of -120 feet amsl was used for simulation of fill sequences one through three and an elevation of -170 feet amsl was used for simulation of fill sequences four and five. Filled portions of the pit were assumed to be comprised of relatively impermeable material with a horizontal and vertical hydraulic conductivity of 0.001 feet/day, which is a typical value for a silty clay material. Simulations were also run using pit fill material hydraulic conductivity values one order of magnitude less than and greater than this value (i.e., 0.0001 feet/day and 0.01 feet/day, respectively) to evaluate the model's sensitivity to this parameter. Details pertaining to the simulated predictions are provided under separate cover. Information contained therein is considered confidential business information subject to the existing NDA. Table 2 summarizes fill sequence duration, North Pit pond elevations, and North and South Pit dewatering elevations.

Table 2: Summary of Groundwater Modeling North Pit Dewatering Rate Projections

Fill Sequence	Estimated Time to Reach Fill Sequence (years)	North Pit Pond Elevation (ft amsl[a])	North Pit Dewatering Elevation (ft amsl)	South Pit Dewatering Elevation (ft amsl)
1	3.1	0	-20	-120
2	8.8	90	70	-120
3	10.5	150	130	-120
4	13.3	176	156	-170
5	20.9	224	167 (Static[b])	-170

[a]feet amsl = feet above mean sea level.
[b]Static = predicted static groundwater elevation at the end of dewatering = 167 feet amsl.

The predictive simulations indicate that the North Pit's dewatering rate would decline as pit filling advances. The supplemental simulations indicate that the model is insensitive to the hydraulic conductivity of the fill material, as illustrated by the similar model-predicted North Pit dewatering rates. Similarly, the differences between model-predicted groundwater level drawdown for the simulations was negligible. It is important to note that a drain boundary was used to simulate dewatering within the model and actual dewatering rates would be dependent, in part, on the selected dewatering method. The drain boundary essentially simulates the removal of water across the entire footprint of the fill sequence at the assigned drain elevation. As such, this application results in a direct hydrologic connection between the drain boundary and the quarry walls and fill material. When this is considered, it is unsurprising that altering the fill material's hydraulic conductivity value would result in only minor changes to the dewatering rate, as the primary source of groundwater contribution would be via lateral flow through the quarry wall and a lesser source would be via upwelling through the fill material.

ECS ran a predictive simulation as part of the initial hydrogeologic study that was completed in 2016 to simulate the simultaneous cessation of dewatering in both the North Pit and the South Pit (see Section 6.2.1 of the groundwater modeling report, which has been provided under separate cover). However, the purpose of this simulation was not to simulate fill material within the pit, and as a result, it was determined that additional simulations should be run to evaluate the impact that ceasing dewatering in the South Pit could have on dewatering rates in the North Pit. The supplemental simulations assessed North Pit dewatering rates at each of the initial four planned fill sequences (i.e., when dewatering would be occurring in the North Pit) and dewatering was inactive in the South Pit for these simulations. In reality, it is unlikely that South Pit dewatering would cease during the initial fill sequences because the South Pit is planned to be active for several more years. Additional details regarding the simulation results have been provided under separate cover. Information contained therein is considered confidential business information subject to an existing non-disclosure agreement (NDA).

V.B. Water Management and Water Quality

Luck Stone maintains a Best Management Practices (BMP) Plan in accordance with the Northern Virginia BMP Handbook. The Luck Stone site is located within a Water Supply Protection Overlay District (WSPOD), which requires that discharge from the site achieve a minimum of 50% phosphorus removal rate. The BMP Plan at Luck Stone's Fairfax Quarry includes a program to monitor water discharge and the site-specific BMPs (i.e. the ponds) are effective in reducing the amount of phosphates carried off-site. Stormwater falling on undisturbed and disturbed areas of the facility is either directed to existing ponds on-site or into the quarries, where it is mixed with groundwater and pumped to three (3) on-site wet ponds (A1, B2, and B3). From the wet ponds, water is pumped to existing ponds that discharge off-site into well vegetated channels and wooded areas leading to Bull Run Creek about 2,000 feet downstream of the quarry.

Reclamation of the quarry will not result in appreciable changes in the way stormwater and pumped stormwater and groundwater are managed and discharged. Current water management practices that will be continued during the reclamation period are described in Sheets 8 of 12 and 12 of 12 of the Special Permit Amendment Plat, SPA 81-S-064-10 drawings.

During the entire Reclamation phase, the VDEQ Virginia Pollutant Discharge Elimination System (VPDES) discharge permit will remain in effect, as reclamation is considered the last phase of mining operations. Therefore, the required Storm Water Pollution Prevention Plan (SWPPP) will remain active and water discharge from the site will meet the existing permit limits for pH and Total Suspended Solids. Water discharge will not be permitted to exceed Virginia's Water Protection Standards at any time.

V.C. Operations & Placement Methods

Luck Stone will place Reclamation Fill being brought to the site in a controlled fashion. The ideal thickness of each lift will depend upon a variety of factors, including physical factors such as the Reclamation Fill's engineering characteristics and the depth at which the Reclamation Fill is being placed. Consolidation of the Reclamation Fill placed at depth will occur due to the surcharge weight of the fill above it. At depth, Reclamation Fill can be placed in up to 4-foot thick lifts and compacted by tracking the surface with several passes of heavy construction equipment such as a compactor or large dozer. The upper 25 to 30 feet of Reclamation Fill will be placed in 1 to 2-foot-thick lifts and compacted as discussed in Section VI.B.

Reclamation Fill cannot be compacted effectively if too wet; therefore, wet fill coming to the site will be placed in a thin lift (under 12-inches) and worked with a disc or harrow until it dries sufficiently for proper compaction. Alternatively, fill will be segregated to an area of the quarry where it can be stored until it becomes dry enough to place and compact.

Reclamation Fill areas will be graded to promote stormwater drainage away from where fill is being placed and compacted, and diversion channels or berms will be constructed as necessary to divert stormwater away from the fill placement area into a temporary pond as shown on the sequence drawings included in Appendix 5.

Luck Stone will routinely document the horizontal location and vertical elevations of its filling operations in the event it is necessary to delineate the location of certain material previously placed in the pit.

V.D. Erosion Control Plan

Stormwater runoff on-site will either sheet flow or is directed to the quarries or to the on-site settling ponds, where sediment is captured prior to discharge. Current practices are effective in preventing off-site migration of sediments as indicated by the well vegetated condition of the off-site discharge channels and downstream areas (see photos included in Sheets 11 of 12 of the Special Permit Amendment Plat, SPA 81-S-064-10 drawings). In accordance with the Northern Virginia BMP Handbook and the site's Storm Water Pollution Prevention Plan (SWPPP) as referenced above, temporary measures such as silt fences, berms, hay bales, stone check dams, temporary sediment traps, temporary and permanent grassing, or other similar means will be employed to deter erosion and control sediment.

V.E. Geotechnical Stability Calculations

Several slopes are indicated on the Reclamation Fill plan during filling and the final conditions. Additional temporary slopes may be constructed during Reclamation Fill placement. Temporary fill slopes constructed of Reclamation Fill will be constructed in accordance with all applicable regulations from the Mine Safety and Health Administration (MSHA) and Virginia Department of Mines Minerals and Energy (DMME). Temporary slopes will not be constructed with Reclamation Fill that predominantly consists of fine-grained materials (silt or clay) or Reclamation Fill that is excessively wet or soft. The following practices will be implemented for all temporary slopes:

- Do not construct slopes at grades steeper than the angle of repose (material, moisture, & exposure dependent).
- Immediately correct a slope that has become steeper than angle of repose or shows signs of instability.
- Barricade the area around an unstable slope/highwall until the issue is remediated.

- Berm or barricade the crest and toe of slopes at an appropriate distance to prevent access to a potential hazard.
- Before and during work observe the slopes in the work area for signs of instability i.e. cracking, slumping, etc. Fix observed issues prior to working in the area.
- Associates working around slopes/highwalls will have appropriate training on hazard awareness, identification, and mitigation.
- When pushing material off the crest of a slope/highwall, use a spotter, only approach the slope in a perpendicular direction, use an excavator when possible
- When dumping material towards the crest of a temporary slope, do not dump right at the crest, stop short, dump a safe distance from the crest, and push material off the crest.
- Construct the slope in short lifts that can be compacted versus a tall, back dump method
- Minimize the height of the temp slope to the degree possible.
- When around a slope in mobile equipment, do not get parallel to the crest or toe of the slope. Only approach from a perpendicular orientation.
- No person will walk closer than 6 feet to the crest of a slope/highwall without being appropriately tied off.
- Warning signs are posted along the berm or barricade to alert people to slope hazards on the other side.

Permanent slopes constructed of Reclamation Fill will generally be 3H:1V or flatter. Permanent slopes steeper than 3H:1V will be designed by a geotechnical engineer. The current Reclamation Fill plan indicates a final pond slope of 5H:1V.

Minor irregularities such as erosion channels and willow surficial sloughing may occur once the face of unvegetated or unstabilized slope is exposed to weather over a period of time. The material, once saturated may become less stable and minor sloughs within the top 3± feet from the slope surface may become more likely. Erosion channels may also develop depending on climatic conditions. Where irregularities are identified they will be regraded to the plan dimensions.

Slope failures associated with temporary construction slopes will be repaired by Luck Stone in order to facilitate reclamation activities. For permanent slopes, specific slope stability calculations will be performed by a professional engineer licensed in the Commonwealth of Virginia with experience in geotechnical engineering upon establishing final approved grades and materials that will be used (see Section VI.E.).

Slope stability analyses of the final permanent slopes will be performed at the time of final site plan review and submission as discussed in Section VI.E using Limit Equilibrium Methods. Limit Equilibrium analysis will be performed for the following scenarios representing permanent conditions:

Permanent Conditions	Minimum Required FS
Static analysis of the slope with impounded water at normal pool elevation. Seepage forces, if possible, will be included	1.5

Certain temporary conditions will be analyzed for the final pond configuration as needed to confirm stability. The following scenarios and minimum required safety factors will be considered.

Temporary Conditions	Minimum Required FS
Static analysis of the slope without impounded water (end of construction prior to pond filling)	1.5
Static analysis of the slope with impounded water at the highest anticipated water level (design storm)	1.3
Static analysis of the slope under rapid drawdown of the impounded water from normal pool elevation to the minimum pool elevation for pond maintenance	1.2
Dynamic analysis of the slope to determine seismic yield acceleration	0.12g*

*Minimum allowable yield acceleration in units of "g" – See Appendix 8 for preliminary seismic analyses of final and rock slopes.

The stability analysis will be performed based on appropriate laboratory and/or insitu testing of the in-place Reclamation Fill materials to establish soil properties. For seismic analysis, the soil strength envelope will be represented by 80% of the laboratory reported undrained shear strength.

A report will be generated documenting the analysis methods and results. The report will be prepared by, or under the supervision of, a professional engineer licensed in the Commonwealth of Virginia with experience in geotechnical engineering.

Ongoing observation of the high wall rock will be performed regularly throughout execution of this reclamation plan in accordance with Luck Stone's current standard of practice and extensive mining experience. Qualified Luck Stone Corporation personnel will visually observe the rock walls to identify potential stability and safety issues.

Maintenance of the exposed high walls will be performed or implemented on an as needed basis at the discretion of Luck Stone personnel as they have done since beginning mining operations at the site. Maintenance may include, but is not limited to rock removal, re-sloping, trimming, and scaling of the rock. Further, protection measures may include the installation of catchment ditches, and/or draping of suspect slopes with wire mesh. Where a stability or safety issue associated with the rock walls cannot be addressed using Luck Stone's typical practices, a licensed professional engineer or certified professional geologist will be engaged to consult.

V.F. Subsurface Slope Water Management

The groundwater in the Reclamation Fill area will be controlled to provide an adequate amount of separation between the lowest level of the fill operations (assumed to be about 15 to 20 feet from the bottom of the temporary stormwater management pond) and the groundwater level. The specified separation is to reduce the potential for saturated conditions within the Reclamation Fill that may adversely affect fill placement operations. If areas of previously placed Reclamation Fill are observed to be saturated and cannot be adequately treated as described in section VI.A, the area will be undercut 12 inches and replaced with open graded aggregate such as VDOT No. 57 stone to provide a stable surface for subsequent placement and compaction of Reclamation Fill.

VI. FILL COMPACTION REQUIREMENTS

VI.A. Moisture Control

Maintenance of soil moisture may be required throughout the life of the project depending on Reclamation Fill conditions at the time of import, depth of the Reclamation Fill placement, as well as local weather conditions. New Reclamation Fill will not be placed over top of areas of standing water. Standing water will be allowed to dry or will be blended with in-place soils prior to placement of additional Reclamation Fill. New Reclamation Fill that has excessive amounts of free water upon delivery will be spread in a maximum 12-inch-thick lift until dry or blended with other Reclamation Fill having less moisture prior to placement and compaction.

Above elevation 200 feet, more stringent moisture control measures will be implemented. Soil moisture will be controlled to within +/- 5% of the optimum water content determined using the One Point Proctor Method (Virginia Test Method VTM-12). Soils meeting this criteria will be moist to the touch (not wet) and friable (can be broken into smaller pieces with light finger pressure) at the time of compaction. Wet soils will be allowed to dry prior to compaction until a proper moisture content is reached or blended with other less moist Reclamation Fill soils. Drying of soils can be accomplished by scarifying and/or windrowing.

VI.B. Compaction

As discussed in Section V.C., Reclamation Fill will be placed and compacted in a controlled manner. Temporary fill slopes will be constructed and maintained consistent with the standard of care for geotechnical engineering and construction practices. Fill placement surfaces will be prepared to receive the next lift of Reclamation Fill by scarifying underlying material to provide a good bond with the new overlying lift.

Methods of achieving proper compaction may vary for different Reclamation Fill materials. Fine-grained, cohesive materials, such as silt and clay, require heavy equipment such as static sheepsfoots, big dozers, scrapers, and loaders for proper compaction. Coarse-grained, granular materials, such as sand and gravel, can be compacted with equipment that adds vibration as well as pressure, such as vibrating sheepsfoots and vibrating rollers.

At depth, Reclamation Fill can be placed in up to a 4-foot-thick lifts and compacted by tracking the surface with several passes of heavy construction equipment as described above. The last 25 to 30 feet of Reclamation Fill will be placed in 1 to 2-foot-thick lifts and compacted.

VI.C. Fill Placement Monitoring & Recordkeeping

To ensure that the Reclamation Fill is being properly placed and compacted, Luck Stone will have staff documenting and monitoring the Reclamation Fill as it is placed and compacted in the pit. To monitor and document the density of the Reclamation Fill lifts after compaction, field testing to determine in-place soil density will be conducted. Luck Stone anticipates that field testing will be conducted in the final 20 feet of reclamation fill placed, and for the construction or installation of the low permeability layer that will line the lake area. Field density testing will be done manually by using a sand cone per ASTM D1556, a drive tube per ASTM D2937 or indirectly by using a nuclear density gauge according to ASTM D6938/D8167.

VI.D. Dust Control

VI.D.i. General Procedures for Dust Control

Luck Stone personnel will regularly spray bare soil areas with water to suppress dust. Areas where reclamation activities are not being conducted in the foreseeable future may be vegetated to minimize dust and erosion. Dust on the site and haul roads will be controlled by applications of water. Watering will be done daily and whenever fugitive dust is observed.

Any material spillage on access or haul roads will be cleaned up immediately and returned to the reclamation area.

The trucks transporting Reclamation Fill will maintain safe driving practices and travel at speeds that are appropriate for the conditions present. Safe driving practices and speeds will be enforced by Luck Stone personnel.

Sediment on truck tires will be removed before the vehicles enter public roads. A wheel wash, tire sprays, and sweeper trucks may be used to clean truck tires as needed.

VI.D.ii. Monitoring and Inspections

During the Reclamation Fill project, the Fairfax Plant will continue to be subject to the Individual Air Permit issued by the Department of Environmental Quality. As such, the facility is required to visually assess the impacts of dust continuously and apply control measures immediately upon the discovery of dusty conditions. These measures include the application of water on roads by a water truck spray; the use of water sprays on piles, berms, and other areas of concern; and any other BMPs that are necessary to prevent an adverse impact beyond the facility’s property line, such as the use of a wheel wash or truck wash. Any maintenance to dust control systems will be documented.

In addition, in the event of a complaint from the neighboring community, representatives from Luck Stone will contact the complainant and maintain contact until the problem is resolved. Documentation of this process will be maintained at the site. At all times, Luck Stone will meet the requirements of its existing air permit, including maintaining necessary records and documentation required.

VI.E. Permanent Lake Design

Once the Reclamation Fill reaches an elevation of about 200 feet (approximately 20 feet from the bottom of the lake), a final detailed design of the lake will be prepared by a professional engineer. Prior to commencing the final design of the lake, a geotechnical field and laboratory testing investigation will be performed to assess the subsurface conditions that resulted from placement of the Reclamation Fill and to develop foundation and final slope design recommendations (see Section V.E). The geotechnical investigation will be conducted under the supervision of a professional engineer licensed to practice geotechnical engineering in the Commonwealth of Virginia.

The design of the lake will meet the pertinent hydrology (to include the 100- year storm event at a minimum) and stormwater design standards for wet ponds detailed in the latest version of Fairfax County's Public Facilities Manual and the Northern Virginia Best Management Plan (BMP) Handbook, the Virginia Mineral Mine Reclamation Laws and Regulations promulgated by DMME, as well as standards of professional engineering practices in place at the time of construction. If a hydrological interaction between the existing storm water management facilities [i.e. existing pond(s)] and the reclamation area lake is necessary, the final design of the entire storm water management (SWM) system will include all SWM facilities and address the design of the specific outlets. The design of the SWM facility will meet or exceed with the requirements of the rules, regulations, and engineering standards discussed above. The liner for the lake will meet the latest Virginia Department of Environmental Quality (VDEQ)'s quality assurance requirements for liner construction (9VAC20-81-130.Q.).

The final design will include technical specifications and quality assurance/quality control (QA/QC) documentation requirements to confirm that the constructed lake liner meets the intent of the design and the requirements of the project.

The final design of the lake and the adjoining reclamation area will be submitted for review and final approval by the Department of Public Works and Environmental Services (DPWES) and/or other appropriate county agencies. The design of the final stormwater management facilities will address final (post-reclamation) site conditions. The facilities will be subject to County issued maintenance agreements as required at the time of design and construction. Furthermore, as part of the final pond design and construction, a County bond will be posted and subject to County inspection and bond release.

VI.E.i. Permanent Lake Liner Material Specifications

In order to maintain a permanent pool elevation in the lakes, a liner will be provided. The liner will consist of either low permeability soils or geosynthetic materials if low permeability soils are not readily available. As stated above, the soils and/or geosynthetic liner will be required to meet the quality assurance criteria in section Q. (*Construction Quality Assurance Program*) of the most current VDEQ Rule 9VAC20-81-130 (*Design and Construction Requirements*).

General material specifications are briefly described in the following sections.

Soil Liner Material

Soil materials that meet the requirements for liner are generally classified as clay with the properties presented in Table 3 below. The liner will have a minimum thickness of 2 feet and will be placed in 6 to 8 inch lifts, compacted to a minimum of 95% of the Standard

Proctor maximum dry density (ASTM D698 or VTM-1). The liner will extend across the full width and up to 1-foot above the permanent pool elevation (El. 240).

Table 3: Permanent Soil Liner Material Specifications

Property	Test Method (or equal)	Unit	Specification
Permeability	ASTM D-2434	cm/sec	1×10^{-6}
Plasticity Index	ASTM D-423 and D-424	percent	Not less than 15
Liquid Limit	ASTM D-2216	percent	Not less than 30
Clay Particles Passing	ASTM D-422	percent	Not less than 30
Clay Compaction	ASTM D-698	percent	95 percent of Standard Proctor Density

All probe entry holes created by quality assurance testing of the compacted liner will be sealed by backfilling with bentonite. Each compacted lift of liner material will be protected from drying out to prevent cracking due to shrinkage. A water truck should be available to lightly water the liner should drying be observed. After completion of the clay liner, a permanent protective layer of Reclamation Fill with a minimum thickness of 12 inches will be placed on top of the clay liner to protect it from desiccation. The protective layer will be compacted and vegetated to prevent erosion.

Geosynthetic Liner Materials

Similar to the soil liner, a geosynthetic liner would extend across the full width and up to 1-foot above the permanent pool elevation (El. 240 ft). The geosynthetic liner would be covered with at least 24 inches of vegetated soil for long-term protection.

There is a variety of products that may be used to hold water in the lake. These include geomembranes of different types as well as products such as geosynthetic clay liners (GCLs). The Geosynthetic Research Institute (GRI) publishes the latest geosynthetic materials standards required from manufacturers that produce these materials (https://geosynthetic-institute.org/specs.htm). Some of the specifications that may be pertinent to the future lake in the reclamation area include:

- GRI-GM13 *Specification for Test Methods, Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes*

- GRI-GM17 *Specification for Test Methods, Properties and Testing Frequency for Linear Low-Density Polyethylene (LLDPE) Smooth and Textured Geomembranes*

- GRI-GM18 *Specification for Test Methods, Properties and Testing Frequency for Flexible Polypropylene (fPP and fPP-R) Nonreinforced and Reinforced Geomembranes*

- GRI-GM19 *Specification for Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barriers*

- GRI-GM21 *Specification for Test Methods, Properties and Testing Frequency for Ethylene Propylene Diene Terpolymer (EPDM) Nonreinforced and Scrim Reinforced Geomembrane*

- GRI-GM25 *Specification for Test Methods, Test Properties and Testing Frequency for Reinforced Linear Low-Density Polyethylene (LLDPE-R) Geomembranes*

- GRI-GM28 *Specification for Test Methods, Test Properties, and Testing Frequencies for Reinforced Chlorosulfonated Polyethylene (CSPE-R) Geomembranes*

- GRI-GCL3 *Specification for Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs)*

As with soil liners, the installation of geosynthetic liners would be subject to strict installation, QA/QC -testing and documentation requirements consistent with the state of the practice at the time of construction.

VII. SEQUENCE OF FILL & TIMING

VII.A. Schedule for Completion, Closing Areas, & Reclaiming

The final reclamation grading plan will result in about 13 million cubic yards of Reclamation Fill being placed in the North Pit. Luck Stone expects that an average of 230 trucks will deliver Reclamation Fill to the North Pit each working day during the currently approved operating hours. The amount of vehicular activity resulting from the proposed reclamation efforts, combined with the number of vehicle trips from on-going quarry sales and operations is not expected to exceed the average volume (+/-350 vehicles per day) approved as part of Luck Stone's 2008 Special Permit Amendment. Assuming that each truck carries about 12 cubic yards of loose fill, the daily loose volume of fill that will be delivered to the site is 2,760 cubic yards per day. Assuming that the compaction of the Reclamation Fill brought to the site results in a 10% reduction in volume (i.e. 1 cubic yard of loose fill is equal to 0.90 cubic yards of compacted fill), the reclamation of the North Pit will be completed in approximately 21 years. The amount of material available for reclamation and the exact duration of the reclamation activities depend on various market conditions which Luck Stone cannot predict with certainty.

In addition to backfilling the pit, Luck Stone will revegetate the areas that have been backfilled inside as well as outside the limits of the pit. Revegetation will be accomplished according to the recommendations provided in the latest version of Sections 3.30 to 3.37 of the Virginia Erosion and Sediment Control Handbook. Revegetation will include at least 12 inches of topsoil and native grass planting mixes, or as otherwise recommended by the local Soil Conservation District soil scientists. A low permeability soil or a geosynthetic layer will also be installed within the lake areas to hold water in the lake and keep it from infiltrating into the Reclamation Fill (see Section VI.E).

All current permits for the facility will remain in effect throughout the reclamation period, if applicable or needed. These permits include:

- DMME Mining Permit 05551AA
- VDEQ VPDES (process water and stormwater) VAG840093
- VDEQ Air permit 70274
- Fairfax County Special Use Permit

VII.B. Reclamation Plan Layout

The proposed sequence of quarry reclamation is shown on the sequence drawings included in Appendix 5. Each sequence will be developed to include a temporary pond capable of holding stormwater that enters the North Pit. These temporary ponds will be consistently pumped out to avoid flooding the Reclamation Fill placement areas. The stormwater in the temporary ponds will be pumped to one of the on-site ponds and ultimately discharged through a permitted VPDES outfall. If a new discharge point is required, it will be permitted in accordance with the VPDES permit.

Under the current plan, the existing tunnel under Route 29 is planned to be left in operation until reclamation of the South Pit is nearing completion. Planning and coordination will take place with Virginia Department of Transportation (VDOT) in regard to the plugging of the tunnel. As this is not expected to take place for more than two decades, a detailed plug design will be prepared at a later date if requested by the VDOT.

The final layout of the reclaimed North Pit will include gentle slopes (20% or less) that transition from the edge of the current North Pit highwall down towards +/-20-acre lake (see Drawing 7 included in Appendix 5). There will be no quarry high-walls left once the reclamation of the North Pit is complete.

VIII. SITE CONDITIONS

VIII.A. Hydrogeological Setting

VIII.A.i. Geology

The site is located on the east-central portion of the Culpeper Basin, which developed during early-Mesozoic continental rifting (Lee, 1979). The Culpeper Basin is an elongate north-northeast trending fault-bounded trough that has an area of approximately 1,060 square miles. It is filled with a thick sequence of Upper Triassic to Lower Jurassic non-marine sedimentary rocks, which are designated as the Newark Supergroup, that have been intruded by Early Jurassic diabase (Lee and Froelich, 1989). Thermally metamorphosed country rock is prevalent along the margins of these diabase intrusions, with metamorphic alteration extending into country rock to lengths of up to one-quarter to one-third the thickness of the diabase intrusion (Lee and Froelich, 1989). Unconsolidated overburden within the Culpeper Basin is extremely thin (Nelms and Brockman, 1997), with typical thickness being less than 12 ft. A geologic map depicting rock types within the Culpeper Basin is included as Figure 1.

The Newark Supergroup is comprised of lacustrine, fluvial, alluvial, thermally-metamorphosed, and basalt strata. The lacustrine deposits, such as the Balls Bluff Formation, are comprised primarily of siltstone and shale. Thermally-metamorphosed zones of these deposits are generally comprised of hornfels. Fluvial deposits are generally comprised of sandstones and conglomerates. Three principal basalt flows with interbedded sedimentary units, which are present at the western margin of the Culpeper Basin, are present within the basin. Early Jurassic diabase intrudes the Newark Supergroup throughout the Culpeper Basin.

Geologic mapping by Drake et al. (1994) indicates that the North Pit straddles the contact between a diabase intrusion and a zone of thermally metamorphosed Balls Bluff Siltstone (hereinafter referred to as Balls Bluff Hornfels or hornfels). Non-metamorphosed Balls Bluff Siltstone is mapped as being present to the west of the hornfels, outside the zone of contact metamorphism. A site visit into the North Pit revealed the visible presence of the diabase-hornfels contact in the walls of both pits. Hornfels/siltstone outcrop was observed in the majority of the North Pit's walls, with the gradational contact between the hornfels and siltstone being not easily distinguishable. Diabase did, however, comprise the majority of the North Pit's eastern wall and minor portions of the north and south walls. The entire floor of the North Pit appears to be within the hornfels/siltstone. Unconsolidated overburden observed at the margins of both pits was observed to be thin, with thicknesses appearing to be 0-5 feet in most locations. Geologic mapping of the area in the immediate vicinity of the North Pit, based on site observations and geologic mapping, is included as Figure 2.

Diabase in the vicinity of the subject site is described as being grey colored, fine crystalline to aphanitic, and having a thickness of approximately 790 feet (Drake et al., 1994). The thermally metamorphosed Balls Bluff Hornfels is described as being variable shades of grey and of highly variable thickness, depending on the thickness of the adjacent diabase. According to Luck Stone's Geologist, Mr. Bruce Faison, P.G., contact metamorphism is typically negligible at a distance of 50 feet or more from the diabase-hornfels contact. As such, it is likely that much of the Balls Bluff outcrop in the North Pit's walls is unaltered by contact metamorphism.

The non-metamorphosed Balls Bluff Siltstone is typically a grayish-red, calcareous, clayey, micaceous, sandy siltstone. Numerous grey, silty shale interbeds are present within the formation. Based on mapping by Drake et al. (1994), the Balls Bluff Siltstone is approximately 4,800 feet thick in the vicinity of the subject site.

VIII.A.ii. Hydrogeology

Sedimentary rocks within the Culpeper Basin, including the Balls Bluff Siltstone, have moderate to excellent water-bearing potential due to the prevalence of closely spaced, interconnected fractures and bedding plane partings (Nelms and Brockman, 1997). The Balls Bluff Siltstone Formation in particular is described as being one of the most productive aquifers in the Culpeper Basin, with the greatest yields produced at depths of less than 450–500 feet (Nelms and Richardson, 1990). Groundwater storage is predominantly within bedrock fractures due to the thin nature of overburden within the basin. Wells completed in these sedimentary units have produced yields of up to 740 gallons per minute (gpm).

Diabase and hornfels within the Culpeper Basin have generally poor water-bearing potential due to the wide fracture spacing, mineralization within fractures, and random fracture orientations (Nelms and Brockman, 1997). Despite the poorly interconnected fracture network, these units can potentially produce high yields when cross-strike fracture lineaments enable the connection of the units' widely spaced fractures. Wells completed in these units have produced yields of up to 110 gpm.

VIII.A.iii. Direction of Groundwater Flow

VIII.A.iii.1. Existing Conditions

Current regional groundwater levels are largely unknown due to a lack of publicly available groundwater level monitoring wells in the vicinity of the site. ECS has produced a numerical groundwater model to assist in estimating groundwater flow direction in the vicinity of the property. The model demonstrates that groundwater currently flows radially toward the quarry from all sides. It further estimates groundwater level drawdown and suggests increases in groundwater velocity within the quarry's cone of depression proximal to the pit. It is likely these current estimated groundwater flow patterns have continually evolved during the 80 years of mining-related activity within Fairfax Quarry's North and South Pits. The noted groundwater patterns are likely greatest in close proximity to the quarry pits and are reduced radially in an outward direction from the quarry. These suspected flow patterns are supported by findings from a numerical groundwater model of the site.

Static groundwater levels listed in recent (2015 or later) Water Well Completion Reports obtained as part of the nearby well identification process, as discussed above, were used to estimate groundwater elevations in the vicinity of the quarry. These static water levels were used in conjunction with approximate ground surface elevations at the well locations, as determined by a 10-meter resolution digital elevation model, to calculate approximate groundwater elevation values. The static water levels listed in these reports are considered approximate actual conditions. A total of 19 records containing static water levels measured in 2015 or later were used as part of this analysis. Of the 19 wells, 15 wells are located to the south of the quarry's South Pit and the remaining wells are located to the north-northwest of the quarry's North Pit. Estimated static groundwater elevations at these well locations are shown in Figure 3.

Groundwater elevation data indicates that groundwater levels in the wells are higher than levels maintained within the quarry pits (i.e., approximately -110 feet above mean sea level [amsl]). As such, groundwater likely flows toward the quarry pits at locations proximal to the quarry. The deepest groundwater elevation (-65 feet amsl) was recorded 1,700 feet south of the South Pit and the shallowest elevation (172 feet amsl) was recorded 1,750 feet northwest of the North Pit. Groundwater elevations in wells to the south of the South Pit range from -65 to -5 feet amsl, and elevations to the north-northwest of the North Pit range from -30 to 172 feet amsl. Groundwater gradients appear to be steeper in the vicinity of the North Pit than in the vicinity of the South Pit, as evidenced by groundwater levels 90–210 feet higher to the north of the North Pit than at similar distances to the south of the South Pit.

VIII.A.iii.2. Model-Projected Conditions

A numerical groundwater model of the subject site was created to assess on-site hydrogeologic conditions, as described in Section V.A of this document. Some of the predictive simulations involved the simulation of North Pit dewatering at each of the planned fill sequences coincident with dewatering in the South Pit. The result of these simulations was that a component of flow toward the North Pit exists for fill sequences one through four and a component of flow toward the South Pit exists for all fill sequences. As would be expected, groundwater gradient decreases and groundwater levels increase as North Pit filling advances and dewatering rates are reduced to allow for higher groundwater levels within the North Pit. As a result, current alterations to the groundwater system associated with North Pit dewatering would be expected to be greater than alterations occurring during filling, as advancement of filling would allow higher groundwater levels to be maintained within the pit. Groundwater levels within the North Pit for Fill Sequence 5, which represents final grade, are predicted to be slightly elevated due to the presence of underlying fill material that is assumed to have relatively low permeability. Additionally, the presence of a permanent lake would be expected to create a groundwater mound within the pit. Model-predicted groundwater elevations for each fill sequence are shown in Figures 4a through 4j. Both an aerial map and cross-sectional map of projected groundwater equipotential contours are included for each of the five fill sequences. Predictive simulations one through four involved the simulation of North Pit dewatering and all simulations involved the simulation of South Pit dewatering. As a result, a component of flow toward the North Pit exists for fill sequences one through four and a component of flow toward the South Pit exists for all fill sequences.

As would be expected, groundwater gradient decreases and groundwater levels increase as North Pit filling advances and dewatering rates are reduced to allow for higher groundwater levels within the North Pit. As a result, current alterations to the groundwater system associated with North Pit dewatering would be expected to be greater than alterations occurring during filling, as advancement of filling would allow higher groundwater levels to be maintained within the pit. Groundwater levels within the North Pit for Fill Sequence 5, which represents final grade, are predicted to be slightly elevated due to the presence of underlying fill material that is assumed to have relatively low permeability. Additionally, the presence of a permanent lake would be expected to create a groundwater mound within the pit. Model-predicted groundwater elevations for each fill sequence are shown in Figures 4a through 4j. Both an aerial map and cross-sectional map of projected groundwater equipotential contours are included for each of the five fill sequences. Projected fill sequence dewatering rates are discussed in Section V.A.

VIII.A.iv. Aquifer Properties

Aquifer properties were assessed at and in the vicinity of the site by reviewing existing regional hydrogeologic publications and by utilizing aquifer testing results from on-site testing conducted. A discussion of findings is provided below.

Studies conducted by Legette, Brashears, and Graham, Inc. (1980), Betz-Converse-Murdoch, Inc. (1982), and Laczniak and Zenone (1985) provide insight into aquifer properties and effective recharge based on lithology within the Culpeper Basin. Table 4 below shows the results from these investigations. As indicated in Table 4, siltstones, such as the Balls Bluff Siltstone at the subject site, generally have the highest capacity to transmit water. Comparatively, the capacity for hornfels and diabase to transmit water is significantly less. It can also be noted from the information on Table 4 that annual effective recharge (i.e. groundwater recharge minus evaporative losses) is significantly less in hornfels and diabase than in sedimentary rocks within the Culpeper Basin.

Table 4: Summary of Published Hydraulic Properties of Aquifers within the Culpeper Basin

Lithology	Transmissivity[a] (ft^2/day)	Hydraulic Conductivity[b] (ft/day)	Storage Coefficient[a]	Effective Recharge[a,c] (in/yr)
Siltstone	1,000 – 3,600	3.3 – 12	0.00002 – 0.002	4.84
Sandstone	260 – 3,000	0.87 – 10	0.00002 – 0.0002	4.18
Thermally Metamorphosed Rocks (i.e., hornfels)	60 - 80	0.20 – 0.27	---[d]	0.17
Diabase	60 - 80	0.20 – 0.27	---	0.17
Basalt	1,890 – 2,520	6.3 – 8.4	---	3.93
Conglomerate	1,875 – 2,500	6.3 – 8.3	---	3.91

[a]Values from Leggette, Brashears, and Graham, Inc. (1980), Betz-Converse-Murdoch, Inc. (1982), and/or Laczniak and Zenone (1985).
[b]Hydraulic conductivity values estimated from transmissivity values by assuming an aquifer thickness of 300 feet, based on typical depths to groundwater and vertical fracture extents.
[c]Effective recharge = groundwater recharge minus evaporative losses.
[d] Data not available.

Aquifer testing was conducted at the subject site and at nearby Luck Stone quarries located within the Culpeper Basin. The purpose of aquifer testing was to assess aquifer properties of geologic units at and in the vicinity of the subject site. Slug testing was conducted at existing off-site monitoring wells completed in diabase, siltstone, and possibly hornfels. A pumping test was conducted using monitoring wells installed in siltstone at the Fairfax Quarry.

Off-site slug testing of two diabase monitoring wells resulted in hydraulic conductivity values of 0.01 ft/day and 0.60 ft/day. The lower value (0.01 ft/day) was less than typical diabase hydraulic conductivity values within the Culpeper Basin, and the high value (0.60 ft/day) was greater than typical values for the basin. Off-site slug testing of two siltstone and possibly hornfels monitoring wells resulted in hydraulic conductivity values ranging from 0.55–0.72 ft/day, which is less than typical values for siltstone and greater than typical values for hornfels within the Culpeper Basin.

On-site testing using a pumping well and observation well installed in siltstone yielded a transmissivity value of 238 ft^2/day, or a hydraulic conductivity value of 0.97 ft/day. A storage coefficient of 0.00059 was calculated from the testing data. This transmissivity value was lower than published Culpeper Basin siltstone values. In addition to the possible presence of minor thermal metamorphism to the siltstone at the well location, this value may be lower due to the 80 years of mining related activity and the resulting effects it may have had on groundwater levels in the immediate vicinity of the pits. The calculated storage coefficient was within the range of published values for siltstone within the Culpeper Basin.

VIII.A.v. Groundwater Discharge Velocity

Groundwater discharge velocity, which is also referred to as Darcy velocity or Darcy flux, is defined as the rate of water movement through a cross-sectional area of aquifer. The groundwater discharge velocity in siltstone was estimated at the location of the site's pumping test wells using the hydraulic conductivity value measured during aquifer testing (0.97 ft/day) and an approximate hydraulic gradient, as groundwater discharge velocity is defined as being equal to hydraulic conductivity multiplied by hydraulic gradient. Based on groundwater modeling results, the existing hydraulic gradient at the testing well locations is approximately 0.04 vertical foot per 1 horizontal foot (i.e., gradient = 0.04). Multiplying the hydraulic conductivity value (0.97 ft/day) by the hydraulic gradient (0.04) yielded a groundwater discharge velocity of 0.039 ft/day.

It is important to note that groundwater discharge velocity would be expected to decrease at further distances from the quarry, as the hydraulic gradient would be lower at distance from the quarry. Additionally, groundwater discharge velocity would be lower in less permeable geologic units, such as diabase and hornfels, as a result of these units' lower hydraulic conductivity values.

VIII.B. Vicinity Wells

Existing wells within 0.5-mile of the site's quarry pits were identified assuming that land parcels containing structures located outside of Fairfax County's municipal water service area are likely supplied with water from domestic wells. Municipal records show that the high-density residential developments to the northeast and east of the quarry are within the municipal water service area and the remaining properties within 0.5-mile of the quarry are largely serviced by domestic wells.

There are seventy (70) likely well locations that were identified within 0.5-mile of the quarry. Of the 70 wells, 10 wells are located on Luck Stone property and the remaining 60 wells are located off-site. With the exception of two monitoring wells at the quarry site, all of the wells are believed to be used for water supply. The property addresses associated with these wells were identified and a list of the addresses was submitted to the Fairfax County Environmental Health Department to request well construction permits, well completion records, and other pertinent documents via the Freedom of Information Act (FOIA). Overall, information associated with 55 of the 70 wells was obtained. Available information for each well varied, as some of the records contained more information than others.

Available well documents were used to record well depths, installation dates, static water levels, well yields, depths to bedrock, water-bearing zones, and other miscellaneous important information. Values for one or more of the aforementioned data fields were absent for numerous wells. Well locations were georeferenced by assigning the wells at associated house locations or in close proximity to the houses. The georeferenced wells were then added to a GIS database and are depicted in Figures 5a through 5c. Well records indicate that wells within 0.5-mile of the quarry pits have a median depth of 500 feet and a median yield of 25 gallons per minute (gpm). A database of compiled well information is provided in Appendix 6.

IX. RISK ASSESSMENT

IX.A. Background

The proposed reclamation plan for the Luck Stone Fairfax Quarry will involve placement of Reclamation Fill beginning at the base of the existing North Pit which currently lies at an approximate elevation of - 110 feet above mean sea level (amsl) and continuing to a planned final elevation across the fill area ranging from 240 to 280 feet amsl. A surface water body covering approximately 20 acres will be constructed within the top portion of the filled pit with a water depth of approximately 10 to 20 feet.

Dewatering of the quarry pit has historically been performed during the active use of the quarry to maintain dry working conditions for mining operations. Dewatering has been accomplished with the use of submersible pumps placed within a sump in the base of the pit that removes both groundwater seepage and stormwater received by the pit. Discharge from the pit has been permitted by a VPDES outfall which enters a tributary of Bull Run. Dewatering operations will continue during the planned filling of the pit. As the elevation of reclamation material ascends within the existing pit, the water level will be allowed to rise. At a minimum, 15 to 20 feet of separation will be maintained between the surface of the Reclamation Fill and the groundwater elevation to enable dry working conditions. Once filling operations are complete, dewatering will cease and groundwater will rise to static or near steady state conditions. A three-dimensional groundwater model was developed to predict the eventual static groundwater elevation following cessation of pumping and also to predict groundwater flow patterns during the filling operations, as discussed in further detail in Sections V.A and VIII.A. Based on the modeling results, static groundwater levels are expected to occur beneath the planned lake with a maximum elevation of approximately 167 feet amsl, which is approximately 277 feet above the base of the North Pit's floor.

IX.B. Identified Sensitive Receptors

To assess potential risk associated with the planned backfill and future use of the reclaimed quarry pit Luck Stone commissioned ECS to perform an assessment of future environmental and human health receptors. Some areas proximal to the quarry are not serviced by public water or sanitary sewer. Groundwater supply wells are currently utilized for residential, commercial, and industrial water needs in the immediate area to the north, south, east, and west of the site. The bedrock groundwater aquifer, which supplies groundwater to wells in proximity to the quarry, represents a sensitive receptor to human health. Water generated from dewatering of the quarry pit is discharged via an outfall permitted by the Virginia Pollutant Discharge Elimination System (VPDES). The permitted outfall currently contributes flow to a tributary of Bull Run along the southwestern portion of the quarry property. Surface water receiving discharge from the permitted outfall represents a sensitive environmental receptor. The Bull Run watershed contributes flow to the Occoquan Reservoir which is used for public water supply by Fairfax County. Airborne particulates associated with fugitive dust from the planned activity have the potential to impact air quality and inhalation for human health receptors.

In summary, the following sensitive receptors have been considered during this risk assessment: bedrock groundwater aquifer, nearby surface water bodies, and air quality.

IX.C. Evaluation of Identified Sensitive Receptors

A Monitoring and Mitigation Plan (MMP) has been developed for the site and is included in Appendix 7 of this plan. The MMP provides details on the planned sampling locations, sampling methods, analytical parameters, and sampling intervals. As outlined within the MMP, planned sampling would occur prior to filling operations in an effort to establish background concentrations. Background monitoring would occur during eight separate events within a 12-month period and then monitoring would continue on a semi-annual basis throughout active filling operations at the site. The MMP also prescribes the measurement of water levels within the monitoring well network to enable assessment of trends in groundwater elevation fluctuation and groundwater flow direction.

Background surface water and groundwater quality concentrations will be evaluated prior to the initiation of pit filling activities. Background water quality data will be collected from upgradient wells and from the existing VPDES outfall. Studies previously conducted at the site indicate that all wells included within the monitoring program are upgradient of the quarry pit and will remain so until quarry pit dewatering is significantly reduced or terminated. Background water quality data will be collected during a one-year period, during which time eight sampling events will occur at a frequency of approximately once every 6–7 weeks. Following the commencement of pit filling activities, groundwater and surface water samples will be collected on a semi-annual basis unless sampling results indicate the need for more frequent sampling events, as described below. The facility's VPDES permitted outfall will also be sampled in accordance with permit requirements. Currently, the outfall is sampled for pH and Total Suspended Solids (TSS).

Sampled parameters for both groundwater and surface water will include select parameters similar to those that will be used for evaluation and acceptance of Reclamation Fill as outlined within Section IV.B of this Reclamation Plan. Two separate parameter lists have been included herein. The lists correspond with parameters contained within Columns A and B of Table 3.1 within the Virginia Solid Waste Groundwater Management Regulations (9VAC20-81-250. Groundwater Monitoring Program). Column A parameters, which are referred to in this report as Phase I Priority Analytes, include select metals and VOCs. Column B parameters, which are referred to in this report as Phase II Comprehensive Analytes, include select metals, VOCs, SVOCs, PCBs, Pesticides and Herbicides. Both Column A and Column B analytes have been provided in Appendix 4.

Groundwater and surface water samples will be analyzed for either Phase I Priority Analytes or Phase II Comprehensive Analytes in accordance with the methodology described herein. Background groundwater and surface water samples collected during the one-year period preceding commencement of pit filling activities will be analyzed for parameters included within the Phase II Comprehensive Analytes list. Sampling results from this background monitoring period will be used to establish background concentrations at the site. These background concentrations will then be used in conjunction with VDEQ Voluntary Remediation Program (VRP) Tier II Residential Groundwater Screening Levels and Tier II Fresh Surface Water Screening Levels (VDEQ, 2018) to establish site-specific Groundwater Protection Standards (GPSs) and Surface Water Protection Standards (SWPSs).

GPSs and SWPSs will be established following the conclusion of the one-year background monitoring period. GPSs for each Phase II Comprehensive Analyte will be established based on measured background concentrations and Virginia VRP Tier II Residential Groundwater Screening Levels (if available), whichever is highest. SWPSs for each Phase II Comprehensive Analyte will be established based on measured background concentrations and Virginia VRP Tier II Fresh Surface Water Screening Levels (if available), whichever is highest. VDEQ VRP Tier II Residential Groundwater Screening Levels and Tier II Fresh Surface Water Screening Levels are included within Appendix 4.

Following the commencement of pit filling activities, groundwater and surface water monitoring will be conducted on a semi-annual basis (i.e., two events per year). Samples collected during these monitoring events will be submitted for laboratory analysis of Phase I Priority Analytes list compounds. If an exceedance of GPSs or SWPSs for any Phase I Priority Analytes list compound is determined, a verification sample for that parameter will be collected within 30 days of notification of the result. At any time during the 30 days, Luck Stone may enlist a 3rd party for data validation. Following the validation of an exceeded groundwater or surface water concentration, groundwater and/or surface water samples from the well/outfall exhibiting the exceedance will be submitted during subsequent monitoring events for an expanded suite of laboratory parameters to consist of the Phase II Comprehensive Analytes list. The laboratory suite may then be reduced back to the Phase I Priority Analytes list if four consecutive monitoring events occur where concentrations are below the applicable GPS or SWPS.

The facility staff will visually assess for the presence of dust continuously and apply control measures immediately upon the discovery of dusty conditions.

IX.D. Protective Measures

Quality testing of Reclamation Fill entering the site will be required as per Section IV.B of this Reclamation Plan. Soil screening levels have been selected to be protective of both groundwater and ecological receptors based on screening levels identified within Table 1 - Protection of Ecological Receptors and Groundwater of the VDEQ's Management and Reuse of Contaminated Media solid waste guidance memorandum LPR-SW-04-2012 (VDEQ, 2012). A summary showing a list of sampling parameters and associated ecological and groundwater protection screening levels is included as Appendix 4. Periodic field screening and random sampling will also be performed to further assess reclaimed soils arriving at the site.

Dust control will be achieved through the use of water spray trucks and by vegetating areas where no reclamation work is occurring in the foreseeable future.

The monitoring well network will have well locations situated near the quarry pit boundary to aid in detecting the presence of contaminants in groundwater. Locations of the wells would be expected to provide data that could be used to assess groundwater quality onsite. Each of the monitor well locations is understood to currently be upgradient of the quarry pit based on groundwater modeling results. Their upgradient status would be expected to remain for an extended period of time until pit filling progresses and dewatering requirements are reduced. In the event that groundwater contamination is identified, mitigation strategies would be implemented with a primary goal of avoiding offsite impact. Mitigation planning is discussed in the MMP which is included in Appendix 7.

IX.E. Monitoring Reports

Annual monitoring reports will be prepared that document the findings of the monitoring program. The reports will include laboratory data and a discussion of findings and conclusions. A review of the data generated from the monitoring program will be made to determine the presence of select contaminants and to identify obvious contaminant concentration trends. Exceedances above the referenced site-specific GPSs or SWPSs, as described herein, will be identified and documented within the report. The report will include a graphic depiction of the location of bedrock monitoring wells or surface water outfalls found to exceed established GPSs or SWPSs. The monitoring report will be prepared for submittal to Fairfax County.

X. GROUNDWATER MONITORING PLAN

A Monitoring and Mitigation Plan (MMP) has been prepared for Luck Stone's planned Reclamation Fill facility. The MMP addresses monitoring prior to filling activities to enable assessment of background conditions and also long-term monitoring activities that will be implemented for the duration of planned filling activity. Monitoring activities have been proposed to address identified sensitive receptors which include the bedrock groundwater aquifer, surface water, and air quality. The MMP also addresses mitigation measures that will be followed in the event that monitored concentrations exceeding selected screening levels and/or background conditions are deemed to have the potential to pose a threat to identified sensitive receptors. The MMP, which includes a Quality Assurance Project Plan (QAPP) and Sampling Analysis Plan (SAP), has been provided in Appendix 7. Maps depicting planned monitoring well locations are included with the MMP.

XI. FINAL RECLAMATION CONDITION

Once all reclamation activities have been completed, the reclaimed areas will include two separate 20-acre lakes and vegetated areas that will encourage the generation of additional natural vegetative and animal habitats and return the site to conditions similar to those present prior to development of the quarry. The final reclamation conditions for the North Pit are shown on Sheet 7 in Appendix 5.

XII. REFERENCES

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[VDEQ] Virginia Department of Environmental Quality 2012. Management and Reuse of Contaminated Media. Solid Waste Guidance Memorandum LPR-SW-04-2012, dated 7/17/2012, sent to Regional Land Protection & Revitalization Program Managers and Regional Water Program Managers.

[VDEQ] Virginia Department of Environmental Quality 2018. Voluntary Remediation Program Screening Levels for Groundwater and Surface Water. Updated May 2018.

Figures

Figure 1

Bedrock Geologic Map of the Culpeper Basin

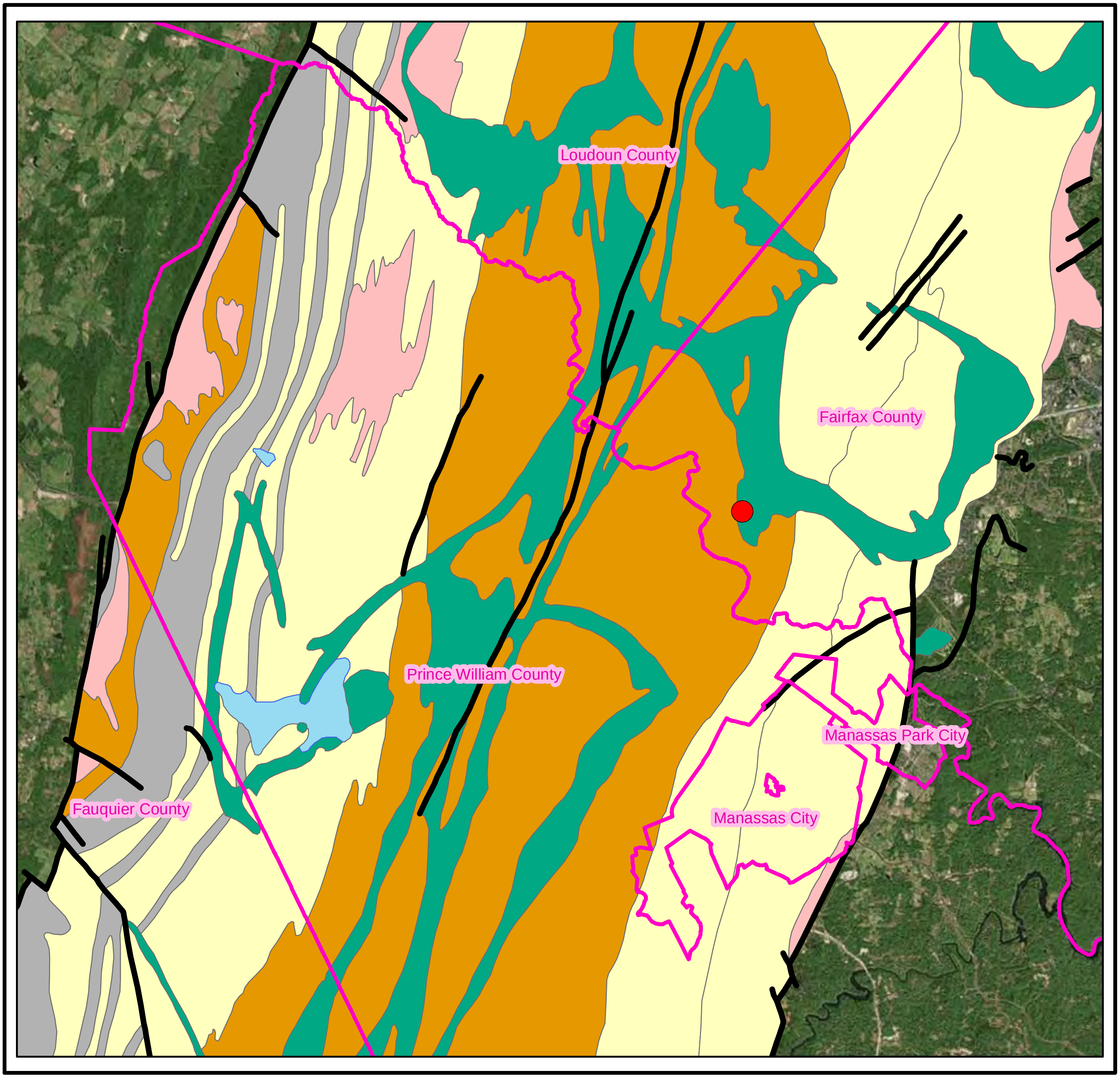

Figure 1: Bedrock Geologic Map of the Culpeper Basin

Luck Stone Fairfax Quarry
15717 Lee Highway
Centreville, VA

Legend

- Luck Stone Fairfax Quarry
- County Boundary
- Fault

Culpeper Basin Geology

- Siltstone/shale
- Diabase
- Sandstone
- Basalt
- Conglomerate
- Water

N

0 1 2 4 Miles

Map Notes:
(1) Based on geologic mapping by the Virginia Division of Mineral Resources (2003).

Figure 2
Bedrock Geologic Map of the Site Vicinity

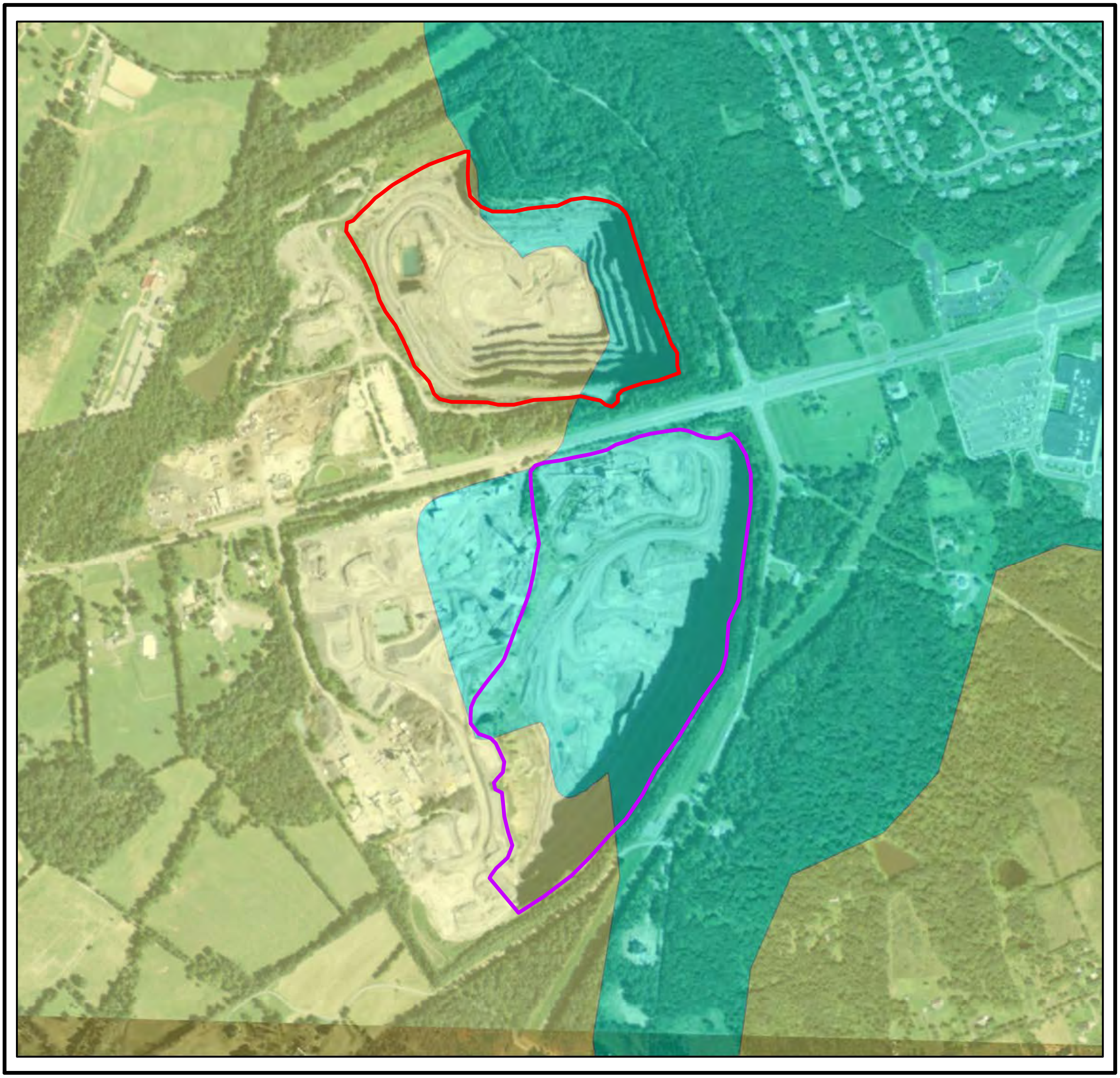

Figure 2: Bedrock Geologic Map of the Site Vicinity

Luck Stone Fairfax Quarry
15717 Lee Highway
Centreville, VA

Legend

Luck Stone Fairfax Quarry

North Pit

South Pit

Geology

Siltstone

Diabase

0 500 1,000 2,000 Feet

N

Map Notes:
Geologic mapping based on site observations and published data.

Figure 3

Estimated Groundwater Elevations in Proximity to the Quarry

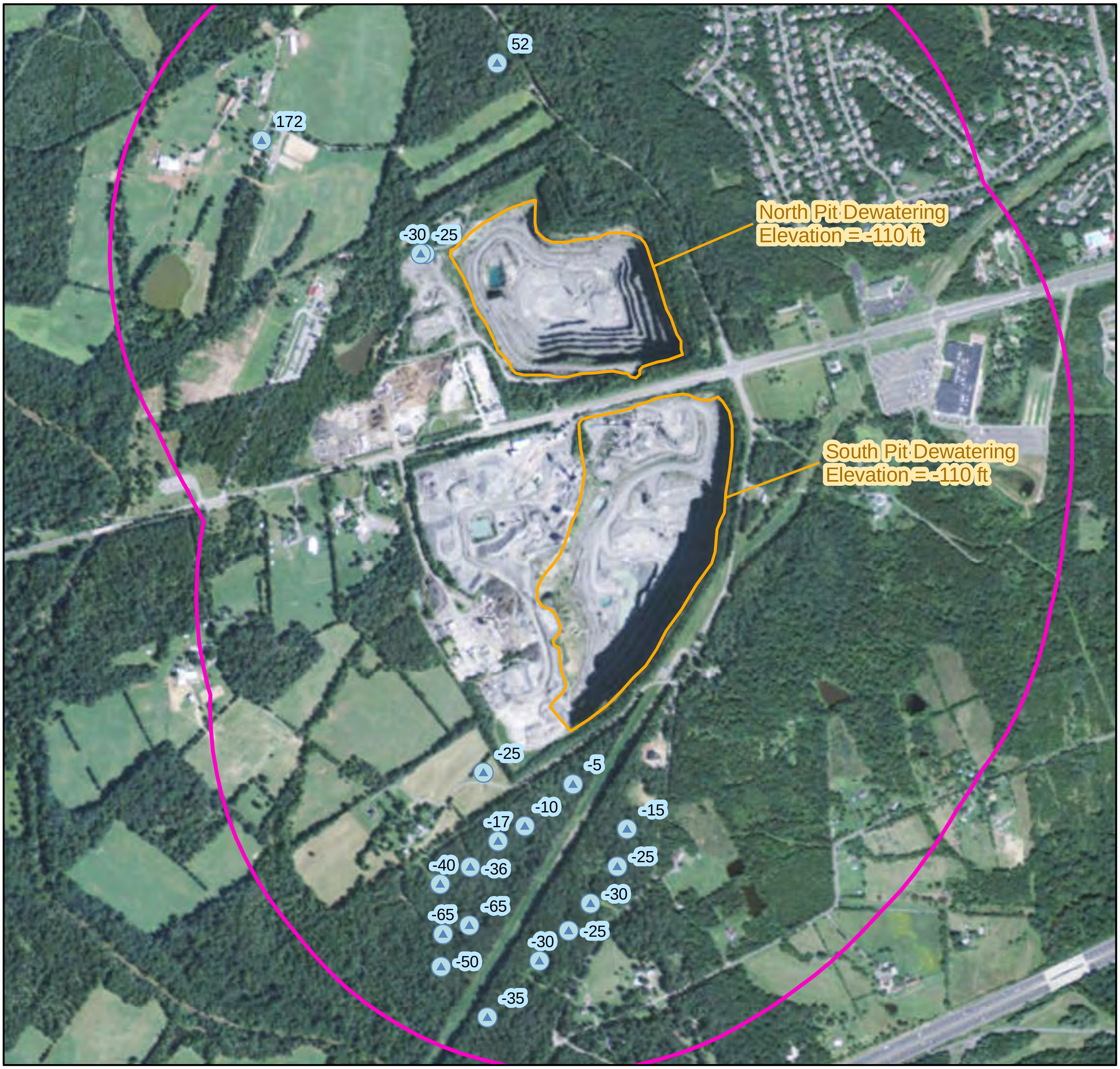

Figure 3: Estimated Groundwater Elevations in Proximity to the Quarry

Reclamation Fill Plan Study
Luck Stone Fairfax Quarry

Legend

Luck Stone Pit Boundaries

Quarry Pit Buffer (0.5-Mile)

Well

0 0.125 0.25 0.5 Miles

N

Map Notes:
(1) Numbers depict estimated groundwater elevations in units of feet above mean sea level;
(2) All groundwater levels were measured in 2015 or later.

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Figures 4a-j

Model-Predicted Groundwater Elevations at Fill Sequences 1-5

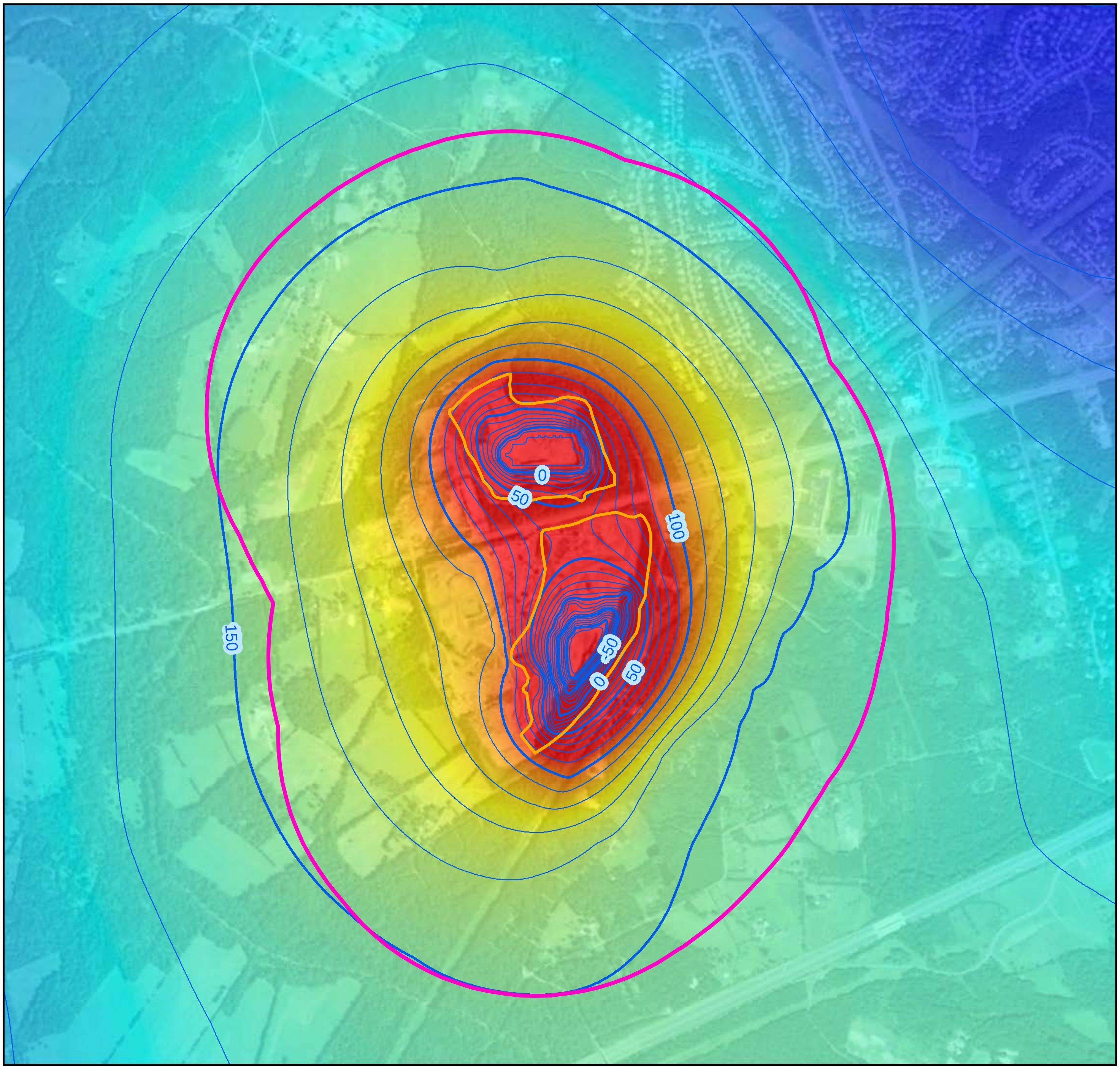


Figure 4a: Model-Predicted Groundwater Elevations at Fill Sequence 1

Reclamation Fill Plan Study
Luck Stone Fairfax Quarry

Legend

Luck Stone Pit Boundaries

Quarry Pit Buffer (0.5-Mile)

Groundwater Equipotential Contour (C.I. = 10 ft)

Index Contour

Intermediate Contour

0 1,000 2,000 4,000 Feet

Model-Predicted Groundwater Elevation

Value

High : 201 ft

Low : -120 ft

Map Notes:
(1) Groundwater elevations are in units of feet above mean sea level (amsl);
(2) Fill sequence 1 dewatering elevations: North Pit = -20 feet amsl and South Pit = -120 feet amsl.

N

ECS Project No. 47-7563

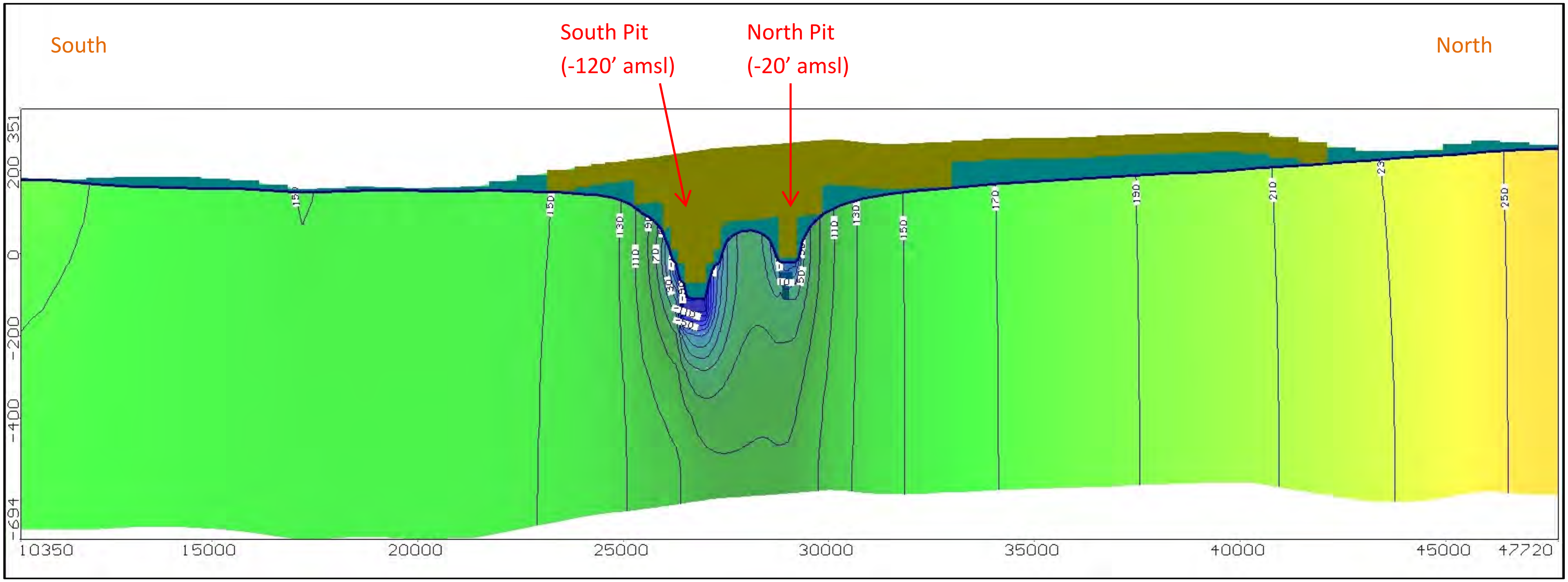


Figure 4b: Fill sequence 1 cross-sectional view of groundwater elevations sliced through the Fairfax Quarry's North Pit and South Pit. Bronze-colored areas represent dry model grid cells. Contour interval = 20 feet. X-axis labels are in units of feet and Y-axis labels are in units of feet above mean sea level. Vertical exaggeration = 10x.

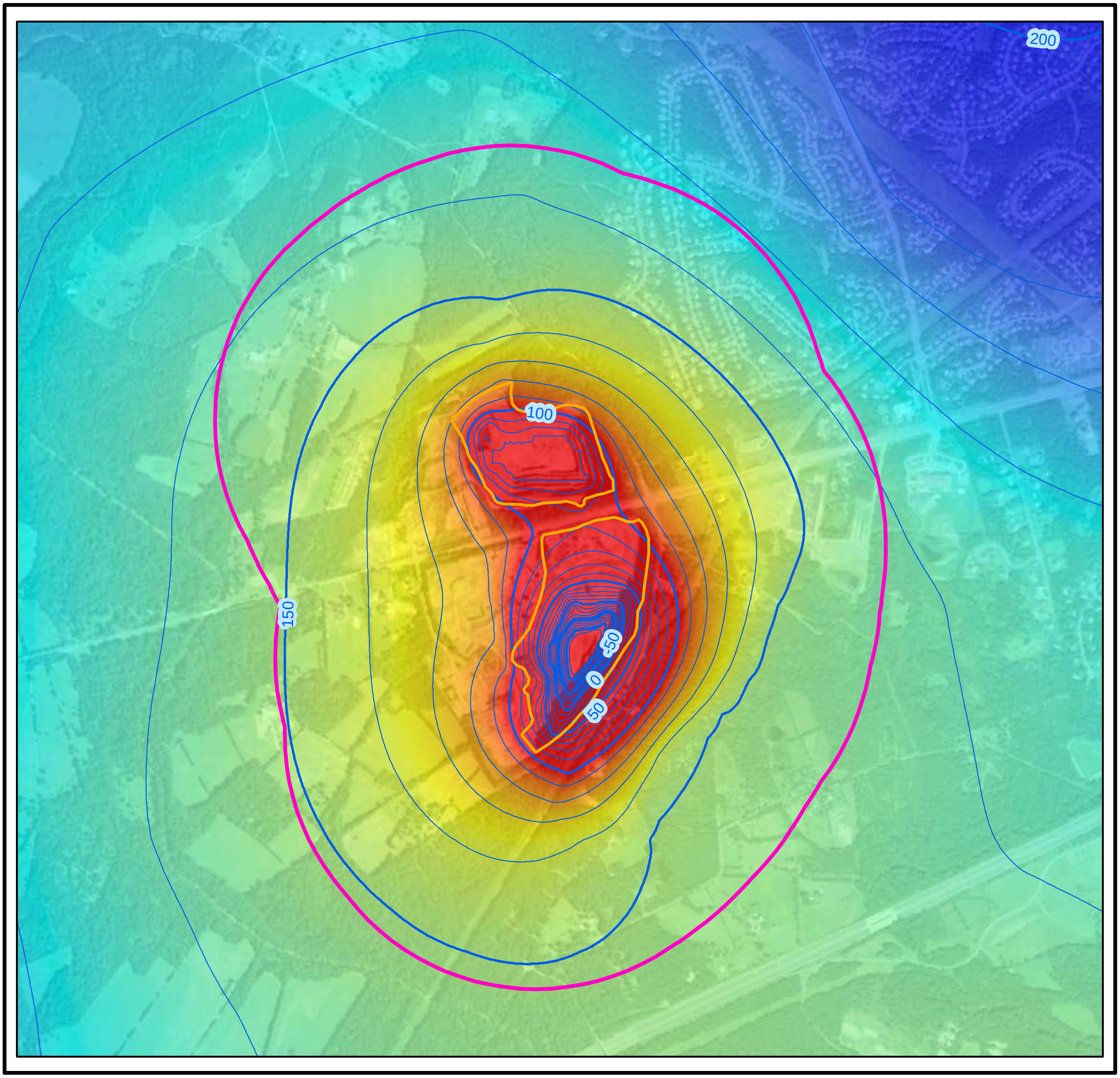


Figure 4c: Model-Predicted Groundwater Elevations at Fill Sequence 2

Reclamation Fill Plan Study
Luck Stone Fairfax Quarry

Legend

Luck Stone Pit Boundaries

Quarry Pit Buffer (0.5-Mile)

Groundwater Equipotential Contour (C.I. = 20 ft)

Index Contour

Intermediate Contour

0 1,000 2,000 4,000 Feet

Model-Predicted Groundwater Elevation

Value

High : 201 ft

Low : -120 ft

N

Map Notes:
(1) Groundwater elevations are in units of feet above mean sea level (amsl);
(2) Fill sequence 2 dewatering elevations: North Pit = 70 feet amsl and South Pit = -120 feet amsl.

ECS Project No. 47-7563

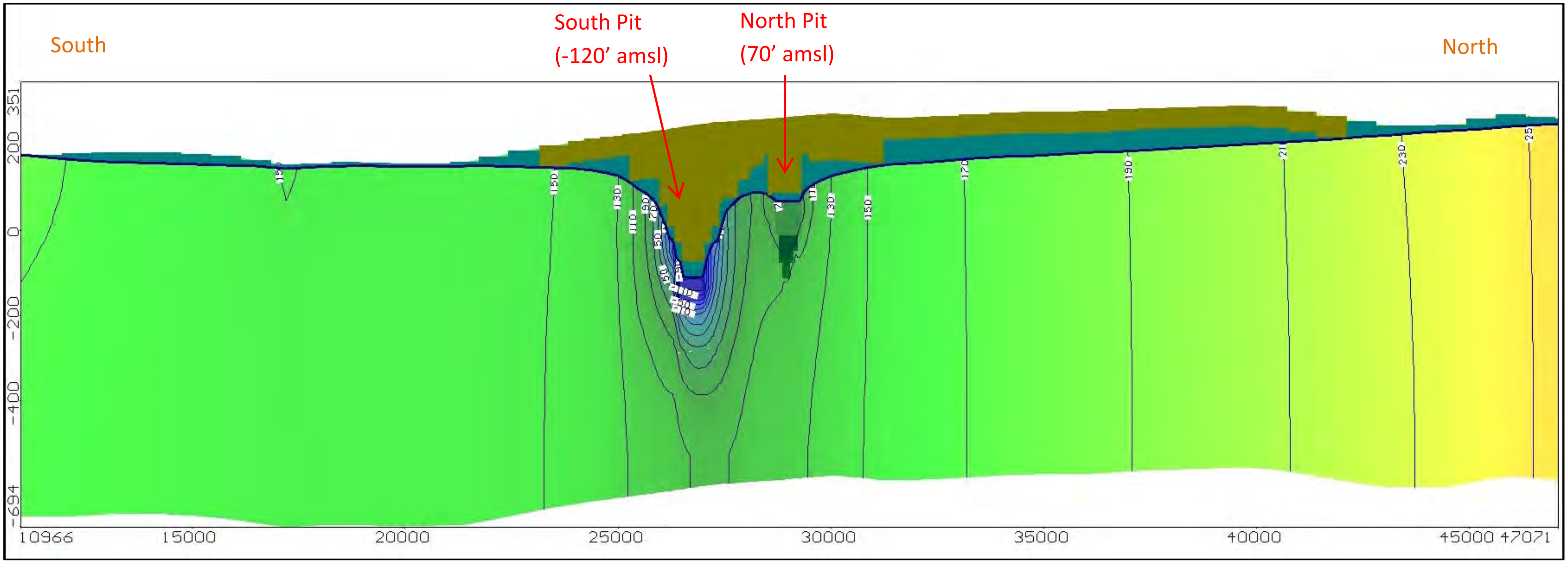


Figure 4d: Fill sequence 2 cross-sectional view of groundwater elevations sliced through the Fairfax Quarry's North Pit and South Pit. Bronze-colored areas represent dry model grid cells. Contour interval = 20 feet. X-axis labels are in units of feet and Y-axis labels are in units of feet above mean sea level. Vertical exaggeration = 10x.

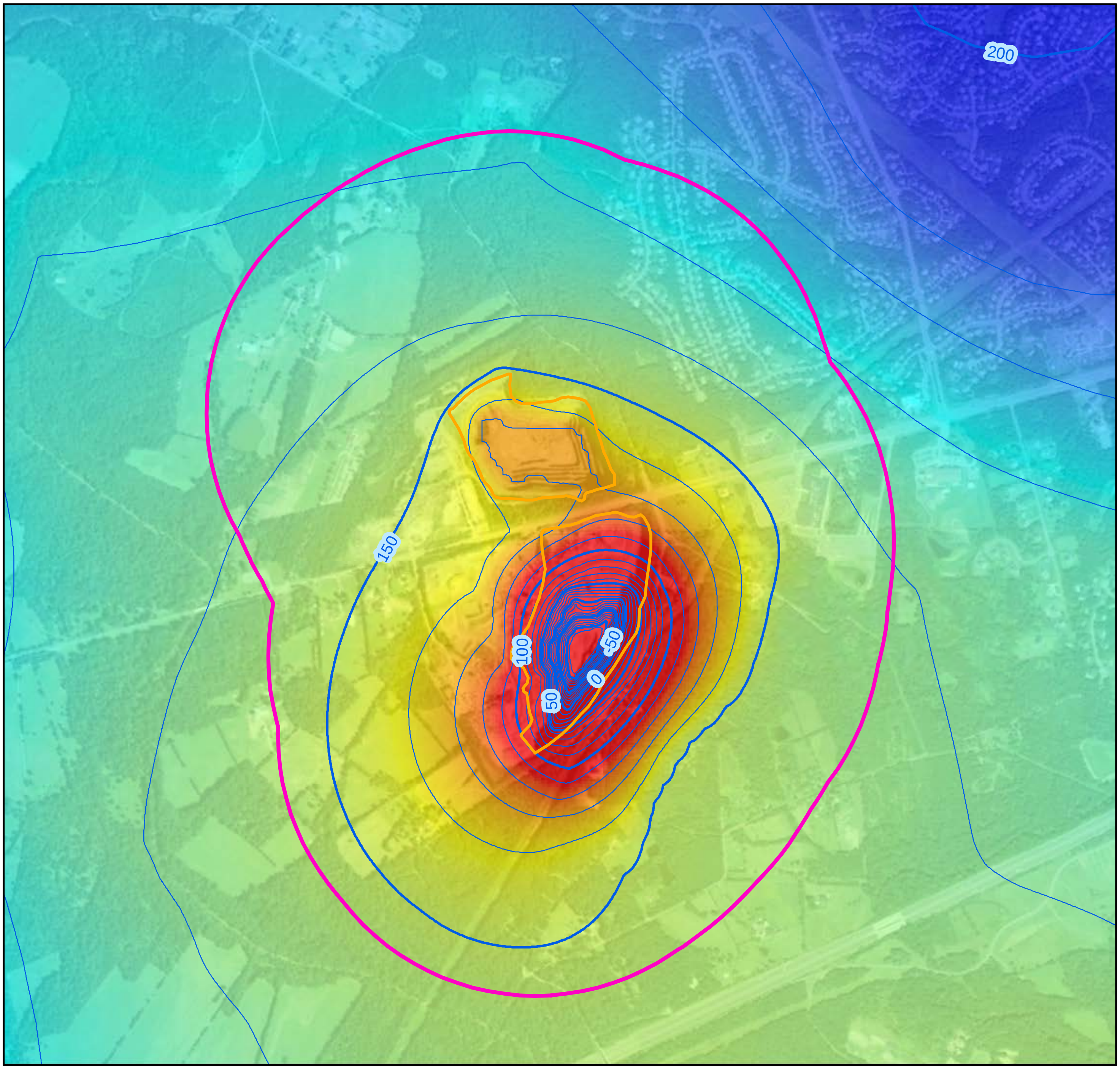


Figure 4e: Model-Predicted Groundwater Elevations at Fill Sequence 3

Reclamation Fill Plan Study
Luck Stone Fairfax Quarry

Legend

Luck Stone Pit Boundaries

Quarry Pit Buffer (0.5-Mile)

Groundwater Equipotential Contour (C.I. = 10 ft)

Index Contour

Intermediate Contour

0 1,000 2,000 4,000 Feet

Model-Predicted Groundwater Elevation

Value

High : 201 ft

Low : -120 ft

N

Map Notes:
(1) Groundwater elevations are in units of feet above mean sea level (amsl);
(2) Fill sequence 3 dewatering elevations: North Pit = 130 feet amsl and South Pit = -120 feet amsl.

ECS Project No. 47-7563

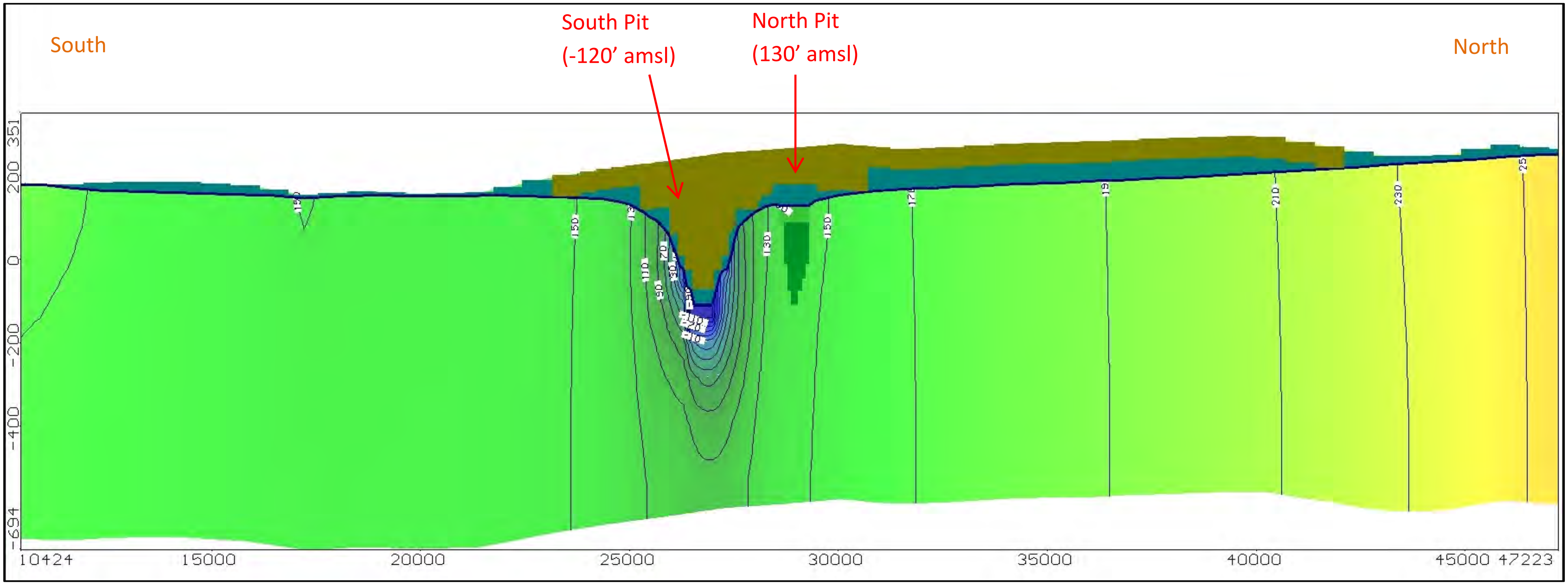


Figure 4f: Fill sequence 3 cross-sectional view of groundwater elevations sliced through the Fairfax Quarry's North Pit and South Pit. Bronze-colored areas represent dry model grid cells. Contour interval = 20 feet. X-axis labels are in units of feet and Y-axis labels are in units of feet above mean sea level. Vertical exaggeration = 10x.

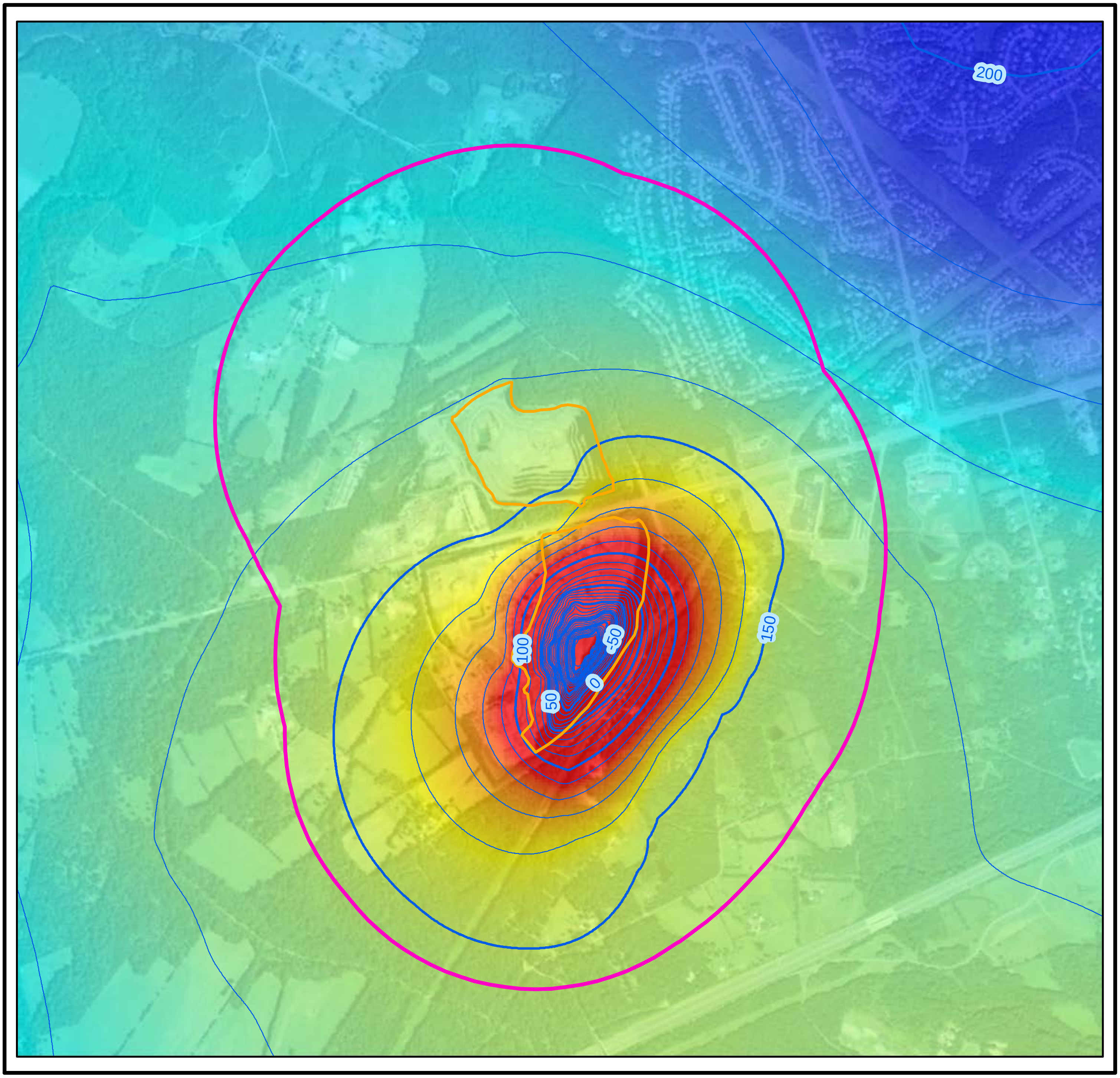


Figure 4g: Model-Predicted Groundwater Elevations at Fill Sequence 4

Reclamation Fill Plan Study
Luck Stone Fairfax Quarry

Legend

Luck Stone Pit Boundaries

Quarry Pit Buffer (0.5-Mile)

Groundwater Equipotential Contour (C.I. = 10 ft)

Index Contour

Intermediate Contour

0 1,000 2,000 4,000 Feet

Model-Predicted Groundwater Elevation

Value

High : 201 ft

Low : -170 ft

N

Map Notes:
(1) Groundwater elevations are in units of feet above mean sea level (amsl);
(2) Fill sequence 4 dewatering elevations: North Pit = 156 feet amsl and South Pit = -170 feet amsl.

ECS Project No. 47-7563

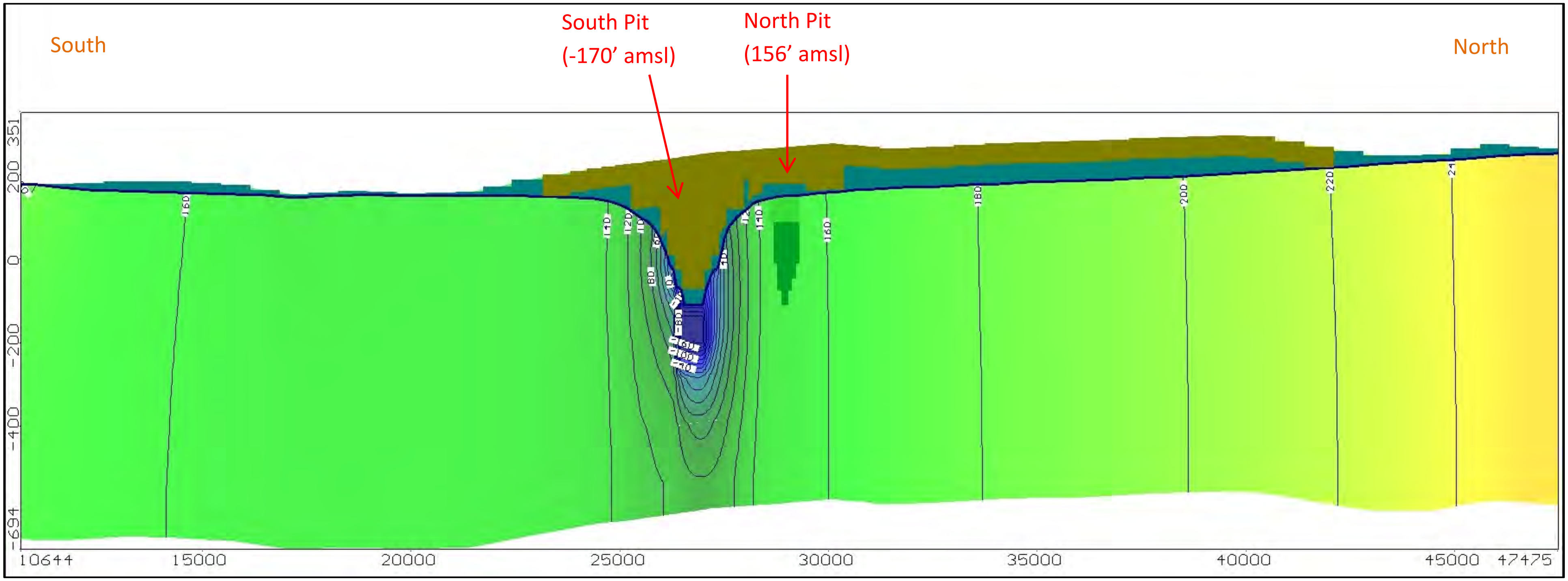


Figure 4h: Fill sequence 4 cross-sectional view of groundwater elevations sliced through the Fairfax Quarry's North Pit and South Pit. Bronze-colored areas represent dry model grid cells. Contour interval = 20 feet. X-axis labels are in units of feet and Y-axis labels are in units of feet above mean sea level. Vertical exaggeration = 10x.

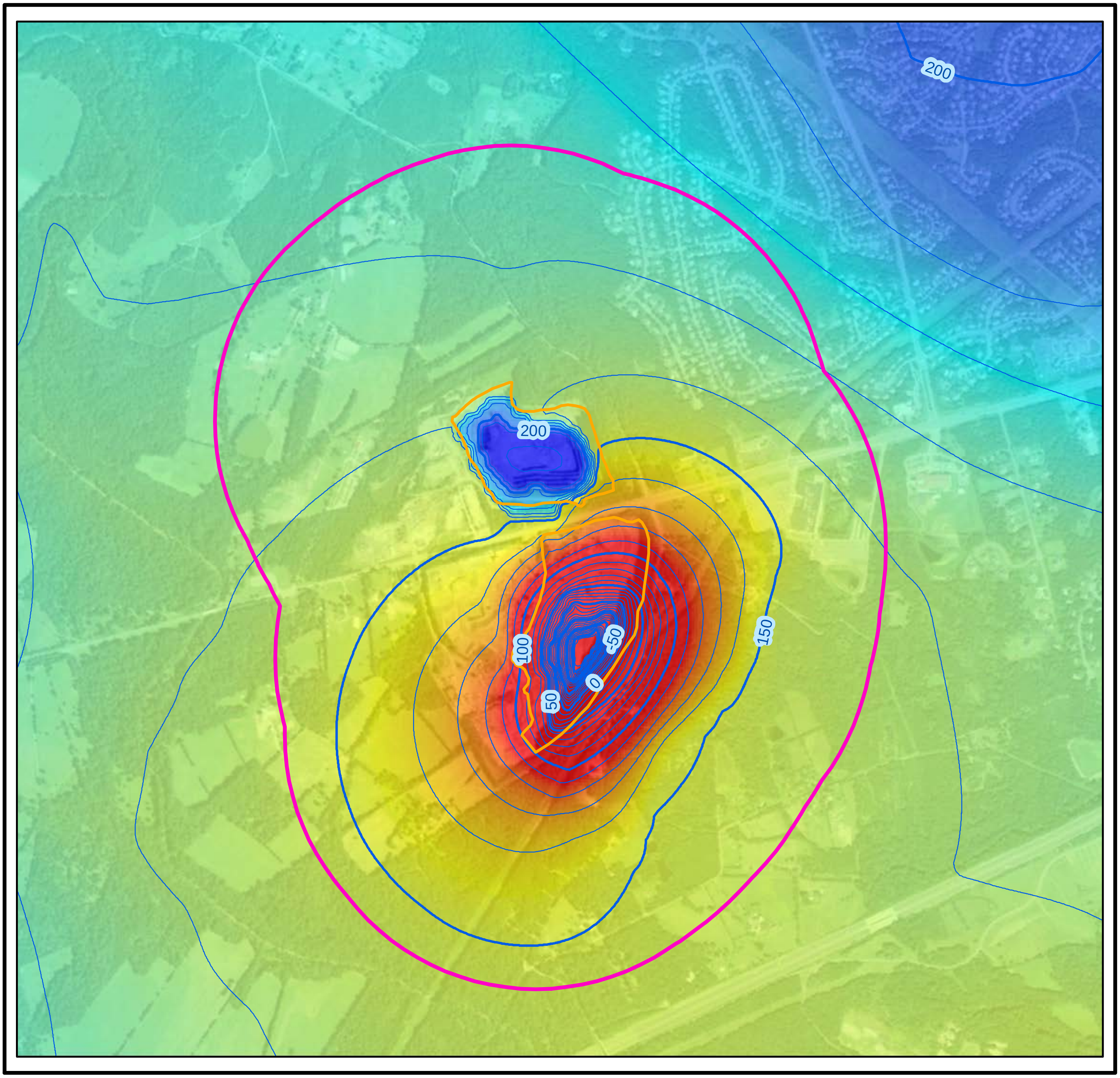


Figure 4i: Model-Predicted Groundwater Elevations at Fill Sequence 5

Reclamation Fill Plan Study
Luck Stone Fairfax Quarry

Legend

Luck Stone Pit Boundaries

Quarry Pit Buffer (0.5-Mile)

Groundwater Equipotential Contour (C.I. = 10 ft)

Index Contour

Intermediate Contour

0 1,000 2,000 4,000 Feet

Model-Predicted Groundwater Elevation

Value

High : 222 ft

Low : -170 ft

N

Map Notes:
(1) Groundwater elevations are in units of feet above mean sea level (amsl);
(2) Fill sequence 5 dewatering elevations: North Pit = Not Dewatering and South Pit = -170 feet amsl.

ECS Project No. 47-7563

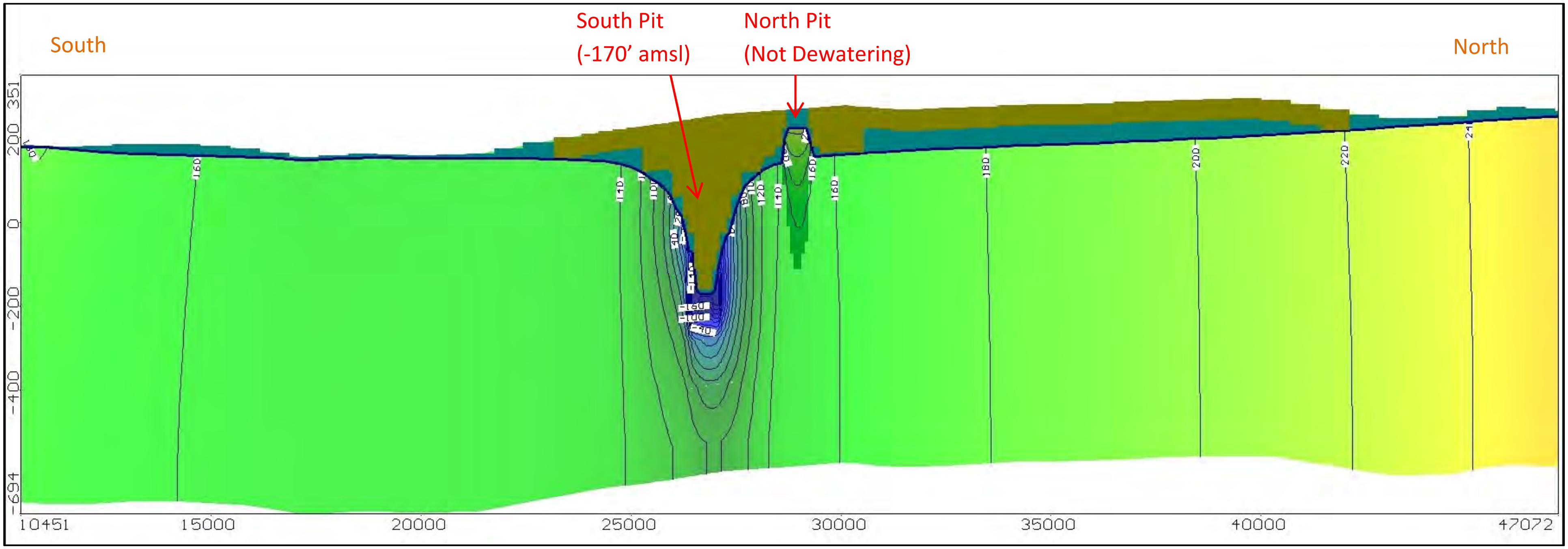


Figure 4j: Fill sequence 5 cross-sectional view of groundwater elevations sliced through the Fairfax Quarry's North Pit and South Pit. Bronze-colored areas represent dry model grid cells. Contour interval = 20 feet. X-axis labels are in units of feet and Y-axis labels are in units of feet above mean sea level. Vertical exaggeration = 10x.

Figures 5a-c

Documented Wells Within 0.5-Mile of Quarry

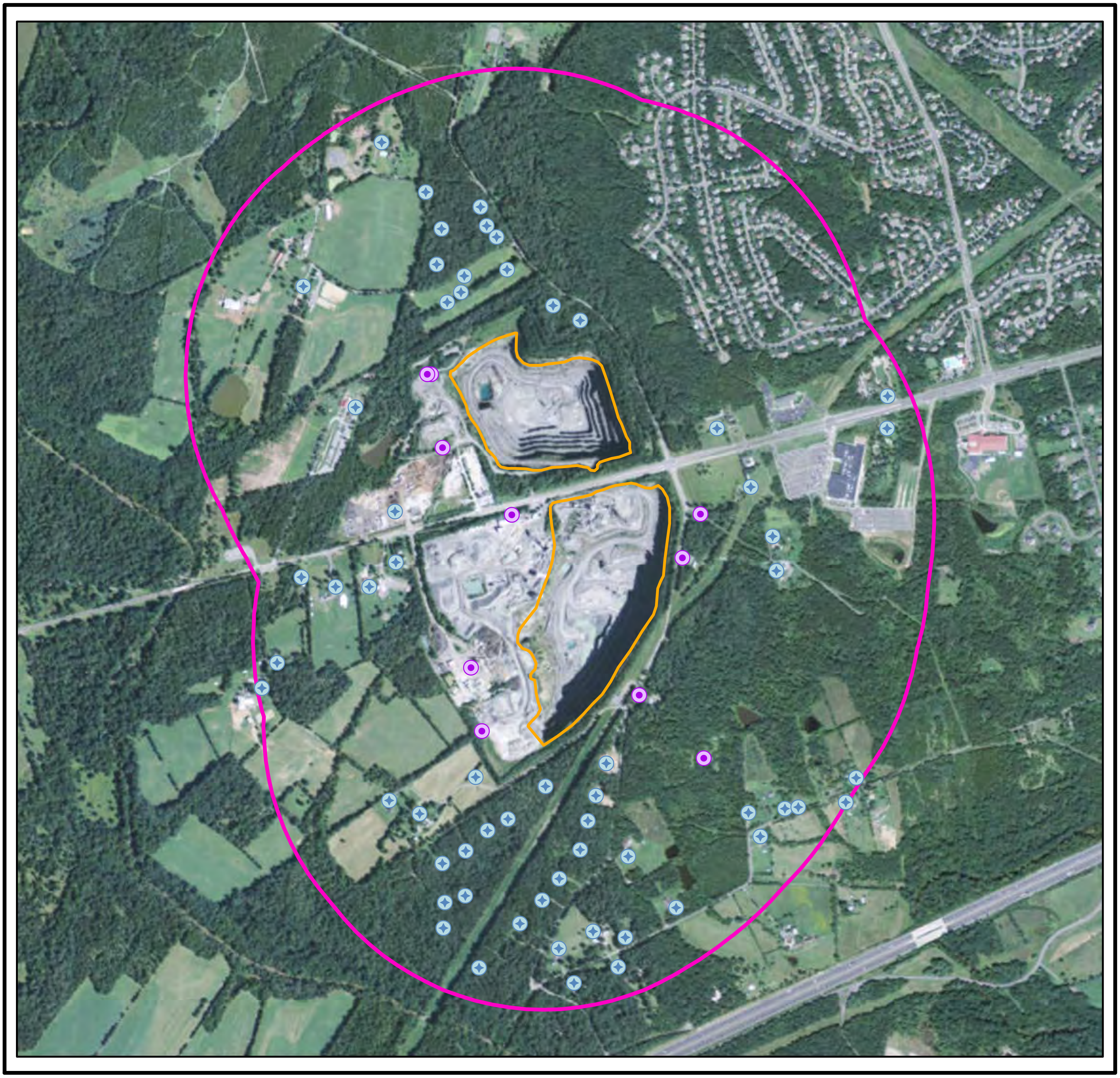


Figure 5a: Documented Wells Within 0.5-Mile of Quarry (All Wells)

Reclamation Fill Plan Study
Luck Stone Fairfax Quarry

Legend

Luck Stone Pit Boundaries

Quarry Pit Buffer (0.5-Mile)

Documented Well

Luck Stone Well

Off-Site Well

N

0 0.125 0.25 0.5 Miles

ECS Project No. 47-7563

Figure 5b: Documented Wells Within 0.5-Mile of Quarry (North Wells)

Reclamation Fill Plan Study
Luck Stone Fairfax Quarry

Legend

Luck Stone Pit Boundaries

Quarry Pit Buffer (0.5-Mile)

Documented Well

Luck Stone Well

Off-Site Well

N

0 0.125 0.25 0.5 Miles

Map Note:
Well numbers are provided for the purpose of cross-referencing with the well database spreadsheet.

ECS Project No. 47-7563

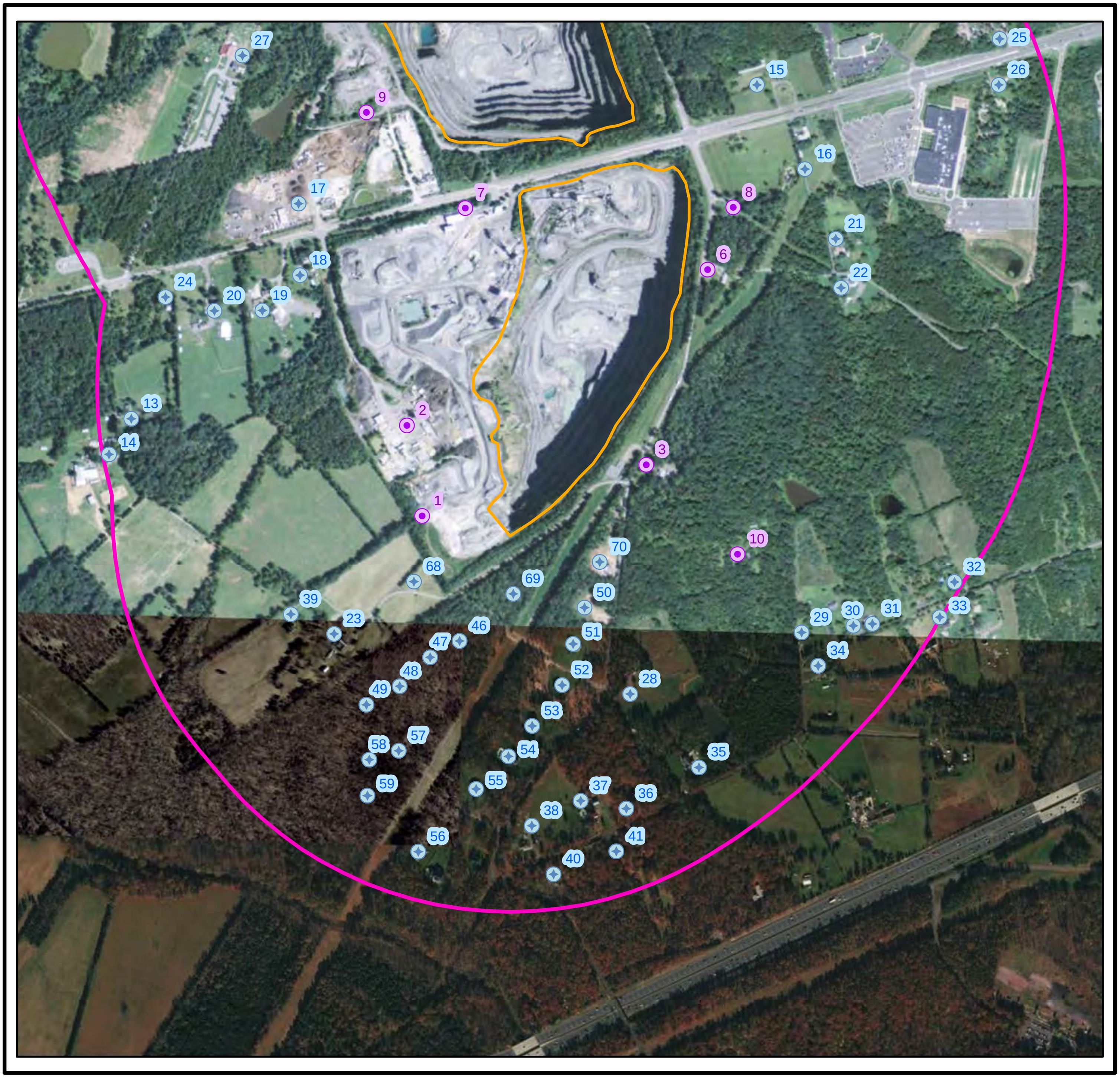


Figure 5c: Documented Wells Within 0.5-Mile of Quarry (South Wells)

Reclamation Fill Plan Study
Luck Stone Fairfax Quarry

Legend

Luck Stone Pit Boundaries

Quarry Pit Buffer (0.5-Mile)

Documented Well

Luck Stone Well

Off-Site Well

N

0 0.125 0.25 0.5 Miles

Map Note:
Well numbers are provided for the purpose of cross-referencing with the well database spreadsheet.

ECS Project No. 47-7563

Appendices

Appendix 1

Reclamation Fill Profile & Agreement

Reclamation Fill Profile and Agreement
Luck Stone Corporation
Fairfax Plant
Physical Address : 15717 Lee Highway, Centreville, Virginia 20121
Mailing Address : P.O. Box 1817, Centreville, Virginia 20122

A. GENERATOR INFORMATION

Generator Name:			Contact Name:
Generator Address:			Phone: / Fax: / Email:
City:	State:	Zip:	Location Description of Fill Origination (include facility name and address, if different from generator):
Generator Mailing Address (if different):			
City:	State:	Zip:	
Contractor License No.:			

B. Fill Description (include source and phycial description of fill)

Phase I ESA Available: Yes No (If available, attach copy)

Fill Volume in Cubic Yards:	Delivery Frequency:

Attach all laboratory analytical data

C. SHIPPING INFORMATION

Transporter Name:			Contact Name:
Transporter Address:			
City:	State:	Zip:	
Transporter Mailing Address (if different):			Phone: / Fax: / Email:
			Shipping Method:
City:	State:	Zip:	

D. GENERATOR CERTIFICATION

I, the undersigned, a duly authorized official or representative of the company or entity listed above, certify that the material requested to be delivered at the Luck Stone Fairfax Plant as part of their reclamation efforts meets the definition of Reclamation Fill as stated below, and that the material being delivered will be born from the source address listed above. Furthermore, I fully understand and agree to the Terms and Conditions listed below and acknowledge that Luck Stone will govern the scheduling of deliveries of Reclamation Fill and I am fully aware that Luck Stone may cease accepting Reclamation Fill from time to time at their discretion.

Generator or Generator's Authorized Representative

Printed Name and Title:	Signature:	Date:	Company:

E. ACKNOWLEDGEMENT BY LUCK STONE CORPORATION

☐ APPROVED ☐ REJECTED	Signature:	Date:	Profile Number:

Luck Stone has the right to reject any material for any reason at any time.

*“**Reclamation Fill**”, for the purposes of the Luck Stone Fairfax Plant will refer to natural (i.e soil and rock) materials that are certified to meet the requirements of this plan as approved on XXXX, XX, 2019; which have been developed to be protective of the environment and human health. Reclamation Fill will include earthen and rock materials that have not been known to be exposed to, or mixed with, solid waste, petroleum products, or chemical contaminants; and shall only contain 5% or less of organics and inert material (pieces less than 6 inches in diameter of non-coated/unpainted concrete, blocks, or brick).*

1. **ONLY APPROVED RECLAMATION FILL MATERIALS CAN AND WILL BE ACCEPTED. This customer certifies that all materials brought to the property meet the "Reclamation Fill" standards established by the Reclamation Fill Plan.** The Luck Stone Fairfax Plant requires up-front laboratory analyses of fill materials prior to delivery to the Luck Stone property at the Customer's expense. No Reclamation Fill shall be accepted without laboratory certification noting compliance with the sampling guidelines set forth in the Reclamation Fill Plan. In particular, any sampling analysis should test for the Column A Phase 1 Priority Analytes attached to this form and meet the appropriate standards identified therein. The Luck Stone Plant will, likewise, have the right to screen loads delivered and collect samples as described by the Reclamation Fill Plan. Materials deemed to not meet the Reclamation Fill criteria will be rejected.

2. **The Luck Stone Fairfax Plant has the right to reject any materials for any reason.** Any materials rejected by the Luck Stone Fairfax Plant shall be immediately removed from the property by the shipper. Any material rejected by the Luck Stone Fairfax Plant shall be reloaded on to the shipper's trucks **at the Generator's cost** and be immediately removed from the property by the Generator.

3. **Generator shall remain liable for any Reclamation Fill Material brought to and/or placed at the facility.** Any material deemed to not meet the standards set forth in the Reclamation Fill Plan discovered after the Generator has left the property may be reloaded by the Luck Stone Fairfax Plant and be properly handled at the Generator's cost. Any costs and expenses, including attorney's fees, incurred by the Luck Stone Fairfax Plant associated with the proper handling of non-compliant Reclamation Fill materials and any other materials affected thereby, shall be paid by the Generator.

Agreement Language Provided by Luck Stone

Groundwater, Surface Water, and Soil Laboratory Analyte List and Screening Levels

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	Acenaphthene	83-32-9	53	990	17.2
	Acenaphthylene	208-96-8	12	---[g]	66.3
Acetone	Acetone	67-64-1	1,400	---	1.25
	Acetonitrile; Methyl cyanide	75-05-8	13	---	---
	Acetophenone	98-86-2	190	---	0.472
	2-Acetylaminofluorene; 2-AAF	53-96-3	0.16	---	---
	Acrolein	107-02-8	0.0042	3	---
Acrylonitrile	Acrylonitrile	107-13-1	0.41	2.5	---
	Aldrin	309-00-2	0.0092	0.0005	0.00336
	Allyl chloride	107-05-1	0.21	---	---
	4-Aminobiphenyl	92-67-1	0.03	---	---
	Anthracene	120-12-7	180	40,000	185
Antimony	Antimony	(Total)	6	640	2.71
Arsenic	Arsenic	(Total)	10	150	2.91
Barium	Barium	(Total)	2,000	---	822
Benzene	Benzene	71-43-2	5	510	0.0246
	Benzo[a]anthracene; Benzanthracene	56-55-3	0.3	0.18	0.644
	Benzo[b]fluoranthene	205-99-2	2.5	0.18	1.82
	Benzo[k]fluoranthene	207-08-9	25	0.18	18.2
	Benzo[g,h,i]perylene	191-24-2	12	---	19,400
	Benzo[a]pyrene	50-32-8	0.2	0.18	8.87
	Benzyl alcohol	100-51-6	200	---	---
Beryllium	Beryllium	(Total)	4	---	31.6
	alpha-BHC	319-84-6	0.072	0.049	0.000461
	beta-BHC	319-85-7	0.25	0.17	0.00158
	delta-BHC	319-86-8	---	---	0.00151

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	gamma-BHC; Lindane	58-89-9	0.2	1.8	0.0106
	Bis(2-chloroethoxy)methane	111-91-1	5.9	---	0.00624
	Bis(2-chloroethyl) ether; Dichloroethyl ether	111-44-4	0.14	5.3	0.0000254
	Bis(2-chloro-1-methylethyl) ether; 2, 2'-Dichlorodiisopropyl ether; DCIP	108-60-1, See Note 1	71	65,000	---
	Bis(2-ethylhexyl)phthalate	117-81-7	6	22	38.0
Bromochloromethane;.Chlorobromomethane	Bromochloromethane;.Chlorobromomethane	74-97-5	8.3	---	0.017
Bromodichloromethane;.Dibromochloromethane	Bromodichloromethane;.Dibromochloromethane	75-27-4	1.3	170	0.35
Bromoform; Tribromomethane	Bromoform; Tribromomethane	75-25-2	33	1,400	0.516
	4-Bromophenyl phenyl ether	101-55-3	---	---	---
	Butyl benzyl phthalate; Benzyl butyl phthalate	85-68-7	160	1,900	56.4
Cadmium	Cadmium	(Total)	5	1.1	3.78
Carbon disulfide	Carbon disulfide	75-15-0	81	---	0.548
Carbon tetrachloride	Carbon tetrachloride	56-23-5	5	16	0.0794
	Chlordane	See Note 2	2	0.0043	14.5
	p-Chloroaniline	106-47-8	3.7	---	---
Chlorobenzene	Chlorobenzene	108-90-7	100	1,600	1.40
	Chlorobenzilate	510-15-6	3.1	---	---
	p-Chloro-m-cresol; 4-Chloro-3-methylphenol	59-50-7	140	2,000	7.47
Chloroethane; Ethyl chloride	Chloroethane; Ethyl chloride	75-00-3	2,100	---	5.58
Chloroform; Trichloromethane	Chloroform; Trichloromethane	67-66-3	2.2	11,000	0.311
	2-Chloronaphthalene	91-58-7	75	1,600	7.0
	2-Chlorophenol	95-57-8	9.1	150	0.173

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	4-Chlorophenyl phenyl ether	7005-72-3	---	---	---
	Chloroprene	126-99-8	0.19	---	---
Chromium	Chromium	(Total)	100	---	19.1
	Chrysene	218-01-9	250	0.018	64.4
Cobalt	Cobalt	(Total)	0.6	---	0.212
Copper	Copper	(Total)	1,300	9	5,570
	m-Cresol; 3-methyphenol	108-39-4	93	---	0.437
	o-Cresol; 2-methyphenol	95-48-7	93	---	0.429
	p-Cresol; 4-methyphenol	106-44-5	190	---	0.819
	Cyanide	57-12-5	200	5.2	20.0
	2,4-D; 2,4-Dichlorophenoxyacetic acid	94-75-7	70	12,000	---
	4,4'-DDD	72-54-8	0.0063	0.0031	13.9
	4,4'-DDE	72-55-9	0.46	0.0022	4.71
	4,4'-DDT	50-29-3	1	0.001	21.4
	Diallate	2303-16-4	5.4	---	---
	Dibenz[a,h]anthracene	53-70-3	0.25	0.18	0.427
	Dibenzofuran	132-64-9	0.79	---	0.391
Dibromochloromethane; Chlorodibromomethane	Dibromochloromethane; Chlorodibromomethane	124-48-1	8.7	130	0.42
1,2-Dibromo-3-chloropropane; DBCP	1,2-Dibromo-3-chloropropane; DBCP	96-12-8	0.2	---	0.00109
1,2-Dibromoethane; Ethylene dibromide; EDB	1,2-Dibromoethane; Ethylene dibromide; EDB	106-93-4	0.05	---	0.000181
	Di-n-butyl phthalate	84-74-2	90	4,500	176
o-Dichlorobenzene; 1,2-Dichlorobenzene	o-Dichlorobenzene; 1,2-Dichlorobenzene	95-50-1	600	1,300	21.2
	m-Dichlorobenzene; 1,3-Dichlorobenzene	541-73-1	75	960	0.0225

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
p-Dichlorobenzene; 1,4-Dichlorobenzene	p-Dichlorobenzene; 1,4-Dichlorobenzene	106-46-7	75	190	3.39
	3,3'-Dichlorobenzidine	91-94-2	1.3	0.28	0.0187
trans-1,4-Dichloro-2-butene	trans-1,4-Dichloro-2-butene	110-57-6	0.013	---	---
	Dichlorodifluoromethane; CFC 12;	75-71-8	20	---	0.595
1.1-Dichloroethane; Ethylidene chloride	1,1-Dichloroethane; Ethylidene chloride	75-34-3	28	---	0.00796
1,2-Dichloroethane; Ethylene dichloride	1,2-Dichloroethane; Ethylene dichloride	107-06-2	5	370	0.0107
1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	75-35-4	7	7,100	0.0456
cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	156-59-2	70	---	0.242
trans-1,2-Dichloroethylene	trans-1,2-Dichloroethylene; trans-1,2-Dichroroethene	156-60-5	100	10,000	0.498
	2,4-Dichlorophenol	120-83-2	4.6	290	0.0345
	2,6-Dichlorophenol	87-65-0	---	---	---
1,2-Dichloropropane; Propylene dichloride	1,2-Dichloropropane; Propylene dichloride	78-87-5	5	150	0.0199
	1,3-Dichloropropane; Trimethylene dichloride	142-28-9	37	---	0.00152
	2, 2-Dichloropropane; isopropylidene chloride	594-20-7	---	---	---
	1,1-Dichloropropene	563-58-6	---	---	---
cis-1,3-Dichloropropene	cis-1,3-Dichloropropene	10061-01-5	3.9	---	0.00156
trans-1,3-Dichloropropene	trans-1,3-Dichloropropene	10061-02-6	3.9	---	0.00164
	Dieldrin	60-57-1	0.018	0.00054	0.000434
	Diethyl phthalate	84-66-2	1,500	44,000	18.8

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	O,O-Diethyl O-2-pyrazinyl phosphorothioate; Thionazin	297-97-2	---	---	---
	Dimethoate	60-51-5	4.4	---	---
	p-(Dimethylamino)azobenzene	60-11-7	0.05	---	---
	7,12-Dimethylbenz[a]anthracene	57-97-6	0.001	---	---
	3,3'-Dimethylbenzidine	119-93-7	0.065	---	---
	2,4-Dimethylphenol; m-Xylenol	105-67-9	36	850	0.323
	Dimethyl phthalate	131-11-3	---	1,100,000	---
	m-Dinitrobenzene	99-65-0	0.2	---	---
	4,6-Dinitro-o-cresol; 4,6-Dinitro-2-methylphenol	534-52-1	0.15	280	0.000136
	2,4-Dinitrophenol	51-28-5	3.9	5,300	0.003
	2,4-Dinitrotoluene	121-14-2	2.4	34	0.00139
	2,6-Dinitrotoluene	606-20-2	0.49	---	0.00592
	Dinoseb; DNBP; 2-sec-Butyl-4,6-dinitrophenol	88-85-7	7	---	---
	Di-n-octyl phthalate	117-84-0	20	---	---
	Diphenylamine	122-39-4	130	---	---
	Disulfoton	298-04-4	0.05	---	---
	Endosulfan I	959-96-8	10	0.056	1.73
	Endosulfan II	33213-65-9	10	0.056	1.73
	Endosulfan sulfate	1031-07-8	10	89	1.27
	Endrin	72-20-8	2	0.036	0.589
	Endrin aldehyde	7421-93-4	2	0.3	0.231
Ethylbenzene	Ethylbenzene	100-41-4	700	2,100	16.8
	Ethyl methacrylate	97-63-2	63	---	---
	Ethylmethanesulfonate	62-50-0	---	---	---
	Famphur	52-85-7	---	---	---
	Fluoranthene	206-44-0	80	140	278

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	Fluorene	86-73-7	29	5,300	17.0
	Heptachlor	76-44-8	0.4	0.00079	0.425
	Heptachlor epoxide	1024-57-3	0.2	0.00039	2.44
	Hexachlorobenzene	118-74-1	1	0.0029	9.96
	Hexachlorobutadiene	87-68-3	0.65	180	0.781
	Hexachlorocyclopentadiene	77-47-4	50	1,100	270
	Hexachloroethane	67-72-1	0.62	33	0.347
	Hexachloropropene	1888-71-7	---	---	---
2-Hexanone; Methyl butyl ketone	2-Hexanone; Methyl butyl ketone	591-78-6	3.8	---	0.00645
	Indeno[1,2,3-cd]pyrene	193-39-5	2.5	0.18	5.16
	Isobutyl alcohol	78-83-1	590	---	---
	Isodrin	465-73-6	---	---	---
	Isophorone	78-59-1	380	9,600	0.243
	Isosafrole	120-58-1	---	---	---
	Kepone	143-50-0	0.035	0	---
Lead	Lead	(Total)	15	11	135
	Mercury	(Total)	2	0.77	1.04
	Methacrylonitrile	126-98-7	0.19	---	---
	Methapyrilene	91-80-5	---	---	---
	Methoxychlor	72-43-5	40	0.03	134
Methyl bromide; Bromomethane	Methyl bromide; Bromomethane	74-83-9	0.75	1,500	0.00148
Methyl chloride; Chloromethane	Methyl chloride; Chloromethane	74-87-3	19	---	0.0392
	3-Methylcholanthrene	56-49-5	0.011	---	---
Methyl ethyl ketone; MEK; 2-Butanone	Methyl ethyl ketone; MEK; 2-Butanone	78-93-3	560	---	0.552
Methyl iodide; Iodomethane	Methyl iodide; Iodomethane	74-88-4	---	---	---
	Methyl methacrylate	80-62-6	140	---	---
	Methyl methanesulfonate	66-27-3	7.9	---	---
	2-Methylnaphthalene	91-57-6	3.6	---	1.01

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	Methyl parathion; Parathion methyl methyl	298-00-0	0.45	---	---
4-Methyl-2-pentanone; Methyl isobutyl ketone	4-Methyl-2-pentanone; Methyl isobutyl ketone	108-10-1	630	---	0.164
Methylene bromide; Dibromomethane	Methylene bromide; Dibromomethane	74-95-3	0.83	---	---
Methylene chloride; Dichloromethane	Methylene chloride; Dichloromethane	75-09-2	5	5,900	0.00936
	Naphthalene	91-20-3	0.61	---	0.0149
	1,4-Naphthoquinone	130-15-4	---	---	---
	1- Naphthylamine	134-32-7	---	---	---
	2-Napthylamine	91-59-8	0.39	---	---
Nickel	Nickel	(Total)	---	---	19.5
	o-Nitroaniline; 2-Nitroaniline	88-74-4	19	---	0.0743
	m-Nitroaniline; 3-Nitroaniline	99-09-2	---	---	---
	p-Nitroaniline; 4-Nitroaniline	100-01-6	7.8	---	0.00791
	Nitrobenzene	98-95-3	1.3	690	0.000595
	o-Nitrophenol; 2-Nitrophenol	88-75-5	---	---	---
	p-Nitrophenol; 4-Nitrophenol	100-02-7	---	---	---
	N-Nitrosodi-n-butylamine	924-16-3	0.027	0.22	---
	N-Nitrosodiethylamine	55-18-5	0.0017	1.24	---
	N-Nitrosodimethylamine	62-75-9	0.0011	30	---
	N-Nitrosodiphenylamine	86-30-6	120	60	0.727
	N-Nitrosodipropylamine; N-Nitroso-N-dipropylamine; Di-n-propylnitrosamine	621-64-7	0.11	5.1	0.0000214
	N-Nitrosomethylethalamine	10595-95-6	0.0071	---	---
	N-Nitrosopiperidine	100-75-4	0.082	---	---
	N-Nitrosopyrrolidine	930-55-2	0.37	34	---

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	5-Nitro-o-toluidine	99-55-8	38	---	---
	Parathion	56-38-2	8.6	0.013	---
	Pentachlorobenzene	608-93-5	0.32	0.1	---
	Pentachloronitrobenzene	82-68-8	1.2	---	---
	Pentachlorophenol	87-86-5	1	6.7	0.0365
	Phenacetin	62-44-2	340	---	---
	Phenanthrene	85-01-8	12	---	160
	Phenol	108-95-2	580	860,000	1
	p-Phenylenediamine	106-50-3	2	---	---
	Phorate	298-02-2	0.3	---	---
	Polychlorinated biphenyls; PCBS; Aroclors	See Note 3	0.5	0.00064	---
	Pronamide	23950-58-5	120	---	---
	Propionitrile; Ethyl cyanide	107-12-0	---	---	---
	Pyrene	129-00-0	12	4,000	32.7
	Safrole	94-59-7	0.96	---	---
Selenium	Selenium	(Total)	50	5	2.55
Silver	Silver	(Total)	9.4	---	0.596
	Silvex; 2,4,5-TP	93-72-1	50	400	---
Styrene	Styrene	100-42-5	100	---	4.89
	Sulfide	18496-25-8	---	---	---
	2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid	93-76-5	16	---	---
	1,2,4,5-Tetrachlorobenzene	95-94-3	0.17	0.03	0.394
1,1,1,2-Tetrachloroethane	1,1,1,2-Tetrachloroethane	630-20-6	5.7	---	0.00999
1,1,2,2-Tetrachloroethane	1,1,2,2-Tetrachloroethane	79-34-5	0.76	40	0.000438
Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	127-18-4	5	33	0.189

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	2,3,4,6-Tetrachlorophenol	58-90-2	24	---	3.05
Thallium	Thallium	(Total)	---	---	1.42
	Tin	(Total)	1,200	---	---
Toluene	Toluene	108-88-3	1,000	6,000	11.9
	o-Toluidine	95-53-4	47	---	---
	Toxaphene	See Note 4	3	0.0002	9.86
	1,2,4-Trichlorobenzene	120-82-1	70	70	7.21
1,1,1-Trichloroethane; Methychloroform	1,1,1-Trichloroethane; Methychloroform	71-55-6	200	200,000	1.81
1,1,2-Trichloroethane	1,1,2-Trichloroethane	79-00-5	5	160	0.0205
Trichloroethylene; Trichloroethene ethene	Trichloroethylene; Trichloroethene ethane	79-01-6	5	300	0.0386
Trichlorofluoromethane; CFC-11	Trichlorofluoromethane; CFC-11	75-69-4	520	---	1.74
	2,4,5-Trichlorophenol	95-95-4	120	600	8.82
	2,4,6-Trichlorophenol	88-06-2	1.2	24	0.0838
1,2,3-Trichloropropane	1,2,3-Trichloropropane	96-18-4	0.0075	---	---
	O,O,O-Triethyl phosphorothioate	126-68-1	---	---	---
	sym-Trinitrobenzene	99-35-4	59	---	---
Vanadium	Vanadium	(Total)	8.6	---	78.0
Vinyl acetate	Vinyl acetate	108-05-4	41	---	---
Vinyl chloride; Chloroethene	Vinyl chloride; Chloroethene	75-01-4	2	24	0.00792
Xylene(total)	Xylene(total)	See Note 5	10,000	---	243
Zinc	Zinc	(Total)	600	120	292

[a]Corresponds with parameters within Table 3.1 of the Virginia Solid Waste Groundwater Management Regulations (9VAC20-81-250).

[b]CAS RN = Chemical Abstracts Service Registry Number. Where "Total" is entered, all species in the groundwater that contain this analyte are included.

[c]VRP = Voluntary Remediation Program.

[d]µg/L = micrograms per liter.

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])

[e]Obtained from Virginia Department of Environmental Quality Memorandum No. LPR-SW-04-2012, dated July 17, 2012, titled Management and Reuse of Contaminated Media.

[f]mg/kg = milligrams per kilogram.

[g]--- = screening level does not exist for this analyte

Note 1: This substance is often called Bis(2-chloroisopropyl) ether, the name Chemical Abstracts Service applies to its noncommercial isomer, Propane, 2.2'-oxybis2-chloro (CAS RN 39638-32-9).

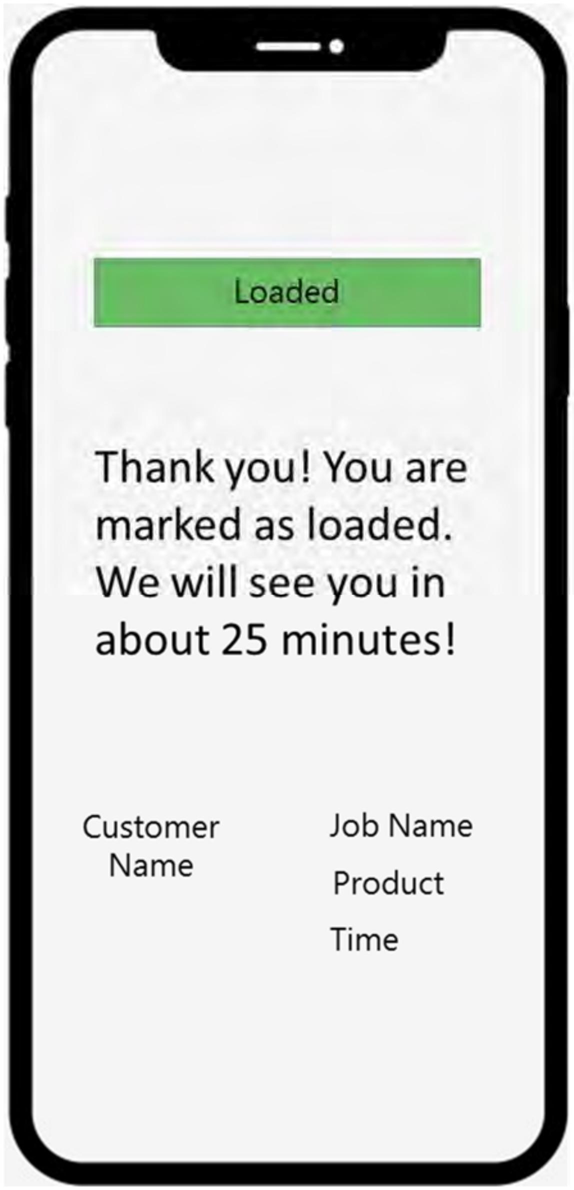
Note 2: Chlordane: This entry includes alpha-chlordane (CAS RN 5103-71-9), beta-chlordane (CAS RN 5103-74-2), gamma-chlordane (CAS RN 5566-34-7), and constituents of chlordane (CAS RN 57-74-9 and CAS RN 12739-03-6).

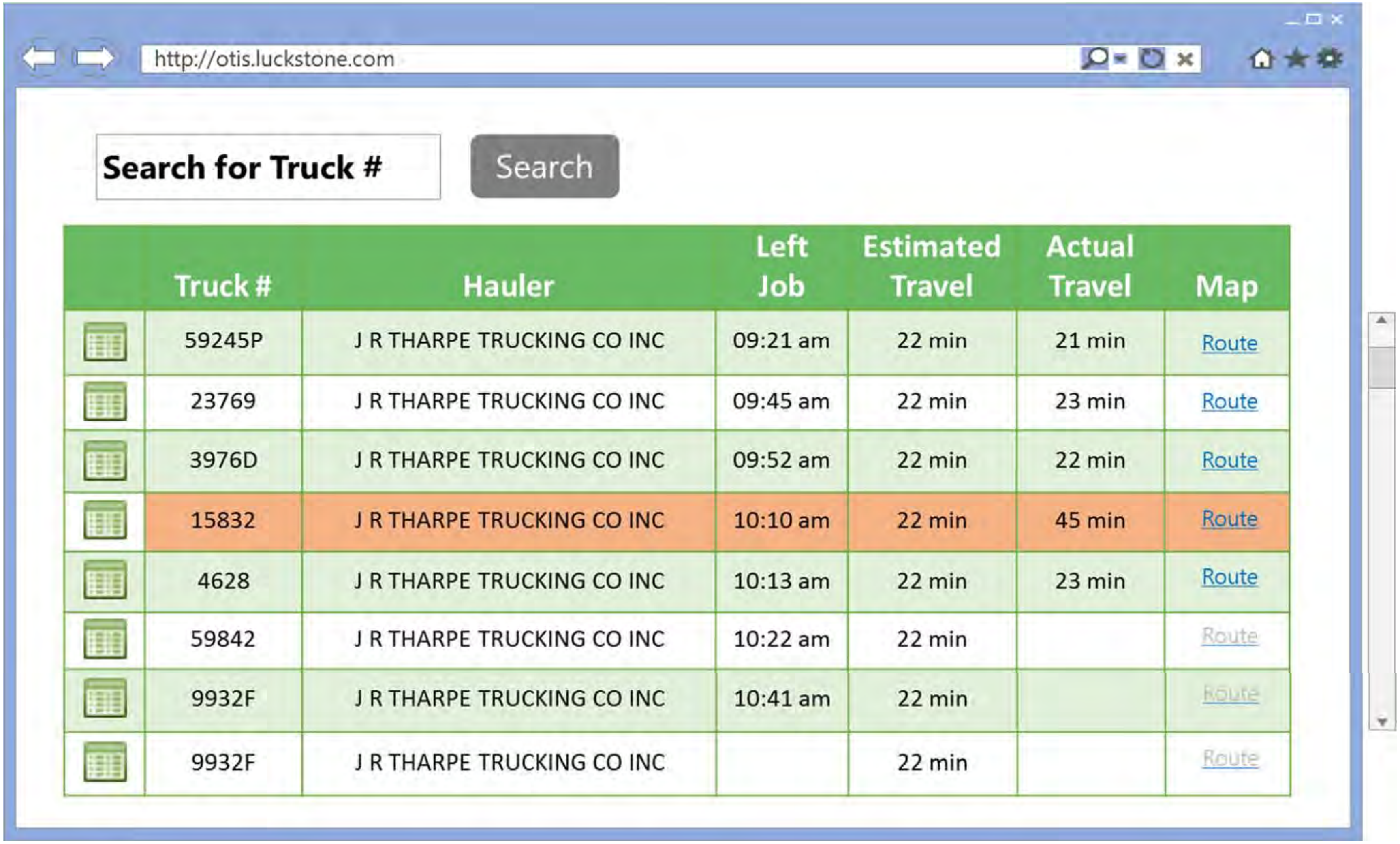
Note 3: Polychlorinated biphenyls (CAS RN 1336-36-3); this category contains congener chemicals, including constituents of Aroclor 1016 (CAS RN 12674-11-2), Aroclor 1221 (CAS RN 11104-28-2), Aroclor 1232 (CAS RN 11141-16-5), Aroclor 1242 (CAS RN 53469-21-9), Aroclor 1248 (CAS RN 12672-29-6), Aroclor 1254 (CAS RN 11097-69-1), and Arclor 1260 (CAS RN 11096-82-5).

Note 4: Toxaphene: This entry includes congener chemicals contained in technical toxaphene (CAS RN 8001-35-2), i.e., chlorinated camphene.

Note 5: Xylene (total): This entry includes o-xylene (CAS RN 96-47-6), m-xylene (CAS RN 108-38-3), p-xylene (CAS RN 106-42-3), and unspecified xylenes (dimethylbenzenes) (CAS RN 1330-20-7).

Appendix 2
QuickHaul Application Information


Loaded
Thank you! You are marked as loaded. We will see you in about 25 minutes!
Customer Name
Job Name
Product
Time

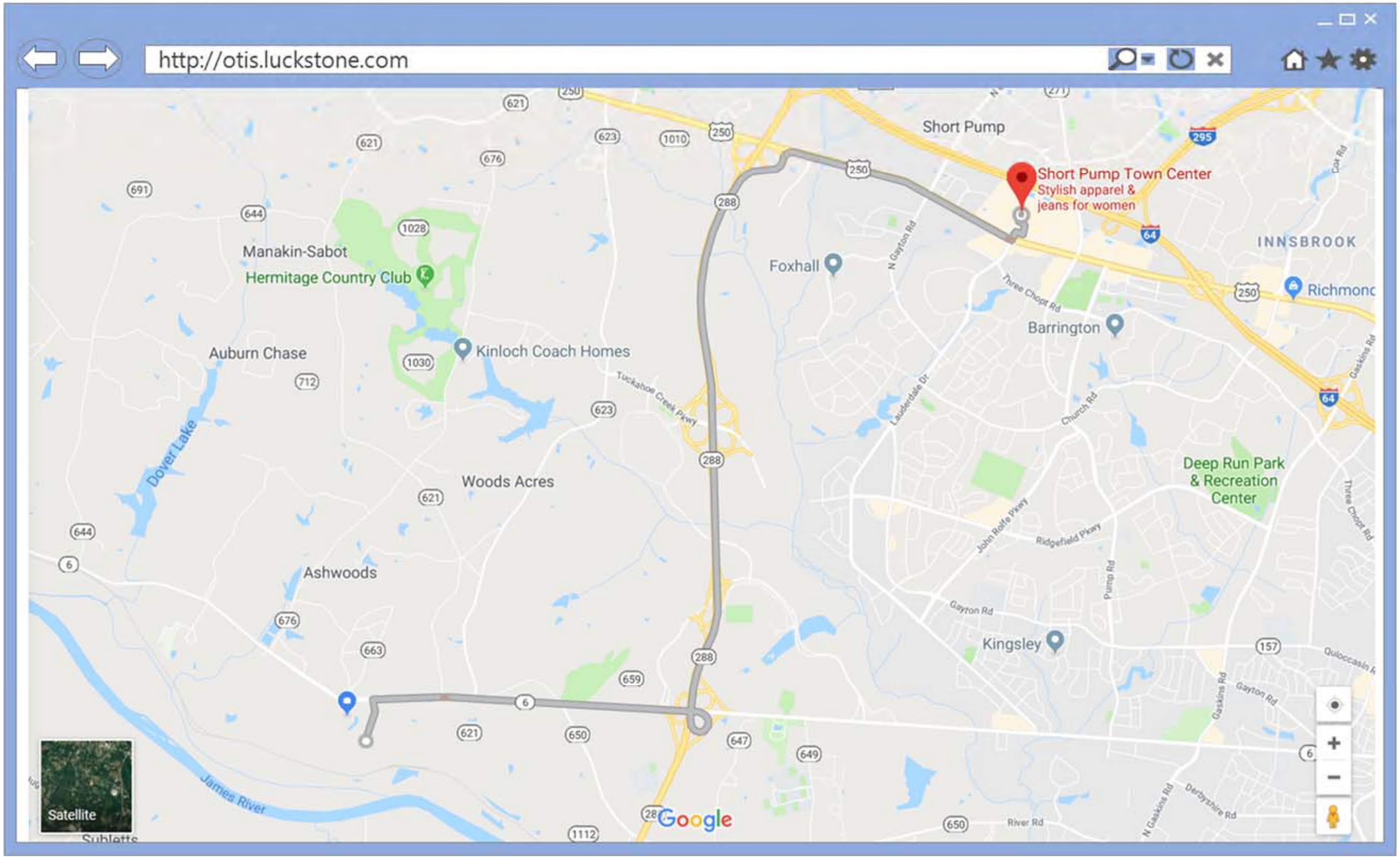


http://otis.luckstone.com

Search for Truck #

Search

	Truck #	Hauler	Left Job	Estimated Travel	Actual Travel	Map
	59245P	J R THARPE TRUCKING CO INC	09:21 am	22 min	21 min	Route
	23769	J R THARPE TRUCKING CO INC	09:45 am	22 min	23 min	Route
	3976D	J R THARPE TRUCKING CO INC	09:52 am	22 min	22 min	Route
	15832	J R THARPE TRUCKING CO INC	10:10 am	22 min	45 min	Route
	4628	J R THARPE TRUCKING CO INC	10:13 am	22 min	23 min	Route
	59842	J R THARPE TRUCKING CO INC	10:22 am	22 min		Route
	9932F	J R THARPE TRUCKING CO INC	10:41 am	22 min		Route
	9932F	J R THARPE TRUCKING CO INC		22 min		Route


http://otis.luckstone.com
Short Pump
Short Pump Town Center
Stylish apparel &
jeans for women
INNSBROOK
Richmond
Foxhall
Barrington
Manakin-Sabot
Hermitage Country Club
Auburn Chase
Kinloch Coach Homes
Dover Lake
Woods Acres
Deep Run Park
& Recreation
Center
Ashwoods
Kingsley
James River
Satellite

Appendix 3
Random Load Inspection Form

Fairfax Plant Reclamation Fill Plan
Random Load Inspection Form

Inspector(s):____

Transporter Name:____
Address:____
Phone Number:____

Vehicle Type:____
Vehicle License Number:_______________________________________
Drivers Name:____

Was the Clean Fill Manifest Profile reviewed? ☐ Yes ☐ No

Date Approved:______________________

Types of Waste Observed:______________________________________
____
____
____

Collect a grab sample and analyze for specified parameters in the Reclamation Fill Plan

Date of Sample Collection:______________ Date Lab Results Furnished:________________

Compare results to specified parameters in the Reclamation Fill Plan.

Did results meet criteria?

☐ Yes
☐ No

Reviewers Initials & Date:____________________

Actions Taken:

☐ Load acceptable for fill
☐ Prohibited media identified and appropriate parties notified
☐ Other, please explain in Additional Comments

Additional Comments:____
____
____

Inspectors Signature:____
Date:______________________________ Time:__________________________

Appendix 4

Groundwater, Surface Water, and Soil Laboratory Analyte List and Screening Levels

Groundwater, Surface Water, and Soil Laboratory Analyte List and Screening Levels

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	Acenaphthene	83-32-9	53	990	17.2
	Acenaphthylene	208-96-8	12	---[g]	66.3
Acetone	Acetone	67-64-1	1,400	---	1.25
	Acetonitrile; Methyl cyanide	75-05-8	13	---	---
	Acetophenone	98-86-2	190	---	0.472
	2-Acetylaminofluorene; 2-AAF	53-96-3	0.16	---	---
	Acrolein	107-02-8	0.0042	3	---
Acrylonitrile	Acrylonitrile	107-13-1	0.41	2.5	---
	Aldrin	309-00-2	0.0092	0.0005	0.00336
	Allyl chloride	107-05-1	0.21	---	---
	4-Aminobiphenyl	92-67-1	0.03	---	---
	Anthracene	120-12-7	180	40,000	185
Antimony	Antimony	(Total)	6	640	2.71
Arsenic	Arsenic	(Total)	10	150	2.91
Barium	Barium	(Total)	2,000	---	822
Benzene	Benzene	71-43-2	5	510	0.0246
	Benzo[a]anthracene; Benzanthracene	56-55-3	0.3	0.18	0.644
	Benzo[b]fluoranthene	205-99-2	2.5	0.18	1.82
	Benzo[k]fluoranthene	207-08-9	25	0.18	18.2
	Benzo[g,h,i]perylene	191-24-2	12	---	19,400
	Benzo[a]pyrene	50-32-8	0.2	0.18	8.87
	Benzyl alcohol	100-51-6	200	---	---
Beryllium	Beryllium	(Total)	4	---	31.6
	alpha-BHC	319-84-6	0.072	0.049	0.000461
	beta-BHC	319-85-7	0.25	0.17	0.00158
	delta-BHC	319-86-8	---	---	0.00151

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	gamma-BHC; Lindane	58-89-9	0.2	1.8	0.0106
	Bis(2-chloroethoxy)methane	111-91-1	5.9	---	0.00624
	Bis(2-chloroethyl) ether; Dichloroethyl ether	111-44-4	0.14	5.3	0.0000254
	Bis(2-chloro-1-methylethyl) ether; 2, 2'-Dichlorodiisopropyl ether; DCIP	108-60-1, See Note 1	71	65,000	---
	Bis(2-ethylhexyl)phthalate	117-81-7	6	22	38.0
Bromochloromethane;.Chlorobromomethane	Bromochloromethane;.Chlorobromomethane	74-97-5	8.3	---	0.017
Bromodichloromethane;.Dibromochloromethane	Bromodichloromethane;.Dibromochloromethane	75-27-4	1.3	170	0.35
Bromoform; Tribromomethane	Bromoform; Tribromomethane	75-25-2	33	1,400	0.516
	4-Bromophenyl phenyl ether	101-55-3	---	---	---
	Butyl benzyl phthalate; Benzyl butyl phthalate	85-68-7	160	1,900	56.4
Cadmium	Cadmium	(Total)	5	1.1	3.78
Carbon disulfide	Carbon disulfide	75-15-0	81	---	0.548
Carbon tetrachloride	Carbon tetrachloride	56-23-5	5	16	0.0794
	Chlordane	See Note 2	2	0.0043	14.5
	p-Chloroaniline	106-47-8	3.7	---	---
Chlorobenzene	Chlorobenzene	108-90-7	100	1,600	1.40
	Chlorobenzilate	510-15-6	3.1	---	---
	p-Chloro-m-cresol; 4-Chloro-3-methylphenol	59-50-7	140	2,000	7.47
Chloroethane; Ethyl chloride	Chloroethane; Ethyl chloride	75-00-3	2,100	---	5.58
Chloroform; Trichloromethane	Chloroform; Trichloromethane	67-66-3	2.2	11,000	0.311
	2-Chloronaphthalene	91-58-7	75	1,600	7.0
	2-Chlorophenol	95-57-8	9.1	150	0.173

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	4-Chlorophenyl phenyl ether	7005-72-3	---	---	---
	Chloroprene	126-99-8	0.19	---	---
Chromium	Chromium	(Total)	100	---	19.1
	Chrysene	218-01-9	250	0.018	64.4
Cobalt	Cobalt	(Total)	0.6	---	0.212
Copper	Copper	(Total)	1,300	9	5,570
	m-Cresol; 3-methyphenol	108-39-4	93	---	0.437
	o-Cresol; 2-methyphenol	95-48-7	93	---	0.429
	p-Cresol; 4-methyphenol	106-44-5	190	---	0.819
	Cyanide	57-12-5	200	5.2	20.0
	2,4-D; 2,4-Dichlorophenoxyacetic acid	94-75-7	70	12,000	---
	4,4'-DDD	72-54-8	0.0063	0.0031	13.9
	4,4'-DDE	72-55-9	0.46	0.0022	4.71
	4,4'-DDT	50-29-3	1	0.001	21.4
	Diallate	2303-16-4	5.4	---	---
	Dibenz[a,h]anthracene	53-70-3	0.25	0.18	0.427
	Dibenzofuran	132-64-9	0.79	---	0.391
Dibromochloromethane; Chlorodibromomethane	Dibromochloromethane; Chlorodibromomethane	124-48-1	8.7	130	0.42
1,2-Dibromo-3-chloropropane; DBCP	1,2-Dibromo-3-chloropropane; DBCP	96-12-8	0.2	---	0.00109
1,2-Dibromoethane; Ethylene dibromide; EDB	1,2-Dibromoethane; Ethylene dibromide; EDB	106-93-4	0.05	---	0.000181
	Di-n-butyl phthalate	84-74-2	90	4,500	176
o-Dichlorobenzene; 1,2-Dichlorobenzene	o-Dichlorobenzene; 1,2-Dichlorobenzene	95-50-1	600	1,300	21.2
	m-Dichlorobenzene; 1,3-Dichlorobenzene	541-73-1	75	960	0.0225

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
p-Dichlorobenzene; 1,4-Dichlorobenzene	p-Dichlorobenzene; 1,4-Dichlorobenzene	106-46-7	75	190	3.39
	3,3'-Dichlorobenzidine	91-94-2	1.3	0.28	0.0187
trans-1,4-Dichloro-2-butene	trans-1,4-Dichloro-2-butene	110-57-6	0.013	---	---
	Dichlorodifluoromethane; CFC 12;	75-71-8	20	---	0.595
1.1-Dichloroethane; Ethylidene chloride	1,1-Dichloroethane; Ethylidene chloride	75-34-3	28	---	0.00796
1,2-Dichloroethane; Ethylene dichloride	1,2-Dichloroethane; Ethylene dichloride	107-06-2	5	370	0.0107
1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	75-35-4	7	7,100	0.0456
cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	156-59-2	70	---	0.242
trans-1,2-Dichloroethylene	trans-1,2-Dichloroethylene; trans-1,2-Dichroroethene	156-60-5	100	10,000	0.498
	2,4-Dichlorophenol	120-83-2	4.6	290	0.0345
	2,6-Dichlorophenol	87-65-0	---	---	---
1,2-Dichloropropane; Propylene dichloride	1,2-Dichloropropane; Propylene dichloride	78-87-5	5	150	0.0199
	1,3-Dichloropropane; Trimethylene dichloride	142-28-9	37	---	0.00152
	2, 2-Dichloropropane; isopropylidene chloride	594-20-7	---	---	---
	1,1-Dichloropropene	563-58-6	---	---	---
cis-1,3-Dichloropropene	cis-1,3-Dichloropropene	10061-01-5	3.9	---	0.00156
trans-1,3-Dichloropropene	trans-1,3-Dichloropropene	10061-02-6	3.9	---	0.00164
	Dieldrin	60-57-1	0.018	0.00054	0.000434
	Diethyl phthalate	84-66-2	1,500	44,000	18.8

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	O,O-Diethyl O-2-pyrazinyl phosphorothioate; Thionazin	297-97-2	---	---	---
	Dimethoate	60-51-5	4.4	---	---
	p-(Dimethylamino)azobenzene	60-11-7	0.05	---	---
	7,12-Dimethylbenz[a]anthracene	57-97-6	0.001	---	---
	3,3'-Dimethylbenzidine	119-93-7	0.065	---	---
	2,4-Dimethylphenol; m-Xylenol	105-67-9	36	850	0.323
	Dimethyl phthalate	131-11-3	---	1,100,000	---
	m-Dinitrobenzene	99-65-0	0.2	---	---
	4,6-Dinitro-o-cresol; 4,6-Dinitro-2-methylphenol	534-52-1	0.15	280	0.000136
	2,4-Dinitrophenol	51-28-5	3.9	5,300	0.003
	2,4-Dinitrotoluene	121-14-2	2.4	34	0.00139
	2,6-Dinitrotoluene	606-20-2	0.49	---	0.00592
	Dinoseb; DNBP; 2-sec-Butyl-4,6-dinitrophenol	88-85-7	7	---	---
	Di-n-octyl phthalate	117-84-0	20	---	---
	Diphenylamine	122-39-4	130	---	---
	Disulfoton	298-04-4	0.05	---	---
	Endosulfan I	959-96-8	10	0.056	1.73
	Endosulfan II	33213-65-9	10	0.056	1.73
	Endosulfan sulfate	1031-07-8	10	89	1.27
	Endrin	72-20-8	2	0.036	0.589
	Endrin aldehyde	7421-93-4	2	0.3	0.231
Ethylbenzene	Ethylbenzene	100-41-4	700	2,100	16.8
	Ethyl methacrylate	97-63-2	63	---	---
	Ethylmethanesulfonate	62-50-0	---	---	---
	Famphur	52-85-7	---	---	---
	Fluoranthene	206-44-0	80	140	278

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	Fluorene	86-73-7	29	5,300	17.0
	Heptachlor	76-44-8	0.4	0.00079	0.425
	Heptachlor epoxide	1024-57-3	0.2	0.00039	2.44
	Hexachlorobenzene	118-74-1	1	0.0029	9.96
	Hexachlorobutadiene	87-68-3	0.65	180	0.781
	Hexachlorocyclopentadiene	77-47-4	50	1,100	270
	Hexachloroethane	67-72-1	0.62	33	0.347
	Hexachloropropene	1888-71-7	---	---	---
2-Hexanone; Methyl butyl ketone	2-Hexanone; Methyl butyl ketone	591-78-6	3.8	---	0.00645
	Indeno[1,2,3-cd]pyrene	193-39-5	2.5	0.18	5.16
	Isobutyl alcohol	78-83-1	590	---	---
	Isodrin	465-73-6	---	---	---
	Isophorone	78-59-1	380	9,600	0.243
	Isosafrole	120-58-1	---	---	---
	Kepone	143-50-0	0.035	0	---
Lead	Lead	(Total)	15	11	135
	Mercury	(Total)	2	0.77	1.04
	Methacrylonitrile	126-98-7	0.19	---	---
	Methapyrilene	91-80-5	---	---	---
	Methoxychlor	72-43-5	40	0.03	134
Methyl bromide; Bromomethane	Methyl bromide; Bromomethane	74-83-9	0.75	1,500	0.00148
Methyl chloride; Chloromethane	Methyl chloride; Chloromethane	74-87-3	19	---	0.0392
	3-Methylcholanthrene	56-49-5	0.011	---	---
Methyl ethyl ketone; MEK; 2-Butanone	Methyl ethyl ketone; MEK; 2-Butanone	78-93-3	560	---	0.552
Methyl iodide; Iodomethane	Methyl iodide; Iodomethane	74-88-4	---	---	---
	Methyl methacrylate	80-62-6	140	---	---
	Methyl methanesulfonate	66-27-3	7.9	---	---
	2-Methylnaphthalene	91-57-6	3.6	---	1.01

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	Methyl parathion; Parathion methyl methyl	298-00-0	0.45	---	---
4-Methyl-2-pentanone; Methyl isobutyl ketone	4-Methyl-2-pentanone; Methyl isobutyl ketone	108-10-1	630	---	0.164
Methylene bromide; Dibromomethane	Methylene bromide; Dibromomethane	74-95-3	0.83	---	---
Methylene chloride; Dichloromethane	Methylene chloride; Dichloromethane	75-09-2	5	5,900	0.00936
	Naphthalene	91-20-3	0.61	---	0.0149
	1,4-Naphthoquinone	130-15-4	---	---	---
	1- Naphthylamine	134-32-7	---	---	---
	2-Napthylamine	91-59-8	0.39	---	---
Nickel	Nickel	(Total)	---	---	19.5
	o-Nitroaniline; 2-Nitroaniline	88-74-4	19	---	0.0743
	m-Nitroaniline; 3-Nitroaniline	99-09-2	---	---	---
	p-Nitroaniline; 4-Nitroaniline	100-01-6	7.8	---	0.00791
	Nitrobenzene	98-95-3	1.3	690	0.000595
	o-Nitrophenol; 2-Nitrophenol	88-75-5	---	---	---
	p-Nitrophenol; 4-Nitrophenol	100-02-7	---	---	---
	N-Nitrosodi-n-butylamine	924-16-3	0.027	0.22	---
	N-Nitrosodiethylamine	55-18-5	0.0017	1.24	---
	N-Nitrosodimethylamine	62-75-9	0.0011	30	---
	N-Nitrosodiphenylamine	86-30-6	120	60	0.727
	N-Nitrosodipropylamine; N-Nitroso-N-dipropylamine; Di-n-propylnitrosamine	621-64-7	0.11	5.1	0.0000214
	N-Nitrosomethylethalamine	10595-95-6	0.0071	---	---
	N-Nitrosopiperidine	100-75-4	0.082	---	---
	N-Nitrosopyrrolidine	930-55-2	0.37	34	---

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	5-Nitro-o-toluidine	99-55-8	38	---	---
	Parathion	56-38-2	8.6	0.013	---
	Pentachlorobenzene	608-93-5	0.32	0.1	---
	Pentachloronitrobenzene	82-68-8	1.2	---	---
	Pentachlorophenol	87-86-5	1	6.7	0.0365
	Phenacetin	62-44-2	340	---	---
	Phenanthrene	85-01-8	12	---	160
	Phenol	108-95-2	580	860,000	1
	p-Phenylenediamine	106-50-3	2	---	---
	Phorate	298-02-2	0.3	---	---
	Polychlorinated biphenyls; PCBS; Aroclors	See Note 3	0.5	0.00064	---
	Pronamide	23950-58-5	120	---	---
	Propionitrile; Ethyl cyanide	107-12-0	---	---	---
	Pyrene	129-00-0	12	4,000	32.7
	Safrole	94-59-7	0.96	---	---
Selenium	Selenium	(Total)	50	5	2.55
Silver	Silver	(Total)	9.4	---	0.596
	Silvex; 2,4,5-TP	93-72-1	50	400	---
Styrene	Styrene	100-42-5	100	---	4.89
	Sulfide	18496-25-8	---	---	---
	2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid	93-76-5	16	---	---
	1,2,4,5-Tetrachlorobenzene	95-94-3	0.17	0.03	0.394
1,1,1,2-Tetrachloroethane	1,1,1,2-Tetrachloroethane	630-20-6	5.7	---	0.00999
1,1,2,2-Tetrachloroethane	1,1,2,2-Tetrachloroethane	79-34-5	0.76	40	0.000438
Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	127-18-4	5	33	0.189

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])
	2,3,4,6-Tetrachlorophenol	58-90-2	24	---	3.05
Thallium	Thallium	(Total)	---	---	1.42
	Tin	(Total)	1,200	---	---
Toluene	Toluene	108-88-3	1,000	6,000	11.9
	o-Toluidine	95-53-4	47	---	---
	Toxaphene	See Note 4	3	0.0002	9.86
	1,2,4-Trichlorobenzene	120-82-1	70	70	7.21
1,1,1-Trichloroethane; Methychloroform	1,1,1-Trichloroethane; Methychloroform	71-55-6	200	200,000	1.81
1,1,2-Trichloroethane	1,1,2-Trichloroethane	79-00-5	5	160	0.0205
Trichloroethylene; Trichloroethene ethene	Trichloroethylene; Trichloroethene ethane	79-01-6	5	300	0.0386
Trichlorofluoromethane; CFC-11	Trichlorofluoromethane; CFC-11	75-69-4	520	---	1.74
	2,4,5-Trichlorophenol	95-95-4	120	600	8.82
	2,4,6-Trichlorophenol	88-06-2	1.2	24	0.0838
1,2,3-Trichloropropane	1,2,3-Trichloropropane	96-18-4	0.0075	---	---
	O,O,O-Triethyl phosphorothioate	126-68-1	---	---	---
	sym-Trinitrobenzene	99-35-4	59	---	---
Vanadium	Vanadium	(Total)	8.6	---	78.0
Vinyl acetate	Vinyl acetate	108-05-4	41	---	---
Vinyl chloride; Chloroethene	Vinyl chloride; Chloroethene	75-01-4	2	24	0.00792
Xylene(total)	Xylene(total)	See Note 5	10,000	---	243
Zinc	Zinc	(Total)	600	120	292

[a]Corresponds with parameters within Table 3.1 of the Virginia Solid Waste Groundwater Management Regulations (9VAC20-81-250).

[b]CAS RN = Chemical Abstracts Service Registry Number. Where "Total" is entered, all species in the groundwater that contain this analyte are included.

[c]VRP = Voluntary Remediation Program.

[d]µg/L = micrograms per liter.

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)	Beneficial Fill Groundwater Protection Soil Screening Level[e] (soil to groundwater) (mg/kg[f])

[e]Obtained from Virginia Department of Environmental Quality Memorandum No. LPR-SW-04-2012, dated July 17, 2012, titled Management and Reuse of Contaminated Media.

[f]mg/kg = milligrams per kilogram.

[g]--- = screening level does not exist for this analyte

Note 1: This substance is often called Bis(2-chloroisopropyl) ether, the name Chemical Abstracts Service applies to its noncommercial isomer, Propane, 2.2'-oxybis2-chloro (CAS RN 39638-32-9).

Note 2: Chlordane: This entry includes alpha-chlordane (CAS RN 5103-71-9), beta-chlordane (CAS RN 5103-74-2), gamma-chlordane (CAS RN 5566-34-7), and constituents of chlordane (CAS RN 57-74-9 and CAS RN 12739-03-6).

Note 3: Polychlorinated biphenyls (CAS RN 1336-36-3); this category contains congener chemicals, including constituents of Aroclor 1016 (CAS RN 12674-11-2), Aroclor 1221 (CAS RN 11104-28-2), Aroclor 1232 (CAS RN 11141-16-5), Aroclor 1242 (CAS RN 53469-21-9), Aroclor 1248 (CAS RN 12672-29-6), Aroclor 1254 (CAS RN 11097-69-1), and Arclor 1260 (CAS RN 11096-82-5).

Note 4: Toxaphene: This entry includes congener chemicals contained in technical toxaphene (CAS RN 8001-35-2), i.e., chlorinated camphene.

Note 5: Xylene (total): This entry includes o-xylene (CAS RN 96-47-6), m-xylene (CAS RN 108-38-3), p-xylene (CAS RN 106-42-3), and unspecified xylenes (dimethylbenzenes) (CAS RN 1330-20-7).

Appendix 5
Sequence Drawings

LEGEND:

PROPERTY LINE	
UNDISTURBED BUFFER	
LIMITS OF EXCAVATION	
UNPAVED ROAD	
2' CONTOUR - EXISTING	
10' CONTOUR - EXISTING	-20
2' CONTOUR - PROPOSED	
10' CONTOUR - PROPOSED	10
TREELINE	

DO NOT USE FOR CONSTRUCTION

100 50 0 100 200
GRAPHIC SCALE IN FEET

SEQUENCE OF FILL GRADING PLAN NO. 1

NORTH QUARRY FILL-IN SEQUENCE

FAIRFAX PLANT

FOR

LUCKSTONE CORPORATION

CENTREVILLE, VIRGINIA

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers
(478) 743-7175
(478) 743-7175 (FAX)
3920 ARKWRIGHT RD.
SUITE 101
MACON, GEORGIA 31210

PROJ. NO.	4780-013-01	DWG. LSFF-NQ-S1	EDIT 02-20-2019
SCALE	1" = 100'	DRAWING 1	
DATE	FEBRUARY 2019		

DISCLAIMER:
ACTUAL GRADING IS SUBJECT TO MODIFICATION TO ACCOUNT FOR FIELD CONDITIONS, MATERIALS PLACED, AND DEWATERING PROCEDURES. TEMPORARY SLOPES WILL BE NO STEEPER THAN 2:1.

NOTES:
1. EXISTING CONDITIONS SHOWN ARE A COMBINATION OF TOPOGRAPHIC INFORMATION FROM SEPTEMBER 27, 2018 INSIDE OF THE PIT AND TOPOGRAPHIC INFORMATION FROM MAY 19, 2014 OUTSIDE OF THE PIT.

LEGEND:

- PROPERTY LINE
- UNDISTURBED BUFFER
- LIMITS OF EXCAVATION
- UNPAVED ROAD
- 2' CONTOUR - EXISTING
- 10' CONTOUR - EXISTING (20)
- 2' CONTOUR - PROPOSED
- 10' CONTOUR - PROPOSED (100)
- TREELINE

DO NOT USE FOR CONSTRUCTION

100 50 0 100 200
GRAPHIC SCALE IN FEET

DISCLAIMER:
ACTUAL GRADING IS SUBJECT TO MODIFICATION TO ACCOUNT FOR FIELD CONDITIONS, MATERIALS PLACED, AND DEWATERING PROCEDURES. TEMPORARY SLOPES WILL BE NO STEEPER THAN 2:1.

NOTES:
1. EXISTING CONDITIONS SHOWN ARE A COMBINATION OF TOPOGRAPHIC INFORMATION FROM SEPTEMBER 27, 2018 INSIDE OF THE PIT AND TOPOGRAPHIC INFORMATION FROM MAY 19, 2014 OUTSIDE OF THE PIT.

SEQUENCE OF FILL GRADING PLAN NO. 2

NORTH QUARRY FILL-IN SEQUENCE
FAIRFAX PLANT
FOR
LUCKSTONE CORPORATION
CENTREVILLE, VIRGINIA

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PROJ. NO.	4780-013-01	DWG. LSFF-NQ-S2	EDIT 02-20-2019
SCALE	1" = 100'	DRAWING 2	
DATE	FEBRUARY 2019		

LEGEND:

- PROPERTY LINE
- UNDISTURBED BUFFER
- LIMITS OF EXCAVATION
- UNPAVED ROAD
- 2' CONTOUR - EXISTING
- 10' CONTOUR - EXISTING
- 2' CONTOUR - PROPOSED
- 10' CONTOUR - PROPOSED
- TREELINE

DO NOT USE FOR CONSTRUCTION

100 50 0 100 200
GRAPHIC SCALE IN FEET

DISCLAIMER:
ACTUAL GRADING IS SUBJECT TO MODIFICATION TO ACCOUNT FOR FIELD CONDITIONS, MATERIALS PLACED, AND DEWATERING PROCEDURES. TEMPORARY SLOPES WILL BE NO STEEPER THAN 2:1.

NOTES:
1. EXISTING CONDITIONS SHOWN ARE A COMBINATION OF TOPOGRAPHIC INFORMATION FROM SEPTEMBER 27, 2018 INSIDE OF THE PIT AND TOPOGRAPHIC INFORMATION FROM MAY 19, 2014 OUTSIDE OF THE PIT.

SEQUENCE OF FILL GRADING PLAN NO. 3

NORTH QUARRY FILL-IN SEQUENCE
FAIRFAX PLANT
FOR
LUCKSTONE CORPORATION
CENTREVILLE, VIRGINIA

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PROJ. NO.	4780-013-01	DWG. LSFF-NQ-S3	EDIT 02-20-2019
SCALE	1" = 100'	DRAWING 3	
DATE	FEBRUARY 2019		

DISCLAIMER:
ACTUAL GRADING IS SUBJECT TO MODIFICATION TO ACCOUNT FOR FIELD CONDITIONS, MATERIALS PLACED, AND DEWATERING PROCEDURES. TEMPORARY SLOPES WILL BE NO STEEPER THAN 2:1.

NOTES:
1. EXISTING CONDITIONS SHOWN ARE A COMBINATION OF TOPOGRAPHIC INFORMATION FROM SEPTEMBER 27, 2018 INSIDE OF THE PIT AND TOPOGRAPHIC INFORMATION FROM MAY 19, 2014 OUTSIDE OF THE PIT.

LEGEND:

PROPERTY LINE	
UNDISTURBED BUFFER	
LIMITS OF EXCAVATION	
UNPAVED ROAD	
2' CONTOUR - EXISTING	
10' CONTOUR - EXISTING	130
2' CONTOUR - PROPOSED	
10' CONTOUR - PROPOSED	170
TREELINE	

DO NOT USE FOR CONSTRUCTION

100 50 0 100 200
GRAPHIC SCALE IN FEET

SEQUENCE OF FILL GRADING PLAN NO. 4

NORTH QUARRY FILL-IN SEQUENCE
FAIRFAX PLANT
FOR
LUCKSTONE CORPORATION
CENTREVILLE, VIRGINIA

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MACON, GEORGIA 31210

PROJ. NO.	4780-013-01	DWG. LSFF-NQ-S4	EDIT 02-20-2019
SCALE	1" = 100'	DRAWING 4	
DATE	FEBRUARY 2019		

LEGEND:

PROPERTY LINE	
UNDISTURBED BUFFER	
LIMITS OF EXCAVATION	
UNPAVED ROAD	
2' CONTOUR - EXISTING	
10' CONTOUR - EXISTING	170
2' CONTOUR - PROPOSED	
10' CONTOUR - PROPOSED	190
TREELINE	

DO NOT USE FOR CONSTRUCTION

100 50 0 100 200
GRAPHIC SCALE IN FEET

DISCLAIMER:
ACTUAL GRADING IS SUBJECT TO MODIFICATION TO ACCOUNT FOR FIELD CONDITIONS, MATERIALS PLACED, AND DEWATERING PROCEDURES. TEMPORARY SLOPES WILL BE NO STEEPER THAN 2:1.

NOTES:
1. EXISTING CONDITIONS SHOWN ARE A COMBINATION OF TOPOGRAPHIC INFORMATION FROM SEPTEMBER 27, 2018 INSIDE OF THE PIT AND TOPOGRAPHIC INFORMATION FROM MAY 19, 2014 OUTSIDE OF THE PIT.

SEQUENCE OF FILL GRADING PLAN NO. 5

NORTH QUARRY FILL-IN SEQUENCE
FAIRFAX PLANT
FOR
LUCKSTONE CORPORATION
CENTREVILLE, VIRGINIA

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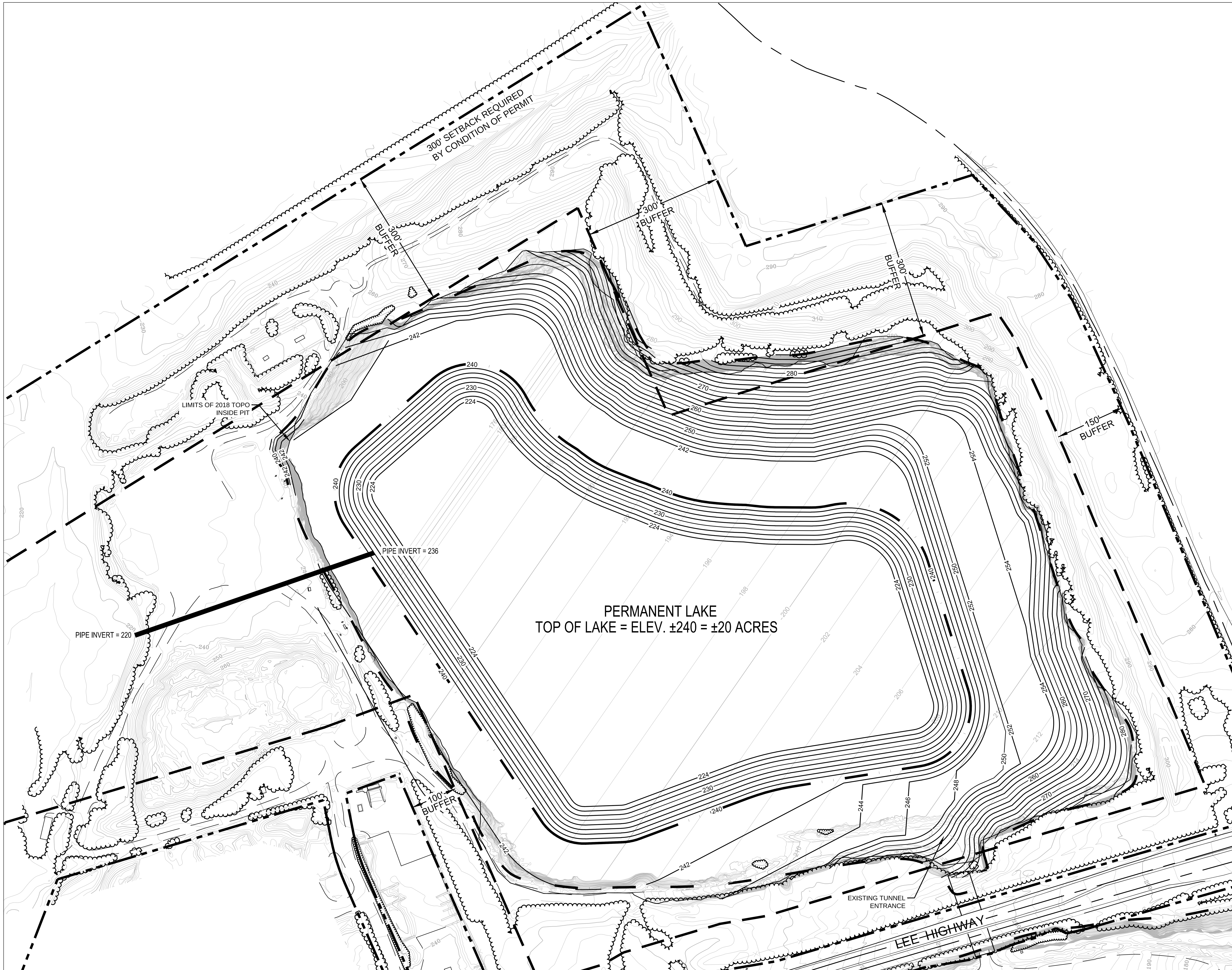
SUITE 101
MACON, GEORGIA 31210

PROJ. NO.	4780-013-01	DWG. LSFF-NQ-S5	EDIT 02-20-2019
SCALE	1" = 100'	DRAWING 5	
DATE	FEBRUARY 2019		



DISCLAIMER:
LAKE DESIGN IS SUBJECT TO MODIFICATIONS WITH FINAL ENGINEERING. THE LAKE WILL COVER NO LESS THAN 20 ACRES.

NOTES:
1. EXISTING CONDITIONS SHOWN ARE A COMBINATION OF TOPOGRAPHIC INFORMATION FROM SEPTEMBER 27, 2018 INSIDE OF THE PIT AND TOPOGRAPHIC INFORMATION FROM MAY 19, 2014 OUTSIDE OF THE PIT.

LEGEND:

- PROPERTY LINE
- UNDISTURBED BUFFER
- LIMITS OF EXCAVATION
- UNPAVED ROAD
- 2' CONTOUR - EXISTING
- 10' CONTOUR - EXISTING (190)
- 2' CONTOUR - PROPOSED
- 10' CONTOUR - PROPOSED (230)
- TREELINE
- PROPOSED PERMANENT LAKE
- PROPOSED PIPE

DO NOT USE FOR CONSTRUCTION

100 50 0 100 200
GRAPHIC SCALE IN FEET

SEQUENCE OF FILL GRADING PLAN NO. 6

NORTH QUARRY FILL-IN SEQUENCE
FAIRFAX PLANT
FOR
LUCKSTONE CORPORATION
CENTREVILLE, VIRGINIA

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SUITE 101
MACON, GEORGIA 31210

PROJ. NO.	4780-013-01	DWG. LSFF-NQ-S6	EDIT 02-20-2019
SCALE	1" = 100'	DRAWING 6	
DATE	FEBRUARY 2019		

DISCLAIMER:
LAKE DESIGN IS SUBJECT TO MODIFICATIONS WITH FINAL ENGINEERING. THE LAKE WILL COVER NO LESS THAN 20 ACRES.

NOTES:
1. EXISTING CONDITIONS SHOWN ARE A COMBINATION OF TOPOGRAPHIC INFORMATION FROM SEPTEMBER 27, 2018 INSIDE OF THE PIT AND TOPOGRAPHIC INFORMATION FROM MAY 19, 2014 OUTSIDE OF THE PIT.

LEGEND:
- PROPERTY LINE
- UNDISTURBED BUFFER
- LIMITS OF EXCAVATION
- UNPAVED ROAD
- 2' CONTOUR - EXISTING
- 10' CONTOUR - EXISTING (230)
- TREELINE
- PERMANENT LAKE
- PIPE

DO NOT USE FOR CONSTRUCTION

100 50 0 100 200
GRAPHIC SCALE IN FEET

FINAL PLAN

NORTH QUARRY FILL-IN SEQUENCE
FAIRFAX PLANT
FOR
LUCKSTONE CORPORATION
CENTREVILLE, VIRGINIA

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MACON, GEORGIA 31210

PROJ. NO.	4780-013-01	DWG. LSFF-NQ-S7	EDIT 02-20-2019
SCALE	1" = 100'	DRAWING 7	
DATE	FEBRUARY 2019		

Appendix 6

Well Inventory Database

Parcel ID	Well Name	ECS Reference ID	Address	Latitude	Longitude	Total Depth (feet)	Date Drilled	Static Depth to Water Level (feet)	Static Water Level Year	Static Groundwater Elevation (feet)	Yield (gpm)	Depth to Bedrock (feet)	Water-Bearing Zones (feet)	Comments
064 01 0033A	Vulcan Well	1	LUCK STONE PROPERTY	38.820383	-77.493153	---	---	---	---	---	---	---	---	Luck Stone Well
0641 01 0038	Superior Well	2	15717 LEE HY	38.82212471	-77.49359642	520	3/13/08	---	---	---	50	---	318, 340, 490	Luck Stone Well
0641 01 0034	Smith Well	3	7101 BULL RUN POST OFFICE RD	38.82149123	-77.48767861	560	3/15/01	45	2001	---	20	22	541-551	Luck Stone Well
0641 04 0007A	PW-1	4	LUCK STONE PROPERTY	38.830133	-77.495281	540	4/22/16	---	---	-28	30	12	440-460, 480-500	Luck Stone Well
0641 04 0007A	OW-1	5	LUCK STONE PROPERTY	38.830125	-77.495406	500	4/26/16	---	---	-23	30	15	420-440	Luck Stone Well
0641 01 0031	Naylor Well	6	6919 BULL RUN POST OFFICE RD	38.82528056	-77.48629454	480	3/1/99	20	1999	---	25	18	449-450	Luck Stone Well
0641 01 0017B	Mine Well	7	15717 LEE HY	38.82634511	-77.4923066	500	10/23/09	100	2009	---	20	6	450-455	Luck Stone Well
0641 01 0023	Haggard Well	8	6911 BULL RUN POST OFFICE RD	38.82648914	-77.48570935	500	1970?	95	1970	---	10	21	480	Luck Stone Well
0641 04 0005	Concrete Plant Well	9	15700 LEE HY	38.82812686	-77.49479694	---	---	---	---	---	---	---	---	Luck Stone Well
0641 01 0036	Barr Well	10	7121 BULL RUN POST OFFICE RD	38.81981319	-77.4853664	210	1/5/89	100	1989	---	7	10	130-135, 165-170	Luck Stone Well
0533 01 0013	---	11	6766 BULL RUN POST OFFICE RD	38.83645036	-77.49721735	400	9/18/95	60	1995	---	30+	35	300-310	---
0632 01 0001	---	12	6780 BULL RUN POST OFFICE RD	38.83244496	-77.49982531	500	12/10/15	60	2015	172	20+	28	240-242, 345-347	Pre-1980 well abandoned in 2016
0632 01 0007	---	13	16001 LEE HY	38.82210772	-77.5003836	---	---	---	---	---	---	---	---	---
0632 01 0009Z	---	14	16009 LEE HY	38.82140659	-77.50090167	---	---	---	---	---	---	---	---	---
0641 01 0006	---	15	15500 LEE HY	38.82886483	-77.48520121	723	10/30/85	133	1985		50	13	715	---
0641 01 0010	---	16	15509 LEE HY	38.82726911	-77.48396456	---	pre 1978	---	---	---	---	---	---	---
0641 01 0018	---	17	15900 LEE HY	38.82634061	-77.49640891	420	8/14/95	50	1995		20	40	355-360	Older site well abandoned in 2008
0641 01 0019	---	18	15901 LEE HY	38.82495914	-77.49632688	320	11/2/93	40	1993		6	6	125-130, 280-285	---
0641 01 0021	---	19	15907 LEE HY	38.82425883	-77.49722362	305	8/12/87	18	1987		30	18	260	Abandoned?
0641 01 0022	---	20	15911 LEE HY	38.82422664	-77.49840965	310	11/17/88	50	1988		25	15	100-105, 260-270	Abandoned?
0641 01 0024	---	21	6915 BULL RUN POST OFFICE RD	38.82594035	-77.48316427	---	---	---	---	---	---	---	---	---
0641 01 0028	---	22	6917 BULL RUN POST OFFICE RD	38.82500028	-77.48299586	540	7/7/95	70	1995	---	2	10	---	---
0641 01 0033	---	23	7100 BULL RUN POST OFFICE RD	38.81806961	-77.49524817	---	---	---	---	---	---	---	---	---
0641 01 0037	---	24	15917 LEE HY	38.82446393	-77.49962595	---	---	---	---	---	---	---	---	---
0641 03 0002	---	25	15320 LEE HY	38.82987674	-77.47925995	---	pre 1962	---	---	---	---	---	---	---
0641 03 0017	---	26	15321 LEE HY	38.82899408	-77.47924838	17.5	6/27/72	---	---	---	---	---	---	---
0641 04 0007Z	---	27	15950 LEE HY	38.82916101	-77.49789065	500	3/26/12	40	2012	---	20+	18	368-369, 468-473	---
0643 01 0003	---	28	7301 BULL RUN POST OFFICE RD	38.81706187	-77.48791486	200	5/27/92	60	1992	---	20	5	80-85, 135-140, 175-180	---
0643 01 0005	---	29	15500 COMPTON RD	38.81834174	-77.48374186	---	---	---	---	---	---	---	---	---
0643 01 0006	---	30	15420 COMPTON RD	38.81849707	-77.48247176	---	---	---	---	---	---	---	---	---
0643 01 0007A	---	31	15412 COMPTON RD	38.81854349	-77.48200537	---	pre 1962	---	---	---	---	---	---	---
0643 01 0010	---	32	15400 COMPTON RD	38.81939354	-77.48000788	---	pre 1962	---	---	---	---	---	---	---
0643 01 0012	---	33	15407 COMPTON RD	38.81870222	-77.48034378	---	---	---	---	---	---	---	---	---
0643 01 0015	---	34	15501 COMPTON RD	38.81770866	-77.48331026	300	10/11/10	---	---	---	12	5	125, 175, 256	---
0643 01 0016	---	35	15600 COMPTON RD	38.8156848	-77.48617573	420	9/28/12	220	2012	---	20	28	295-297, 373-378	---
0643 01 0017	---	36	15602 COMPTON RD	38.81485183	-77.48793317	200	10/30/96	31	1996	---	20	27	180	---
0643 01 0018	---	37	15610 COMPTON RD	38.81498026	-77.48906174	410	6/7/12	180	2012	---	100	18	385, 405	---
0643 01 0018A	---	38	15620 COMPTON RD	38.81447985	-77.49025224	383	3/13/09	170	2009	---	60	3	248-250, 370	---
0643 01 0023	---	39	7120 BULL RUN POST OFFICE RD	38.81841676	-77.49632109	---	---	---	---	---	---	---	---	---
0643 02 0021	---	40	7401 BULL RUN DR	38.81355775	-77.48967733	300	2/2/12	180	2012	---	60	5	200-210, 235, 257	---
0643 02 0022	---	41	15607 COMPTON RD	38.81402178	-77.48815584	420	7/31/12	240	2012	---	33	---	390-393	---

Appendix 7
Monitoring and Mitigation Plan (MMP)

ECS Mid-Atlantic, LLC

Monitoring and Mitigation Plan

Luck Stone Fairfax Quarry
Centreville, Virginia
ECS Project No. 47:7563

July 1, 2020

July 1, 2020

Mr. Anthony Venafro
Luck Stone Corporation – Northern Region Office
106 Harrison Street SE, Suite 200
Leesburg, Virginia 20175

ECS Project No. 47-7563

Reference: Monitoring and Mitigation Plan
Luck Stone Fairfax Quarry

Dear Mr. Venafro:

ECS Mid-Atlantic, LLC (ECS) is pleased to provide Luck Stone Corporation with the following Monitoring and Mitigation Plan for the Luck Stone Fairfax Quarry. If there are any questions regarding this report, or a need for further information, please contact the undersigned at (540) 785-6608.

Respectfully Submitted,

ECS MID-ATLANTIC, LLC

Michael L. Maloy

Michael L. Maloy, C.P.G.
Principal Geologist

Thomas P. Nelson, C.P.G.
Senior Hydrogeologist

Monitoring and Mitigation Plan
Luck Stone Fairfax Quarry
Centreville, Virginia

CLIENT

Mr. Anthony Venafro
Land Use Development Manager
Luck Stone Corporation – Northern Region Office
106 Harrison Street SE, Suite 200
Leesburg, Virginia 20175

SUBMITTED BY

ECS Mid-Atlantic, LLC
4004 Hunterstand Court, Suite 102
Charlottesville, Virginia 22911

PROJECT	47-7563
DATE	July 1, 2020

Monitoring and Mitigation Plan
Luck Stone Fairfax Quarry
Centreville, Virginia

ECS PROJECT NO. 47-7563

FIGURES

TABLES

APPENDICES

1.0 INTRODUCTION

The Monitoring and Mitigation Plan, hereinafter referred to as the MMP, has been prepared for Luck Stone's planned reclamation fill facility at its Fairfax Quarry site. A site location map has been provided as Figure 1. The MMP addresses monitoring prior to filling activities to enable assessment of background conditions and also long-term monitoring activities that will be implemented for the duration of planned filling activity. Monitoring activities have been proposed to address identified sensitive receptors which include the bedrock groundwater aquifer, surface water, and air quality.

The MMP also addresses mitigation measures that will be followed in the event that monitored concentrations exceeding selected screening levels and/or background conditions are deemed to have the potential to pose a threat to identified sensitive receptors.

2.0 GROUNDWATER MONITORING

2.1 Groundwater Monitoring Wells

A total of seven (7) bedrock groundwater monitoring wells have been proposed for the groundwater monitoring program. The well network will consist of five existing wells and two proposed well locations. Existing wells were formerly used for aquifer testing (PW-1), were formerly used for water supply (MW-2, MW-4, and MW-5), or are actively used for water supply (MW-3). Locations for proposed wells PMW-A and PMW-B were selected to provide spatial coverage of the site at locations accessible to a drilling rig. The planned depth of these wells is 450 feet. Only bedrock monitoring wells are planned to be used for monitoring because overburden is documented to be very thin and is likely unsaturated. The monitoring wells will be used for sample collection of groundwater from the bedrock aquifer and also for measurement of groundwater surface elevation. A summary of existing well construction information as well as planned construction details for proposed monitoring wells has been provided in Table 1. Figure 2 depicts the locations of the existing and proposed monitoring wells and the approximate boundaries of the quarry's existing North Pit and South Pit.

Table 1: Monitoring Well Construction Summary.

Well	Well Status	Total Well Depth (feet bgs[a])	Air-Lift Well Yield (gpm[b])
PW-1	Existing	540	30
MW-2	Existing	TBM[c]	Unknown
MW-3	Existing	500	20
MW-4	Existing	480	25
MW-5	Existing	500	10
PMW-A	Planned	450	TBD[c]
PMW-B	Planned	450	TBD[c]

[a]bgs = below ground surface
[b]gpm = gallons per minute
[c]TBM / TBD = to be measured / to be determined

2.2 Monitoring Intervals and Sampling

The bedrock monitoring wells will be subject to the following schedule.

- Background groundwater gauging and sampling data will be collected during a one year period, during which time eight sampling events will occur at a frequency of approximately once every 6–7 weeks. Groundwater samples will be collected from the bedrock wells and be measured for the following field parameters: turbidity, pH, specific conductivity, and temperature. These parameters will be measured using properly calibrated field instrumentation. Additionally, groundwater samples will be collected and submitted for laboratory analysis of parameters listed in Column B of Table 3.1 within the Virginia Solid Waste Groundwater Management Regulations (9VAC20-81-250. *Groundwater Monitoring Program*). Column B parameters, which are referred to in this document as Phase II Comprehensive Analytes, include select metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), Pesticides, and Herbicides. A list of Phase II Comprehensive Analytes is included within Appendix A.

- Following the commencement of pit filling activities, groundwater monitoring will be conducted on a semi-annual basis (i.e., two events per year). Samples collected during these monitoring events will be submitted for laboratory analysis of parameters contained within Column A of Table 3.1 within the Virginia Solid Waste Groundwater Management Regulations (9VAC20-81-250. *Groundwater Monitoring Program*). Column A parameters, which are referred to in this document as Phase I Primary Analytes, include select metals and VOCs. If an exceedance of site-specific Groundwater Protection Standards (GPSs), as described within the Fill Reclamation Plan, for any Phase I Priority Analytes list compound is determined, a verification sample for that parameter shall be collected within 30 days of notification of the result. At any time during the 30 days, Luck Stone may enlist a 3rd party for data validation. Following the validation of an exceeded groundwater concentration, a groundwater sample from the well exhibiting the exceedance will be submitted during subsequent monitoring events for an expanded suite of laboratory parameters to consist of Phase II Comprehensive Analytes parameters. The laboratory suite may then be reduced back to the Phase I Priority Analytes list if four consecutive monitoring events occur where concentrations are below the applicable GPS. A list of Phase I Priority Analytes is included within Appendix A.

2.3 Sampling Methodology

Groundwater samples will be collected utilizing low-flow sampling techniques where applicable in accordance with the Quality Assurance Project Plan (QAPP) and Sampling and Analysis Plan (SAP) which has been provided as Appendix B. To determine stabilized conditions during purging, the stabilization indicators shown in Table 2 will be used prior to sample collection. The flow rate used to achieve a stable pumping level will remain constant while monitoring the indicator parameters for stabilization and while collecting the samples. A summary of proposed groundwater sampling activities is provided in Table 3.

Table 2: Low-Flow Sampling Stabilization Criteria.

Field Parameter	Stabilized Parameter Indicator (measured at 5 minute intervals)
Turbidity	10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized
Dissolved Oxygen	10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized
Specific Conductivity	3%
Temperature	3%
pH	± 0.1 unit
Oxidation Reduction Potential	±10 millivolts

Note: Stability is deemed to have been achieved when three consecutive readings have met the stabilized parameter indicator threshold.

Table 3: Groundwater Monitoring Summary.

Bedrock Monitoring Wells	Sampling/Gauging Frequency	Sampling Parameters
PW-1 MW-2 MW-3 MW-4 MW-5 PMW-A PMW-B	*Background Monitoring:* Eight monitoring events over a one year period. *Active Operation Monitoring:* Semi-annual.	*Field Parameters*: Turbidity, pH, Specific Conductivity, and Temperature. *Laboratory Parameters*[a]*:* Phase I Priority Analytes List = select metals and VOCs[b]; Phase II Comprehensive Analytes List = select metals, VOCs, SVOCs[c], PCBs[d], Pesticides, and Herbicides.

[a]See Appendix A for complete list of Phase I and Phase II analytes
[b]VOCs = volatile organic compounds
[c]SVOCs = semi-volatile organic compounds
[d]PCBs = polychlorinated biphenyls

3.0 SURFACE WATER MONITORING

3.1 Surface Water Monitoring Location

Currently, water generated from North Pit dewatering is discharged via an existing outfall permitted by the Virginia Pollutant Discharge Elimination System (VPDES), as shown in Figure 3. The permitted outfall contributes to a tributary of Bull Run at a location approximately ¾-mile upstream of the tributary's convergence with Bull Run. Surface water sampling at the VPDES outfall will be conducted at the point of discharge into surface water via the grab method.

3.2 Monitoring Intervals and Sampling

Surface water sampling will be subject to the following schedule.

- Background surface water sampling data will be collected during a one year period, during which time eight sampling events will occur at a frequency of approximately once every 6–7 weeks. Surface water samples will be collected from the site's existing VPDES outfall located to the west of the facility's South Pit to be measured for the following field parameters: turbidity, pH, specific conductivity, and temperature. These parameters will be measured using properly calibrated field instrumentation. Additionally, surface water samples will be collected and submitted for laboratory analysis of parameters listed in Column B of Table 3.1 within the Virginia Solid Waste Groundwater Management Regulations (9VAC20-81-250. *Groundwater Monitoring Program*). Column B parameters, which are referred to in this document as Phase II Comprehensive Analytes, include select metals, VOCs, SVOCs, PCBs, Pesticides, and Herbicides. A list of Phase II Comprehensive Analytes is included within Appendix A.

- Following the commencement of pit filling activities, surface water monitoring will be conducted on a semi-annual basis (i.e., two events per year). Samples collected during these monitoring events will be submitted for laboratory analysis of parameters contained within Column A of Table 3.1 within the Virginia Solid Waste Groundwater Management Regulations (9VAC20-81-250. *Groundwater Monitoring Program*). Column A parameters, which are referred to in this document as Phase I Primary Analytes, include select metals and VOCs. If an exceedance of site-specific Surface Water Protection Standards (SWPSs), as described within the Fill Reclamation Plan, for any Phase I Priority Analytes list compound is determined, a verification sample for that parameter shall be collected within 30 days of notification of the result. At any time during the 30 days, Luck Stone may enlist a 3rd party for data validation. Following the validation of an exceeded surface water concentration, surface water samples will be submitted during subsequent monitoring events for an expanded suite of laboratory parameters to consist of Phase II Comprehensive Analytes parameters. The laboratory suite may then be reduced back to the Phase I Priority Analytes list if four consecutive monitoring events occur where concentrations are below the applicable SWPS. A list of Phase I Priority Analytes is included within Appendix A.

3.3 Sampling Methodology

Surface water samples will be collected in accordance with ECS's QAPP and SAP, which is included as Appendix B. A summary of proposed surface water sampling activities is provided in Table 4.

Table 4: Surface Water Monitoring Summary.

Surface Water Sampling Location	Sampling Frequency	Sampling Parameters
Existing VPDES[a]-Permitted Outfall Located to the West of the Facility's South Pit	*Background Monitoring:* Eight monitoring events over a one year period. *Active Operation Monitoring:* Semi-annual.	*Field Parameters*: Turbidity, pH, Specific Conductivity, and Temperature. *Laboratory Parameters[b]:* Phase I Priority Analytes List = select metals and VOCs[c]; Phase II Comprehensive Analytes List = select metals, VOCs, SVOCs[d], PCBs[e], Pesticides, and Herbicides.

[a]VPDES = Virginia Pollutant Discharge Elimination System
[b]See Appendix A for complete list of Phase I and Phase II analytes
[c]VOCs = volatile organic compounds
[d]SVOCs = semi-volatile organic compounds
[e]PCBs = polychlorinated biphenyls

4.0 DUST CONTROL

Facility staff will visually assess for the presence of airborne dust continuously and apply dust suppression measures (wetting of surfaces) immediately upon discovery. Haul roads and work areas will receive regular applications of water to control dust. Areas where reclamation activities are not being conducted in the foreseeable future may be vegetated to minimize both dust and erosion.

5.0 SAMPLING QUALITY ASSURANCE AND QUALITY CONTROL

The monitoring program will generally conform to applicable sections of the QAPP and SAP, which is included as Appendix B.

6.0 REPORTING

Laboratory data results (groundwater and surface water) will be provided in tabular format within annual monitoring reports. The first year of monitoring, during which time eight monitoring events will occur, will be used to evaluate background concentrations of detected parameters. Following the initial one year of background monitoring, the report will include a laboratory results summary table to include site-specific GPSs and SWPSs, as established based on background concentrations and Virginia Voluntary Remediation Program Tier II Residential Groundwater Screening Levels and Fresh Surface Water Screening Levels, in accordance with the site's Fill Reclamation Plan.
Comprehensive annual monitoring reports will be prepared that document the sampling methodology and laboratory results, and will include a discussion of findings along with conclusions and recommendations.

7.0 MITIGATION MEASURES

In the event that monitored contaminant concentrations are found to exceed site-specific GPSs or SWPSs and are deemed to have the potential to pose a threat to identified sensitive receptors, mitigation action will be performed to limit contaminant migration and to protect identified sensitive receptors.

Groundwater monitoring results will be used to assess groundwater quality in the bedrock aquifer. The monitoring well network may be expanded, if necessary, to enable additional sampling if contaminant migration is observed. Likewise, extension of the planned monitoring effort may occur if contaminant migration were documented near the end of the filling operations. Monitoring results would be used to guide subsurface characterization activity deemed necessary to develop a corrective action plan (CAP). The CAP would be developed with an objective of establishing remediation strategies as warranted to protect sensitive receptors deemed at risk. A CAP would identify specific implementation measures required to protect identified sensitive receptors. Efforts would focus on measures to avoid contaminant migration. In the event that groundwater quality was impacted and deemed to affect an off-site neighboring well following the initiation of reclamation filling activities, Luck Stone will provide water or a new well to the affected person, as well as initiate corrective action for groundwater impacts. The VDEQ will also be notified, along with Fairfax County, of any confirmed results that exceed groundwater protection standards.

The VPDES permitted outfall is obligated to meet permit requirements for water quality. If outfall sampling performed during the monitoring program identifies water quality concerns from the discharge at the site, remedial strategies will be developed as may be necessary to mitigate impact to sensitive environmental receptors.

Dust control methods have been included in the reclamation plan, which includes wetting of surface areas and vegetating areas where reclamation work will not be occurring in the foreseeable future. In the event that complaints are received, the complaints will be reviewed in a timely manner and an expeditious response will be provided. Should air quality concerns be identified, dust control efforts will be re-evaluated to ensure adequate dust control measures are being performed on the site.

8.0 REFERENCES

[VDEQ] Virginia Department of Environmental Quality 2012. Management and Reuse of Contaminated Media. Solid Waste Guidance Memorandum LPR-SW-04-2012, dated 7/17/2012, sent to Regional Land Protection & Revitalization Program Managers and Regional Water Program Managers.

[VDEQ] Virginia Department of Environmental Quality 2018. Voluntary Remediation Program Screening Levels for Groundwater and Surface Water. Updated May 2018.

Figures

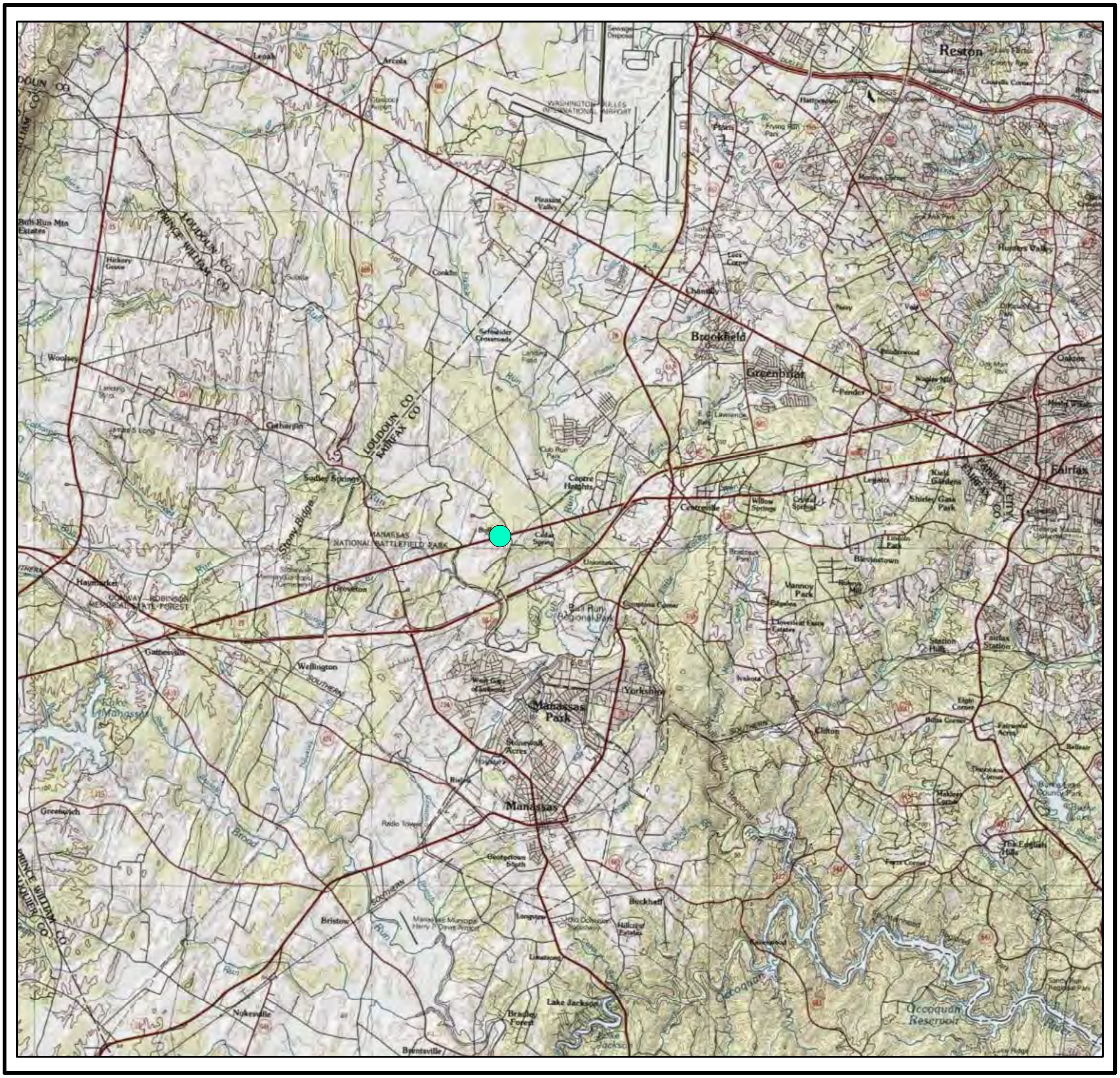


Figure 1: Site Location Map

Monitoring and Mitigation Plan
Luck Stone Fairfax Quarry

Legend

Luck Stone Fairfax Quarry

N

0 1 2 4
Miles

ECS Project No. 47-7563

Figure 2: Proposed Bedrock Monitoring Wells

Monitoring and Mitigation Plan
Luck Stone Fairfax Quarry

Legend

Luck Stone Fairfax Quarry

North Pit Boundary

South Pit Boundary

Monitoring Wells

Existing Well

Planned Well

N

0 250 500 1,000 Feet

ECS Project No. 47-7563

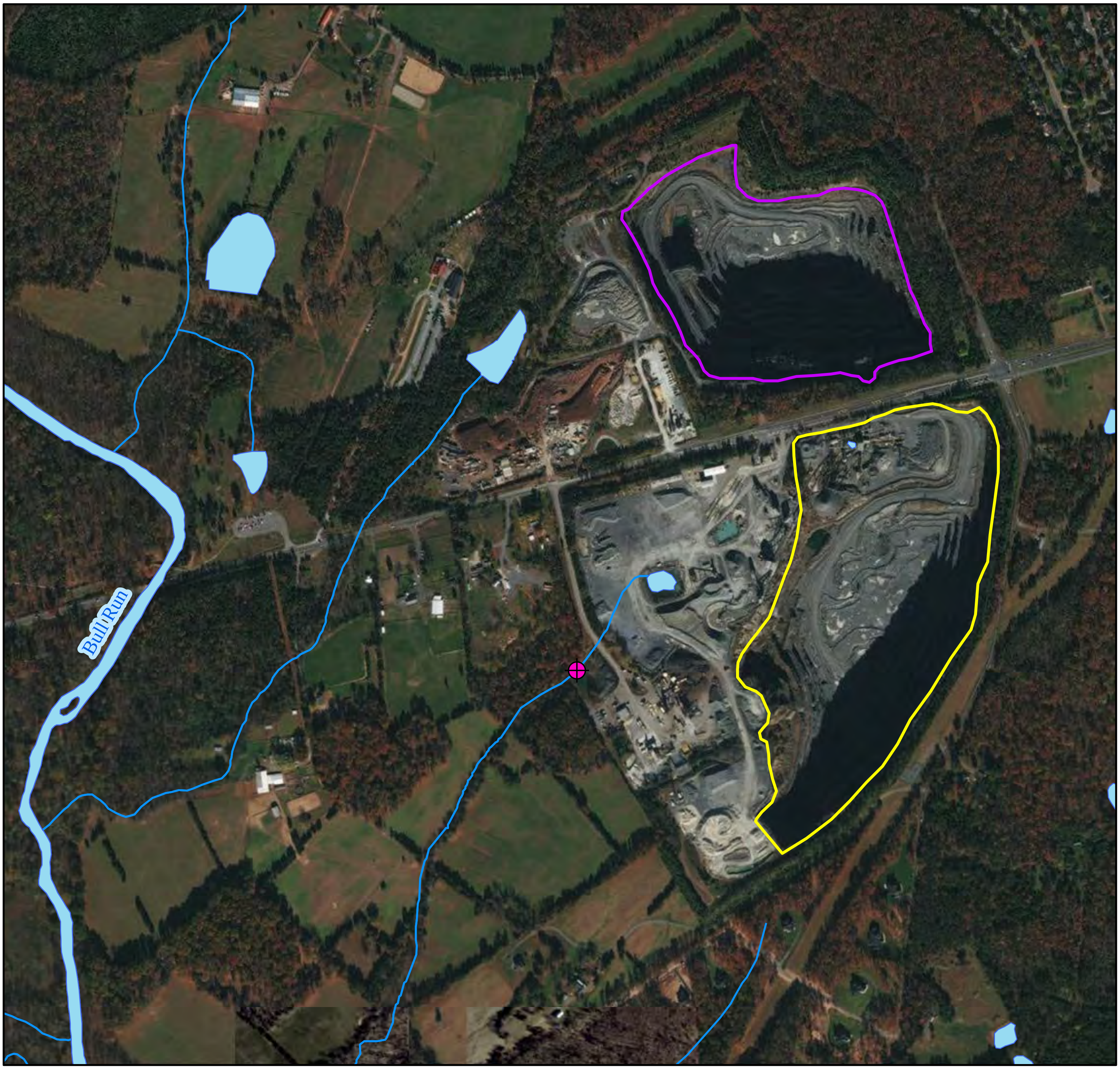


Figure 3: Proposed Surface Water Sampling Location

Monitoring and Mitigation Plan
Luck Stone Fairfax Quarry

Legend

Luck Stone Fairfax Quarry

North Pit

South Pit

Surface Water Sampling Location (VPDES Outfall)

Surface Waterbody

Stream

N

0 500 1,000 2,000
Feet

ECS Project No. 47-7563

Appendix A

Laboratory Sampling Parameter List

Groundwater and Surface Water Laboratory Analyte List and Screening Levels

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)
	Acenaphthene	83-32-9	53	990
	Acenaphthylene	208-96-8	12	---[e]
Acetone	Acetone	67-64-1	1,400	---
	Acetonitrile; Methyl cyanide	75-05-8	13	---
	Acetophenone	98-86-2	190	---
	2-Acetylaminofluorene; 2-AAF	53-96-3	0.16	---
	Acrolein	107-02-8	0.0042	3
Acrylonitrile	Acrylonitrile	107-13-1	0.41	2.5
	Aldrin	309-00-2	0.0092	0.0005
	Allyl chloride	107-05-1	0.21	---
	4-Aminobiphenyl	92-67-1	0.03	---
	Anthracene	120-12-7	180	40,000
Antimony	Antimony	(Total)	6	640
Arsenic	Arsenic	(Total)	10	150
Barium	Barium	(Total)	2,000	---
Benzene	Benzene	71-43-2	5	510
	Benzo[a]anthracene; Benzanthracene	56-55-3	0.3	0.18
	Benzo[b]fluoranthene	205-99-2	2.5	0.18
	Benzo[k]fluoranthene	207-08-9	25	0.18
	Benzo[g,h,i]perylene	191-24-2	12	---
	Benzo[a]pyrene	50-32-8	0.2	0.18
	Benzyl alcohol	100-51-6	200	---
Beryllium	Beryllium	(Total)	4	---
	alpha-BHC	319-84-6	0.072	0.049
	beta-BHC	319-85-7	0.25	0.17
	delta-BHC	319-86-8	---	---
	gamma-BHC; Lindane	58-89-9	0.2	1.8
	Bis(2-chloroethoxy)methane	111-91-1	5.9	---

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)
	Bis(2-chloroethyl) ether; Dichloroethyl ether	111-44-4	0.14	5.3
	Bis(2-chloro-1-methylethyl) ether; 2, 2'-Dichlorodiisopropyl ether; DCIP	108-60-1, See Note 1	71	65,000
	Bis(2-ethylhexyl)phthalate	117-81-7	6	22
Bromochloromethane;.Chlorobromomethane	Bromochloromethane;.Chlorobromomethane	74-97-5	8.3	---
Bromodichloromethane;.Dibromochloromethane	Bromodichloromethane;.Dibromochloromethane	75-27-4	1.3	170
Bromoform; Tribromomethane	Bromoform; Tribromomethane	75-25-2	33	1,400
	4-Bromophenyl phenyl ether	101-55-3	---	---
	Butyl benzyl phthalate; Benzyl butyl phthalate	85-68-7	160	1,900
Cadmium	Cadmium	(Total)	5	1.1
Carbon disulfide	Carbon disulfide	75-15-0	81	---
Carbon tetrachloride	Carbon tetrachloride	56-23-5	5	16
	Chlordane	See Note 2	2	0.0043
	p-Chloroaniline	106-47-8	3.7	---
Chlorobenzene	Chlorobenzene	108-90-7	100	1,600
	Chlorobenzilate	510-15-6	3.1	---
	p-Chloro-m-cresol; 4-Chloro-3-methylphenol	59-50-7	140	2,000
Chloroethane; Ethyl chloride	Chloroethane; Ethyl chloride	75-00-3	2,100	---
Chloroform; Trichloromethane	Chloroform; Trichloromethane	67-66-3	2.2	11,000
	2-Chloronaphthalene	91-58-7	75	1,600
	2-Chlorophenol	95-57-8	9.1	150
	4-Chlorophenyl phenyl ether	7005-72-3	---	---
	Chloroprene	126-99-8	0.19	---
Chromium	Chromium	(Total)	100	---
	Chrysene	218-01-9	250	0.018

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)
Cobalt	Cobalt	(Total)	0.6	---
Copper	Copper	(Total)	1,300	9
	m-Cresol; 3-methyphenol	108-39-4	93	---
	o-Cresol; 2-methyphenol	95-48-7	93	---
	p-Cresol; 4-methyphenol	106-44-5	190	---
	Cyanide	57-12-5	200	5.2
	2,4-D; 2,4-Dichlorophenoxyacetic acid	94-75-7	70	12,000
	4,4'-DDD	72-54-8	0.0063	0.0031
	4,4'-DDE	72-55-9	0.46	0.0022
	4,4'-DDT	50-29-3	1	0.001
	Diallate	2303-16-4	5.4	---
	Dibenz[a,h]anthracene	53-70-3	0.25	0.18
	Dibenzofuran	132-64-9	0.79	---
Dibromochloromethane; Chlorodibromomethane	Dibromochloromethane; Chlorodibromomethane	124-48-1	8.7	130
1,2-Dibromo-3-chloropropane; DBCP	1,2-Dibromo-3-chloropropane; DBCP	96-12-8	0.2	---
1,2-Dibromoethane; Ethylene dibromide; EDB	1,2-Dibromoethane; Ethylene dibromide; EDB	106-93-4	0.05	---
	Di-n-butyl phthalate	84-74-2	90	4,500
o-Dichlorobenzene; 1,2-Dichlorobenzene	o-Dichlorobenzene; 1,2-Dichlorobenzene	95-50-1	600	1,300
	m-Dichlorobenzene; 1,3-Dichlorobenzene	541-73-1	75	960
p-Dichlorobenzene; 1,4-Dichlorobenzene	p-Dichlorobenzene; 1,4-Dichlorobenzene	106-46-7	75	190
	3,3'-Dichlorobenzidine	91-94-2	1.3	0.28
trans-1,4-Dichloro-2-butene	trans-1,4-Dichloro-2-butene	110-57-6	0.013	---
	Dichlorodifluoromethane; CFC 12;	75-71-8	20	---

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)
1.1-Dichloroethane; Ethylidene chloride	1,1-Dichloroethane; Ethylidene chloride	75-34-3	28	---
1,2-Dichloroethane; Ethylene dichloride	1,2-Dichloroethane; Ethylene dichloride	107-06-2	5	370
1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	75-35-4	7	7,100
cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	156-59-2	70	---
trans-1,2-Dichloroethylene	trans-1,2-Dichloroethylene; trans-1,2-Dichroroethene	156-60-5	100	10,000
	2,4-Dichlorophenol	120-83-2	4.6	290
	2,6-Dichlorophenol	87-65-0	---	---
1,2-Dichloropropane; Propylene dichloride	1,2-Dichloropropane; Propylene dichloride	78-87-5	5	150
	1,3-Dichloropropane; Trimethylene dichloride	142-28-9	37	---
	2, 2-Dichloropropane; isopropylidene chloride	594-20-7	---	---
	1,1-Dichloropropene	563-58-6	---	---
cis-1,3-Dichloropropene	cis-1,3-Dichloropropene	10061-01-5	3.9	---
trans-1,3-Dichloropropene	trans-1,3-Dichloropropene	10061-02-6	3.9	---
	Dieldrin	60-57-1	0.018	0.00054
	Diethyl phthalate	84-66-2	1,500	44,000
	O,O-Diethyl O-2-pyrazinyl phosphorothioate; Thionazin	297-97-2	---	---
	Dimethoate	60-51-5	4.4	---
	p-(Dimethylamino)azobenzene	60-11-7	0.05	---
	7,12-Dimethylbenz[a]anthracene	57-97-6	0.001	---
	3,3'-Dimethylbenzidine	119-93-7	0.065	---
	2,4-Dimethylphenol; m-Xylenol	105-67-9	36	850

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)
	Dimethyl phthalate	131-11-3	---	1,100,000
	m-Dinitrobenzene	99-65-0	0.2	---
	4,6-Dinitro-o-cresol; 4,6-Dinitro-2-methylphenol	534-52-1	0.15	280
	2,4-Dinitrophenol	51-28-5	3.9	5,300
	2,4-Dinitrotoluene	121-14-2	2.4	34
	2,6-Dinitrotoluene	606-20-2	0.49	---
	Dinoseb; DNBP; 2-sec-Butyl-4,6-dinitrophenol	88-85-7	7	---
	Di-n-octyl phthalate	117-84-0	20	---
	Diphenylamine	122-39-4	130	---
	Disulfoton	298-04-4	0.05	---
	Endosulfan I	959-96-8	10	0.056
	Endosulfan II	33213-65-9	10	0.056
	Endosulfan sulfate	1031-07-8	10	89
	Endrin	72-20-8	2	0.036
	Endrin aldehyde	7421-93-4	2	0.3
Ethylbenzene	Ethylbenzene	100-41-4	700	2,100
	Ethyl methacrylate	97-63-2	63	---
	Ethylmethanesulfonate	62-50-0	---	---
	Famphur	52-85-7	---	---
	Fluoranthene	206-44-0	80	140
	Fluorene	86-73-7	29	5,300
	Heptachlor	76-44-8	0.4	0.00079
	Heptachlor epoxide	1024-57-3	0.2	0.00039
	Hexachlorobenzene	118-74-1	1	0.0029
	Hexachlorobutadiene	87-68-3	0.65	180
	Hexachlorocyclopentadiene	77-47-4	50	1,100
	Hexachloroethane	67-72-1	0.62	33
	Hexachloropropene	1888-71-7	---	---
2-Hexanone; Methyl butyl ketone	2-Hexanone; Methyl butyl ketone	591-78-6	3.8	---

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)
	Indeno[1,2,3-cd]pyrene	193-39-5	2.5	0.18
	Isobutyl alcohol	78-83-1	590	---
	Isodrin	465-73-6	---	---
	Isophorone	78-59-1	380	9,600
	Isosafrole	120-58-1	---	---
	Kepone	143-50-0	0.035	0
Lead	Lead	(Total)	15	11
	Mercury	(Total)	2	0.77
	Methacrylonitrile	126-98-7	0.19	---
	Methapyrilene	91-80-5	---	---
	Methoxychlor	72-43-5	40	0.03
Methyl bromide; Bromomethane	Methyl bromide; Bromomethane	74-83-9	0.75	1,500
Methyl chloride; Chloromethane	Methyl chloride; Chloromethane	74-87-3	19	---
	3-Methylcholanthrene	56-49-5	0.011	---
Methyl ethyl ketone; MEK; 2-Butanone	Methyl ethyl ketone; MEK; 2-Butanone	78-93-3	560	---
Methyl iodide; Iodomethane	Methyl iodide; Iodomethane	74-88-4	---	---
	Methyl methacrylate	80-62-6	140	---
	Methyl methanesulfonate	66-27-3	7.9	---
	2-Methylnaphthalene	91-57-6	3.6	---
	Methyl parathion; Parathion methyl methyl	298-00-0	0.45	---
4-Methyl-2-pentanone; Methyl isobutyl ketone	4-Methyl-2-pentanone; Methyl isobutyl ketone	108-10-1	630	---
Methylene bromide; Dibromomethane	Methylene bromide; Dibromomethane	74-95-3	0.83	---
Methylene chloride; Dichloromethane	Methylene chloride; Dichloromethane	75-09-2	5	5,900
	Naphthalene	91-20-3	0.61	---
	1,4-Naphthoquinone	130-15-4	---	---
	1- Naphthylamine	134-32-7	---	---

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)
	2-Napthylamine	91-59-8	0.39	---
Nickel	Nickel	(Total)	---	---
	o-Nitroaniline; 2-Nitroaniline	88-74-4	19	---
	m-Nitroaniline; 3-Nitroaniline	99-09-2	---	---
	p-Nitroaniline; 4-Nitroaniline	100-01-6	7.8	---
	Nitrobenzene	98-95-3	1.3	690
	o-Nitrophenol; 2-Nitrophenol	88-75-5	---	---
	p-Nitrophenol; 4-Nitrophenol	100-02-7	---	---
	N-Nitrosodi-n-butylamine	924-16-3	0.027	0.22
	N-Nitrosodiethylamine	55-18-5	0.0017	1.24
	N-Nitrosodimethylamine	62-75-9	0.0011	30
	N-Nitrosodiphenylamine	86-30-6	120	60
	N-Nitrosodipropylamine; N-Nitroso-N-dipropylamine; Di-n-propylnitrosamine	621-64-7	0.11	5.1
	N-Nitrosomethylethalamine	10595-95-6	0.0071	---
	N-Nitrosopiperidine	100-75-4	0.082	---
	N-Nitrosopyrrolidine	930-55-2	0.37	34
	5-Nitro-o-toluidine	99-55-8	38	---
	Parathion	56-38-2	8.6	0.013
	Pentachlorobenzene	608-93-5	0.32	0.1
	Pentachloronitrobenzene	82-68-8	1.2	---
	Pentachlorophenol	87-86-5	1	6.7
	Phenacetin	62-44-2	340	---
	Phenanthrene	85-01-8	12	---
	Phenol	108-95-2	580	860,000
	p-Phenylenediamine	106-50-3	2	---
	Phorate	298-02-2	0.3	---
	Polychlorinated biphenyls; PCBS; Aroclors	See Note 3	0.5	0.00064
	Pronamide	23950-58-5	120	---

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)
	Propionitrile; Ethyl cyanide	107-12-0	---	---
	Pyrene	129-00-0	12	4,000
	Safrole	94-59-7	0.96	---
Selenium	Selenium	(Total)	50	5
Silver	Silver	(Total)	9.4	---
	Silvex; 2,4,5-TP	93-72-1	50	400
Styrene	Styrene	100-42-5	100	---
	Sulfide	18496-25-8	---	---
	2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid	93-76-5	16	---
	1,2,4,5-Tetrachlorobenzene	95-94-3	0.17	0.03
1,1,1,2-Tetrachloroethane	1,1,1,2-Tetrachloroethane	630-20-6	5.7	---
1,1,2,2-Tetrachloroethane	1,1,2,2-Tetrachloroethane	79-34-5	0.76	40
Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	127-18-4	5	33
	2,3,4,6-Tetrachlorophenol	58-90-2	24	---
Thallium	Thallium	(Total)	---	---
	Tin	(Total)	1,200	---
Toluene	Toluene	108-88-3	1,000	6,000
	o-Toluidine	95-53-4	47	---
	Toxaphene	See Note 4	3	0.0002
	1,2,4-Trichlorobenzene	120-82-1	70	70
1,1,1-Trichloroethane; Methychloroform	1,1,1-Trichloroethane; Methychloroform	71-55-6	200	200,000
1,1,2-Trichloroethane	1,1,2-Trichloroethane	79-00-5	5	160
Trichloroethylene; Trichloroethene ethene	Trichloroethylene; Trichloroethene ethane	79-01-6	5	300
Trichlorofluoromethane; CFC-11	Trichlorofluoromethane; CFC-11	75-69-4	520	---
	2,4,5-Trichlorophenol	95-95-4	120	600
	2,4,6-Trichlorophenol	88-06-2	1.2	24

Column A: Phase I Priority Analytes[a]	Column B: Phase II Comprehensive Analytes[a]	CAS RN[b]	Virginia VRP[c] Tier II Residential Groundwater Screening Level (µg/L[d])	Virginia VRP Tier II Surface Water Screening Level (µg/L)
1,2,3-Trichloropropane	1,2,3-Trichloropropane	96-18-4	0.0075	---
	O,O,O-Triethyl phosphorothioate	126-68-1	---	---
	sym-Trinitrobenzene	99-35-4	59	---
Vanadium	Vanadium	(Total)	8.6	---
Vinyl acetate	Vinyl acetate	108-05-4	41	---
Vinyl chloride; Chloroethene	Vinyl chloride; Chloroethene	75-01-4	2	24
Xylene(total)	Xylene(total)	See Note 5	10,000	---
Zinc	Zinc	(Total)	600	120

[a]Corresponds with parameters within Table 3.1 of the Virginia Solid Waste Groundwater Management Regulations (9VAC20-81-250).

[b]CAS RN = Chemical Abstracts Service Registry Number. Where "Total" is entered, all species in the groundwater that contain this analyte are included.

[c]VRP = Voluntary Remediation Program.

[d]µg/L = micrograms per liter.

[e]--- = screening level does not exist for this analyte

Note 1: This substance is often called Bis(2-chloroisopropyl) ether, the name Chemical Abstracts Service applies to its noncommercial isomer, Propane, 2.2'-oxybis2-chloro (CAS RN 39638-32-9).

Note 2: Chlordane: This entry includes alpha-chlordane (CAS RN 5103-71-9), beta-chlordane (CAS RN 5103-74-2), gamma-chlordane (CAS RN 5566-34-7), and constituents of chlordane (CAS RN 57-74-9 and CAS RN 12739-03-6).

Note 3: Polychlorinated biphenyls (CAS RN 1336-36-3); this category contains congener chemicals, including constituents of Aroclor 1016 (CAS RN 12674-11-2), Aroclor 1221 (CAS RN 11104-28-2), Aroclor 1232 (CAS RN 11141-16-5), Aroclor 1242 (CAS RN 53469-21-9), Aroclor 1248 (CAS RN 12672-29-6), Aroclor 1254 (CAS RN 11097-69-1), and Arclor 1260 (CAS RN 11096-82-5).

Note 4: Toxaphene: This entry includes congener chemicals contained in technical toxaphene (CAS RN 8001-35-2), i.e., chlorinated camphene.

Note 5: Xylene (total): This entry includes o-xylene (CAS RN 96-47-6), m-xylene (CAS RN 108-38-3), p-xylene (CAS RN 106-42-3), and unspecified xylenes (dimethylbenzenes) (CAS RN 1330-20-7).

Appendix B

Quality Assurance Project Plan & Sampling and Analysis Plan

QUALITY ASSURANCE PROJECT PLAN (QAPP)
SAMPLING AND ANALYSIS PLAN (SAP)

1.0 BACKGROUND AND OBJECTIVES

1.1 Project Description and Background

Luck Stone Corporation (Luck Stone) owns and operates an existing stone quarry on approximately 210.25 acres located on Lee Highway (Route 29) about 3 miles west of Centerville in Fairfax County, Virginia. The Luck Stone Fairfax Facility is located on both sides of Lee Highway, and generally east of Bull Run Post Office Road (Route 621), in the Centreville area of the Sully Magisterial District. The property is surrounded primarily by residential land zoned R-C to the north, east and south, and by industrial land zoned I-6 to the west. Quarrying has been conducted in two pits – the "North Pit" and the "South Pit". Luck Stone is proposing to begin the reclamation of its quarrying operation by backfilling the North Pit with clean fill generated from specific, tested, and documented sources. Luck Stone expects to reclaim the South Pit in a similar manner in the future, once it is no longer operational.

A Monitoring and Mitigation Plan (MMP) has been developed for the site and is discussed within Section XI of the Reclamation Plan. The MMP provides details on the planned sampling locations, sampling methods, sampling parameters and sampling intervals. As outlined within the MMP, planned sampling of groundwater and surface water would occur prior to filling operations in an effort to establish background concentrations of select parameters. Background sampling would involve conducting eight monitoring events over a 12 month period prior to initiation of filling operations. Long-term monitoring would then continue semi-annually for the life of the filling operations. The MMP also prescribes the measurement of water levels within the monitoring well network to enable assessment of trends in groundwater elevation fluctuation and groundwater flow direction.

1.2 Purpose

This document presents the Quality Assurance Project Plan (QAPP) and Sampling and Analysis Plan (SAP) prepared to support monitoring tasks conducted for Luck Stone's Fairfax Plant Reclamation Fill facility.

The purpose of the QAPP is to verify that procedures used and data collected are of sufficient quality to support technical and management decisions during fill and reclamation of the quarry pit, and the associated monitoring and testing of groundwater discharged during initial dewatering operations. The Plan includes procedures associated with sample collection and handling, laboratory analyses, field instrumentation and data assessment. The primary components of the QAPP are:

- Project Description/Background and Quality Assurance Objectives
- Field Sampling and Sample Custody Procedures
- Analytical and Calibration Procedures
- Data Validation and Reporting
- Quality Control Checks, Performance Audits and Preventative Maintenance
- Data Assessment, Quality Assurance and Corrective Action

1.3 Health and Safety

Environmental field operations will be conducted under the general guidance of Luck Stone's Health and Safety Program. Environmental consultants assisting Luck Stone with monitoring tasks at the site will adhere to their own safety programs as well as meet the criteria of Luck Stone's Safety Program. Health and Safety will include site-specific safety training.

1.4 Subcontractors and Vendors

Subcontractors used by environmental consultants as part of the monitoring tasks may include well drillers and analytical laboratories. Contractors will be appropriately licensed in the Commonwealth of Virginia. Analytical laboratories will maintain in-house QA/QC programs and will be certified under both the National Voluntary Laboratory Accreditation Program (NVLAP) and Virginia Environmental Laboratory Accreditation Program (VELAP) for performing soil, water, and waste analytical procedures.

1.5 Quality Objectives

To ensure the precision, accuracy and completeness of the data obtained, this QAPP describes the necessary quality assurance (QA), quality control (QC), and other technical activities that will be implemented to ensure that the results of the work performed will satisfy the scope of work outlined in the Work Plan.

Quality assurance is an integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected. Quality control is the overall system of technical activities (including checks on sampling and analysis) that measure the performance of a process against defined standards to verify that they meet predefined requirements. Since errors can occur in the field, laboratory, or office, QC must be part of each of these functions.

The QAPP includes the following:

- Sampling design
- Sampling methods
- Sample handling and chain of custody procedures
- Analytical methods
- Quality control
- Instrument/equipment testing, inspection and maintenance
- Instrument calibration; and,
- Data management

Prior to environmental measurement activities, site-specific Data Quality Objectives (DQO) and measurement performance criteria will be determined. DQOs are typically assessed by evaluating PARCC (Precision, Accuracy, Representativeness, Completeness, and Comparability) of all aspects of the data collection process. PARCC is defined as:

1. ***Precision:*** a measure of the reproducibility of analyses under a given set of conditions. Precision is a measure of the scatter of the data when more than one measurement is made on the same sample. Scatter is commonly attributed to sampling activities or chemical analysis. Duplicate samples are collected in the field to assess precision attributable to sampling activities. Replicate analyses are

performed with each test to assess data variability attributable to laboratory analysis. Precision will be expressed as the relative percent difference (RPD). Project managers will indicate their preference as to what sample should be duplicated. For concentrations well above the reporting limit, 20% RPD is acceptable. If concentrations are low, precision will be assessed by difference. Until the analyzing laboratory has collected sufficient data, it is acceptable to arbitrarily set the control limit to that presented in the cited method.

2. ***Accuracy:*** a measure of the bias that exists in a measurement system. Accuracy is a measure of the difference between observed test results and true sample concentration. Inasmuch as true concentrations are not known, accuracy is inferred from recovery data determined from standard reference materials and by matrix spikes. Some methods specify control limits. For those methods that do not, routine accuracy for inorganic parameters is 100 ± 20 % recovery for spikes, and 100 ± 10 % recovery for standard reference materials. For organic parameters the routine accuracy is ± 30% for standard reference materials and 100 ± 50% for matrix spikes. Matrix spike/matrix spike duplicates are used on analyses where contaminants are not routinely detected. Some organic methods require surrogate spikes on each sample, from which accuracy is assessed. Inorganic parameters typically have an accuracy limit of 100 ± 25%, organic parameters are 100 ± 30%, and standard reference materials limits are 100 ± 20%. Until the analyzing laboratory has collected sufficient data, it is acceptable to arbitrarily set the control limit to that presented in the cited method.

3. ***Representativeness:*** the degree sampling data accurately and precisely depict selected characteristics. Representativeness is a measure of how closely the observed test results on the sample matrix reflect the actual site conditions. Sampling procedures must be designed so results represent the matrix being measured. Sample handling protocols for storage, preservation, and transportation have been developed to preserve the representation of the collected samples. Proper documentation will establish that protocols have been followed and sample identification and integrity assured. Transfer blanks, transport blanks, and field duplicates will be used to assess field and transport contamination and method variation. Laboratory method-blanks will be run on a daily basis.

4. ***Completeness:*** the measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under “normal” conditions. It is defined as the total number of samples taken for which valid analytical data are obtained divided by the total number of samples collected and multiplied by 100. For this project at least 90% of all samples tested should yield valid data.

5. ***Comparability:*** the degree of confidence with which one data set can be compared to another. The objective of this parameter is to assure that data developed during the investigation are either directly comparable, or comparable with defined limitations, to literature data or other applicable criteria. Comparability of the data will be maintained by using EPA approved procedures. The analyzing laboratory shall list analytical methods used in their *Quality Systems Manual*.

2.0 SAMPLING AND ANALYSIS PLAN (SAP) PROCEDURES

2.1 Bedrock Well Installation

Bedrock monitor wells will be installed using air rotary percussion methods. The wells will be installed within an approximately 10-inch diameter boring completed through overburden and into competent bedrock. A 6-inch diameter steel casing will then extend from above ground surface to the base of the 10-inch diameter hole. The annular space between the well casing and the outer 10-inch hole will be tremie grouted to form a seal. The well casing will stick up approximately 3 feet and will be fitted with a locking metal cap. In potential traffic areas, the wells will be protected with bollards.

Well top-of-casing elevations will be approximated using publically available 1-meter resolution Lidar data.

2.2 Groundwater Sampling

Groundwater sampling from the monitor wells will be performed by low-flow sampling techniques in general accordance with guidance provided in: USEPA EQASOP-GW4 Region 1 Low-Stress (Low-Flow) SOP Revision Number: 4 Date: July 30, 1996 Revised: September 19, 2017. The sampling procedure will entail the following steps:

A. Initial Water Level
The water level in the well will be measured before installing the pump if a non-dedicated pump is being used. The initial water level is recorded on the purge form or in the field logbook. Water levels will be obtained with an electronic water level meter with measurements taken relative to the top of the well casing to the nearest 0.01 foot. The water level meter will be decontaminated between uses.

B. Install Pump
Lower pump, safety cable, tubing slowly (to minimize disturbance) into the well to the appropriate depth. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well. Pump tubing lengths, above the top of well casing should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to degas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

C. Measure Water Level
Before starting pump, measure water level.

D. Purge Well
From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. This information is recorded on the purge form or in the field logbook.
Start the pump at low speed and slowly increase the speed until discharge occurs. Check water level. Check equipment for water leaks and if present fix or replace the affected equipment. Try to match pumping rate used during previous sampling event(s). Otherwise, adjust pump speed until there is little or no water level drawdown. If the minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging. Monitor and record the water level and pumping rate every five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure

stabilization of the water level. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" somewhat as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. If the initial water level is above the top of the screen do not allow the water level to fall into the well screen. The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

The flow rate used to achieve a stable pumping level should remain constant while monitoring the indicator parameters for stabilization and while collecting the samples. Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (e.g., bladder, peristaltic), and/or the use of dedicated equipment. For new monitoring wells, or wells where the following situation has not occurred before, if the recovery rate to the well is less than 50 mL/min., or the well is being essentially dewatered during purging, the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. The project manager or field team leader will need to make the decision when samples should be collected, how the sample is to be collected, and the reasons recorded on the purge form or in the field logbook. A water level measurement needs to be performed and recorded before samples are collected. If the project manager decides to collect the samples using the pump, it is best during this recovery period that the pump intake tubing not be removed, since this will aggravate any turbidity problems. Samples in this specific situation may be collected without stabilization of indicator field parameters. Note that field conditions and efforts to overcome problematic situations must be recorded in order to support field decisions to deviate from normal procedures described herein.

E. Monitor Indicator Field Parameters

After the water level has stabilized, connect the "T" connector with a valve and the flow-through-cell to monitor the indicator field parameters. If excessive turbidity is anticipated or encountered with the pump startup, the well may be purged for a while without connecting up the flow-through-cell, in order to minimize particulate buildup in the cell (This is a judgment call made by the sampler). Water level drawdown measurements should be made as usual

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, ORP, DO) at a frequency of five minute intervals or greater. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 mLs/min., the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell it would be every ten minutes). If the cell volume cannot be replaced in the five minute interval, then the time between measurements must be increased accordingly. Note: during the early phase of purging, emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments followed by stabilization of indicator parameters. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings are within the following limits:

Turbidity (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),

Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),

Specific Conductance (3%),

Temperature (3%),

pH (± 0.1 unit),

Oxidation/Reduction Potential (±10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Samples for turbidity measurements are obtained before water enters the flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell.

F. Collect Water Samples

When samples are collected for laboratory analyses, the pump's tubing is disconnected from the "T" connector with a valve and the flow-through-cell. The samples are collected directly from the pump's tubing. Samples must not be collected from the flow-through-cell or from the "T" connector with a valve.

VOC samples are normally collected first and directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence. If the pump's flow rate is too high to collect the VOC/dissolved gases samples, collect the other samples first. Lower the pump's flow rate to a reasonable rate and collect the VOC/dissolved gases samples and record the new flow rate.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help ensure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use the following procedure to collect samples: collect non-VOC/dissolved gases samples first, then increase flow rate slightly until the water completely fills the tubing, collect the VOC/dissolved gases samples, and record new drawdown depth and flow rate.

For bladder pumps that will be used to collect VOC or dissolved gas samples, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL VOC vial.

Use pre-preserved sample containers or add preservative, as required by analytical methods, to the samples immediately after they are collected. Check the analytical methods. Label each sample as collected. Samples requiring cooling will be placed into a cooler with ice or refrigerant for delivery to the laboratory.

Sampling equipment and containers will be handled with clean nitrile gloves. Groundwater samples will be labeled and preserved in new laboratory prepared sample containers. Ground-water samples will be analyzed pursuant to Section 5.

In summary groundwater sampling will occur in the following manner.

- Make ready all forms, labels, and the equipment, including calibration:
- Record well location and well number.
- Well Purging with Low Flow Sampling Technique
- Sample Collection
- Parameters shall be sampled in order of decreasing volatility as follows:

    - Volatile Organic Compounds (VOCs)
    - Semi-Volatile Organic Compounds (SVOCs)
    - Other Organics
    - Metals
    - Other Inorganics

- Affix properly completed label to sample container (Section 3.0)
- After collecting the water samples, place bottles immediately in the cooler chilled to 4°C.
- A chain-of-custody form shall be completed for each sample at the time of collection and accompany each sample from the time of collection onward, through all transportation (Section 3.4).
- Secure the monitoring well prior to leaving the well site.

2.3 Surface Water Sampling

Surface water samples will be collected from a permitted outfall by grab method. Sampling will be performed under chain of custody procedures as described in Section 2.2 above. Field instrumentation will be used to measure values of water temperature, turbidity and pH at the time of sampling. These values will be recorded along with the time and location of the sample.

2.4 Laboratory Analysis

Laboratory analyses shall be performed in accordance with Test Methods for Evaluating Solid Waste (USEPA, SW-846). The analytical parameters are those described in the site's Monitoring and Mitigation Plan.

2.5 Sample Designation

Each sample collected will be assigned a sample designation according to the pre-determined numbering system. The sample designation includes in abbreviated form: the sample type, the sample location number, and the depth interval (where applicable). These sample designations will be written in indelible ink on an identification label and attached to each sample container.

Sample types will be designated by matrix as follows:

- MW - monitoring well samples
- SW- surface water samples

At a minimum, each label will contain the following information:

- Site Name
- Sample designation number (field number)
- Sample description (sample type)
- Date sampled

- Time sampled
- Sampler name
- pH adjustment and acid/base used
- Analysis requested

Each sample will be assigned a unique laboratory identification number that will be used for analysis assignment, sample tracking, and data reporting while the samples are at the laboratory.

2.6 Field Data Documentation/Field Logs

Logging of all pertinent data collected during sampling operations will be completed using bound field log books. Each page will be numbered, dated, and signed by the person making the entry. All entries will be made in ink. All sample locations will be recorded and referenced to the site map so that each location is permanently established. Pertinent site information to be supplied in the field log for each task is listed below:

- Name and location of well
- Names of personnel on-site
- All field instruments used, date and time of calibration and calibration checks, method of calibration, standards used
- All field measurement results
- Date, time, and location of all sampling points
- Any factors which could affect sample integrity
- Sample identification and sample description
- Weather conditions

Field notebooks will be kept in the project file.

3.0 SAMPLE PREPARATION, HANDLING, CUSTODY AND CONTROL

Prior to collection, sample bottles will be prepared by the analyzing laboratory, with the appropriate preservation agents added as necessary. Samples will be preserved with the proper preservatives in accordance with *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods*, - latest edition (SW-846). Sampling equipment and sample containers are handled with new latex or nitrile gloves. The samples will be labeled using a permanent marker with the following:

- Sample I.D. by location or well number
- Date and time of sampling
- Site location
- Parameters and methods for testing
- Sample preservatives
- Collector's name

All sample containers and samples will be maintained under strict custody procedures throughout the investigation. Samples for chemical analysis collected on each sampling day will be considered under custody if:

- They are in possession.

- They are in view, after being in possession.
- They were in possession and were locked up or sealed in a tamper-proof manner.
- They are placed in a designated secure area.

The samples will be shipped using a common carrier to the laboratory in a container chilled to approximately 4°C. The Chain-of-Custody and Request for Analysis forms will be completed by the sampling personnel at the time of sampling and will include the information previously noted on the labels, as well as the following:

- Signatures of the sampler and the receiver at the laboratory
- Number and type of containers for each sample
- Sample type and matrix
- Parameters and methods of testing
- Times and dates of possession and relinquishment
- Method of transport
- Temperature of shipment

When the sample container is shipped to the laboratory, a minimum of two custody seals will be placed on the shipping container in such a way that the shipping containers cannot be opened in transport without breaking the seal. In addition, the shipping sample containers will be sealed with strapping tape in a manner that the shipping container cannot be opened without cutting through the tape.

If damage, tampering or other conditions evident of questionable sample integrity are observed by the receiving lab, the laboratory QA/QC officer or his/her representative shall notify the consultant within 24 hours of receipt. Subsequent to notification, sample integrity will be evaluated and appropriate actions taken to assure representative samples. Sample integrity determination and needs for additional actions will be conducted according to QA/QC guidance from USEPA SW-846. Re-sampling will be conducted, if determined necessary.

The laboratory will assume custody of the samples upon receipt and a designated sample custodian will be charged with sample receipt, completion of custody forms, checking correctness of sample documentation, sample log-in, and sample distributions.

4.0 INSTRUMENT CALIBRATION AND MAINTENANCE

4.1 Laboratory Equipment Calibration

Laboratory instruments will be calibrated following the referenced USEPA guidance and the laboratory QA Procedures. Initial calibrations will be performed before sample analysis. Calibration checks will be performed at the frequencies specified in each analytical method.

4.2 Field Equipment Calibration

Field equipment will be calibrated prior to use at the project site. In addition, maintenance activities will be conducted as indicated by the operations and/or owners manual. The following is a summary of field equipment requiring routine calibration and maintenance:

Photoionization Detector (PID) – PID screening instruments will be calibrated once daily according to the instrument manufacturer's specifications using certified calibration gases.

Battery checks will be performed daily. The PID will generally utilize a 10.6 electro-volt lamp. However, higher energy lamps may be required for compounds with higher ionization potentials. The lamp will be inspected for deposits or residues that may affect readings and cleaned or changed as necessary. The equipment will be calibrated prior to use with an appropriate calibration gas, such as isobutylene. The PID will have a range of 1 to 2,000 parts per million (ppm).

pH Meter – The pH meter will be calibrated prior to use in the field using known buffer solutions of 4.0, 7.0, and 10.0. The meter will also be calibrated daily in the field using known buffer solutions of 4.0 and 7.0, with ambient temperature compensation. Calibration will also be performed each time the instrument is turned on. The electrode will be stored, when not in-use, submersed in a 4.0 solution or a potassium chloride solution. The electrode will be changed as necessary. For field measurements, samples will be placed into a clean glass or polyethylene container. The probe will be rinsed with distilled water between samples.

Conductivity Meter – The conductivity meter will be calibrated using a solution of 70, 700, 7000 umho/cm depending on the expected range of the samples. The meter will automatically compensate to 25^{O}C. The probe will be changed as necessary. For field measurements, samples will be placed into a clean glass or polyethylene container. The probe will be rinsed with distilled water between samples.

Temperature Probe – The temperature probe will be calibrated against a thermometer accurate to 0.1^{O}C in the laboratory prior to use. The probe will be rinsed with distilled water between samples.

Interface Probe – The interface probe will be accurate to 0.01 feet. The lens will be protected by a sheath to prevent scratching or marring. If the lens is scratched or damaged, it will be replaced. The meter will be cleaned between uses in accordance with the decontamination procedures in Section 2.7. The meter will be operated to prevent damage to the tape or leads while unwinding into, or rewinding from, the well casing.

Dissolved Oxygen – The dissolved oxygen meters will be calibrated by the consultant prior to use in the field using a 100 percent relative humidity chamber (air calibration method). Dissolved oxygen meters will be calibrated in the field daily by the sampling personnel using the air calibration method.

All results of field calibrations and measurements will be maintained in bound logbooks assigned to the specific instrument and/or field logbooks. Initial calibrations of field instruments will be performed by a qualified technician prior to mobilization of equipment to the site. Daily calibrations will be performed onsite by sampling personnel. The recorded calibration information includes date of calibration, standards used, and calibration results.

5.0 ANALYTICAL PROCEDURES

Groundwater and outfall surface water samples will be analyzed for parameters listed within the Monitoring and Mitigation Plan. All samples will be analyzed for select metals and VOCs. Additionally, background samples and samples collected following the exceedance of a site-specific Groundwater Protection Standard or Surface Water Protection Standard, as discussed in the Reclamation Fill Plan, will be analyzed for select SVOCs, Pesticides, and Herbicides.

Quality assurance/quality control (QA/QC) will be maintained by the following procedures:

- Samples for laboratory analysis will be properly labeled and proper chain-of custody and analysis request forms will be completed as discussed above.
- Field QC samples: (i) minimum of one duplicate sample per medium per container type per field day; (ii) equipment rinse blanks and VOA trip blanks will be utilized.
- If holding time is exceeded, the analytical result will be considered invalid and qualifications to the data will be noted.
- Results of samples that are improperly preserved, exceed allowable temperature during shipping/transport (temperature blank) or that are compromised due to damaged sample containers will be considered invalid.
- The laboratory used for this assessment will be certified by VELAP and NVLAP as well as the National Environmental Laboratory Accreditation Conference (NELAC) that meets or exceeds the requirements of SW-846.

6.0 DATA REPORTING AND VALIDATION

Each Certificate of Analysis shall include the following information:

- Project name and number
- Report date
- Laboratory certification
- Sample numbers (field and laboratory numbers, if different)
- Sample type and matrix
- Collector's Initials.
- Date and time of collection
- Date and time of analyses
- Sample preparation and analytical methods
- Analyst's initials
- Tabulated sample results
- Detection Limits
- Units
- Qualifiers
- QC Data for laboratory blanks, spikes, surrogates, and calibration samples, as applicable
- Data reviewer signature and date
- Chain-of-custody

In the case of a subcontracted laboratory, data review and validation will be performed by the laboratory in accordance with its QA and the results of all QC analyses and the data review will be provided with the analytical results upon request. Data will be verified by the head chemist and laboratory director then faxed or e-mailed to the ECS Project Manager. The Project Manager will inspect the data to provide a final review and approval before it is used to make any Project decisions. The Project Manager will review data for laboratory spikes and duplicates, laboratory blanks, and the field blank to ensure that they are acceptable. The Project Manager will also compare the sample descriptions with the field sheets for consistency and will ensure that any anomalies in the data are appropriately documented. Further validation will occur to ensure:

- The data are consistent, correct, and complete according to the field data sheets
- Any qualifiers with the data are identified
- Accuracy meets program objectives

- The protocols outlined in this QAPP were followed

When requested, the laboratory data validation will include a signed document attesting that the data were validated according to the aforementioned protocols. The full data validation report, data summary tables, and support documentation appendices will be supplied as appendices to the Report.

6.1 Data Qualifiers

Analytical data sheets provided by the lab should qualify the data presented. Common qualifiers are listed below. Corrective actions needed when these qualifiers are encountered must be determined and will be based upon the data quality requirements for that data.

Data Qualifiers	
Qualifier	**Description**
J	Analyte positively identified but quantitation is an estimation
U	Analyte not detected. The associated numerical value is at or below the method detection limit (MDL)
R	The data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria
B	Analyte was found in associated blank, as well as in the sample

6.2 Corrective Action

If performance in any aspect of laboratory operation is determined to be out-of-control based on quality control evaluations, analysis must be immediately halted and the cause determined. Standard Operating Procedures routinely address particular issues with suggestions on how to determine and eliminate the cause of QC results out of the acceptance range. As an overall rule, no values may be reported until quality control is within acceptance limits and/or the cause had been identified or determined to be a random event no longer affecting data. Supervisors are made aware of any out-of-control situation occurring in the laboratory. In most cases, samples are re-analyzed after the quality control issue is resolved. All failures to meet quality control standards must be fully documented and submitted to the laboratory QA Coordinator.

If sampling, field procedures, shipping, or documentation procedures are determined to be the cause of data quality control failure, the Project Manager will prepare and implement a specific Corrective Action Plan to address the problems.

7.0 INTERNAL QC CHECKS

Internal Quality Control (QC) checks will be performed as follows:

Field Quality Control Requirements			
QC Sample	**Frequency**	**Acceptance Criteria**	**Corrective Action**
Field Duplicate	One per twenty samples per matrix or one per day, per matrix whichever is more frequent.	+/- 10%	Review laboratory QA/QC - Collect additional duplicate
Split Sample **(Optional)**	One sample per analysis per matrix	+/- 10%	Review laboratory QA/QC - Collect additional sample
Matrix Spike/Matrix Spike Duplicate **(Optional)** (MS/MSD)	One per twenty samples per matrix or one per day, per matrix whichever is more frequent.	+/- 10%	Review laboratory QA/QC - Collect additional sample
Equipment Rinsate Blank	One per equipment type used	Below Detection	Decontaminate equipment and resample
VOA Trip Blank	One for each cooler which contains samples for VOA analyses.	Below Detection	Review laboratory QA/QC
Cooler Temperature Blank	One per cooler.	<4° C	Evaluate data, delivery time and cooling agent.

7.1 Field (Rinse) Blanks

Field (rinse) blanks, in the form of equipment rinse blanks, are required for each phase of sampling for which field sampling equipment will be used. Field (rinsate) blanks consist of pouring demonstrated analyte-free water over decontaminated sampling equipment as a check that the decontamination procedure has been adequately carried out and that there is no cross-contamination of samples occurring due to the equipment itself. Analyses of field (rinsate) blanks are performed for all analytes of interest as specified in the Work Plan. For soil samples, a field blank will be collected at a rate of 10 percent of the total number of samples per sampling event with a maximum of one field blank per sampling day. For groundwater samples, a field blank will be collected for each sampling day.

7.2 Trip Blanks

Trip blanks (VOC analysis only) consist of reagent grade water filled in the specific sampling containers to be used in the sample collection for the project. Trip blanks are prepared at the laboratory, sealed, and transported to the sampling site. Without being opened, they are returned to the laboratory for analysis with the same set of bottles they accompanied to the field. Trip blanks are used to assess contamination that may have occurred during transport of the bottles to and from the field. Trip blanks will be analyzed for aqueous volatile organic sampling events only. Trip blanks will be prepared at a rate of one per sample shipment, and shall not be held on site for more than two (2) calendar days, with one day for transport from the laboratory to the site and one day for return.

Any contaminants found in the trip blanks can be attributed to (1) interaction between the sample and the container, (2) contaminated rinse water, or (3) a handling procedure that alters the sample analysis results. The concentration levels of any contaminants found in the trip blank should not be used to correct the sample data. The contaminant levels should be noted, and if the levels are within an order of magnitude when compared to the field sample results, the sampling event should be repeated.

7.3 Field Duplicate Samples

Duplicate samples consist of an actual sample taken in the field that has been split into two identical aliquots and put into two separate sampling containers. The samples are then transported to the laboratory and analyzed as two separate samples. The results will be used to assess laboratory accuracy and precision of sampling and analysis. Samples for volatile organics (VOCs) will be filled from the same bailer full of water and will be the first set of containers filled. VOC vials will not be alternately filled. One duplicate sample will be collected per sample matrix at a rate of five percent of the total number of samples collected.

8.0 PERFORMANCE AND SYSTEM AUDITS

A performance audit is made to evaluate the accuracy of the total measurement system or component thereof. A systems audit focuses on evaluating the principle R&A components of a measurement system to determine proper selection and use. In regard to field sampling operations, this oversight activity is performed to critique the quality control procedures which are to be employed. Systems audits of this nature are to be performed periodically prior to or shortly after field operations commence and until the project is completed.

The Project Manager is responsible for conducting audits for all for field and laboratory activities. Sampling program and laboratory audits evaluate numerous items which impact the quality of data. Audits include the evaluation of management, technical expertise, facilities, equipment, reference materials, methods, calibration, training, documentation and reporting.

A pre-performance audit can identify the capabilities of a laboratory before any samples are submitted. Follow-on audits can be used to identify problems and deficiencies so they can be corrected early in the project saving both time and money. Audits are performed to evaluate a laboratory's conformance with NELAC quality systems criteria and specific testing procedures. Audits performed throughout the life of the project will be provided to the appropriate stakeholders for dissemination. Historical audit reports will be used as a reference for follow-on audits.

Each set of data (batch) received from the analytical laboratory is systematically evaluated and compared to established data quality objectives before the results can be authenticated and accepted into the environmental monitoring database. Categories of data quality objectives include accuracy, precision, representativeness, comparability, and completeness. When possible, quantitative criteria will be used to define and assess data quality.

Specifically, the audit program will meet the following environmental monitoring objectives:

1. To ensure that data generated are within acceptable limits of precision and accuracy.
2. To ensure that these quality assurance measures are, in fact, being carried out.
3. To ensure the "accountability" of the data (i.e., that the results reported do apply to the monitoring/sample as collected or submitted for analysis).
4. To ensure that any result reported is traceable to:
    a. The date and time the monitoring/analysis was performed.
    b. The technician who collected/performed the monitoring/test.
    c. The raw data generated during the performance of the monitoring/test.

d. The condition of any instrument or equipment at the time it was used in the monitoring/test.

5. To minimize the possibility of loss, damage, or tampering with data.

Appendix 8
Seismic Design Considerations

SEISMIC DESIGN CONSIDERATIONS

Ground Motion Parameters: ECS has determined the design spectral response acceleration parameters following the NEHRP 2015 methodology for the 2,500 year return period event (2% probability of exceedence in 50 years). The Mapped Reponses were estimated from the U.S. Seismic Design Maps available from the Structural Engineer's Association of California (SEAC) and California's Office of Statewide Health Planning and Development (OSHPD) Seismic Design Maps website (http://seismicmaps.org/). The design responses for the short (0.2 sec, S_{DS}) and 1-second period (S_{D1}) are noted in bold at the far right end of the following tables. For the purposes of this evaluation, the spectral response was estimated for bedrock (Site Class B) to select bedrock input ground motions for a hypothetical site response analysis. The project was also evaluated to determine mapped spectral response parameters for Site Class D (stiff soil) to represent the filled condition.

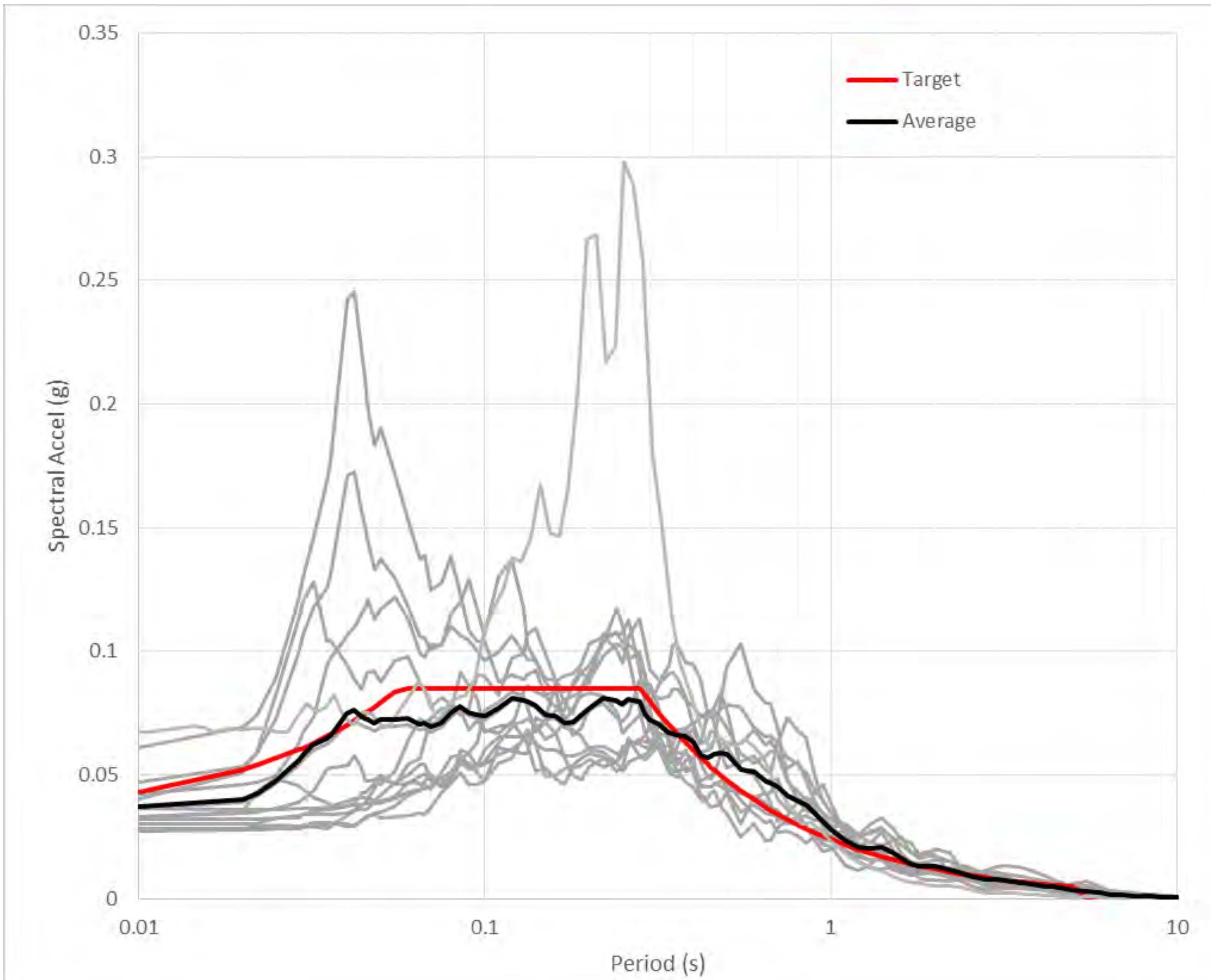
GROUND MOTION PARAMETERS [NEHRP 2015 Method - Bedrock]								
Period (sec)	**Mapped Spectral Response Accelerations (g)**		**Values of Site Coefficient for Site Class**		**Maximum Spectral Response Acceleration Adjusted for Site Class (g)**		**Design Spectral Response Acceleration (g)**	
Reference	Figures 1613.3.1 (1) & (2)		Tables 1613.3.3 (1) & (2)		Eqs. 16-37 & 16-38		Eqs. 16-39 & 16-40	
0.2	S_S	0.141	F_a	0.9	$S_{MS}=F_aS_s$	0.127	S_{DS}=2/3 S_{MS}	**0.085**
1.0	S_1	0.045	F_v	0.8	$S_{M1}=F_vS_1$	0.036	S_{D1}=2/3 S_{M1}	**0.024**

GROUND MOTION PARAMETERS [NEHRP 2015 Method – Stiff Soil]								
Period (sec)	**Mapped Spectral Response Accelerations (g)**		**Values of Site Coefficient for Site Class**		**Maximum Spectral Response Acceleration Adjusted for Site Class (g)**		**Design Spectral Response Acceleration (g)**	
Reference	Figures 1613.3.1 (1) & (2)		Tables 1613.3.3 (1) & (2)		Eqs. 16-37 & 16-38		Eqs. 16-39 & 16-40	
0.2	S_S	0.141	F_a	1.6	$S_{MS}=F_aS_s$	0.226	S_{DS}=2/3 S_{MS}	**0.151**
1.0	S_1	0.045	F_v	2.4	$S_{M1}=F_vS_1$	0.107	S_{D1}=2/3 S_{M1}	**0.074**

Site Class	Mapped PGA
B	0.067
D	0.118

The bedrock response spectrum was used to identify input ground motions for use in site response analysis. Eleven input motions were selected from the PEER CEUS database plus a recording of the 2011

Mineral Virginia earthquake as measured in Reston, Virginia scaled to match the Peak Ground Acceleration (PGA) of the target bedrock spectrum. The site and ground motion response spectra are shown in the figure below.

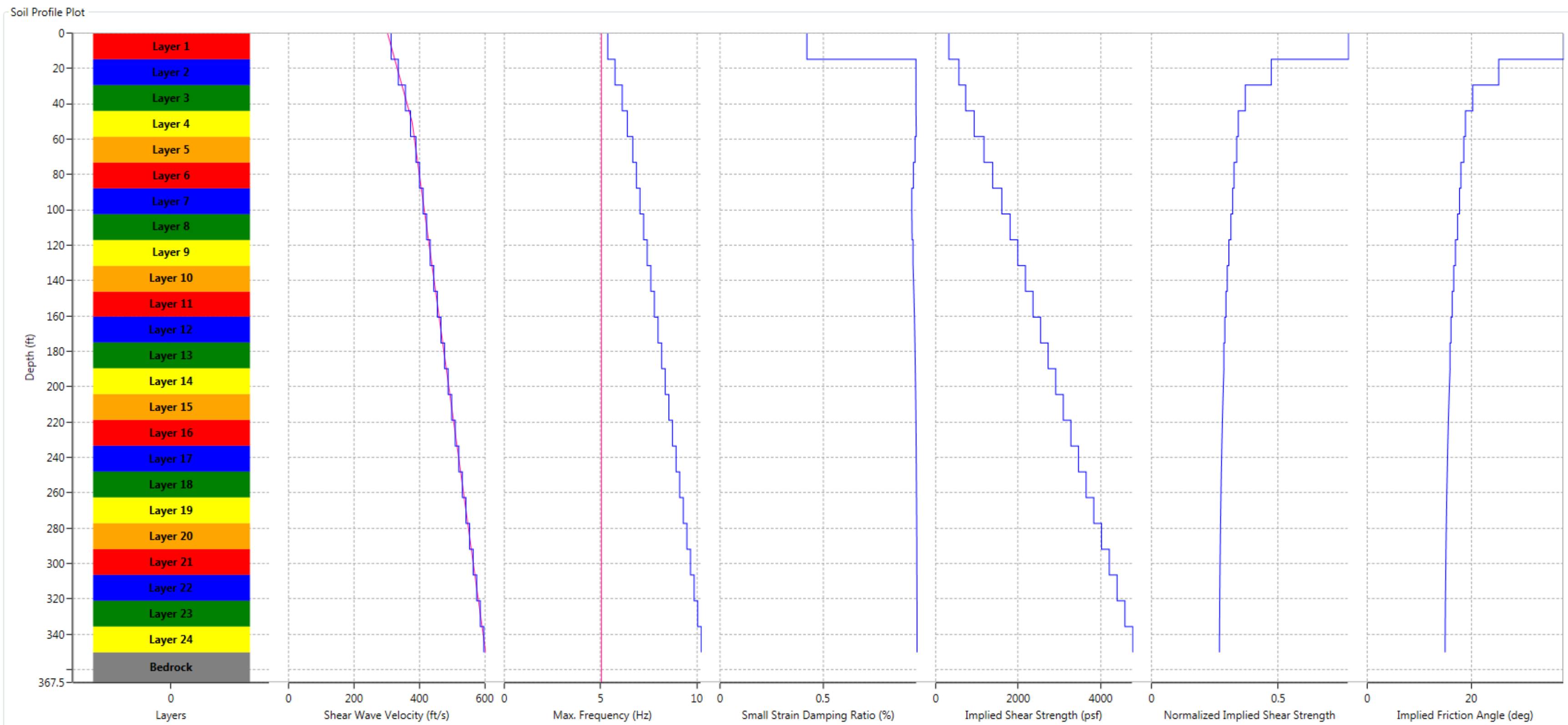


The selected ground motions were evaluated in DEEPSOIL v7.0 software for site response using the equivalent linear method. Assumed soil properties were selected for the fill in the quarry. These properties are considered appropriate for the materials in the general region that are most likely to contribute to the fill placement. Below are plots summarizing the soil properties.

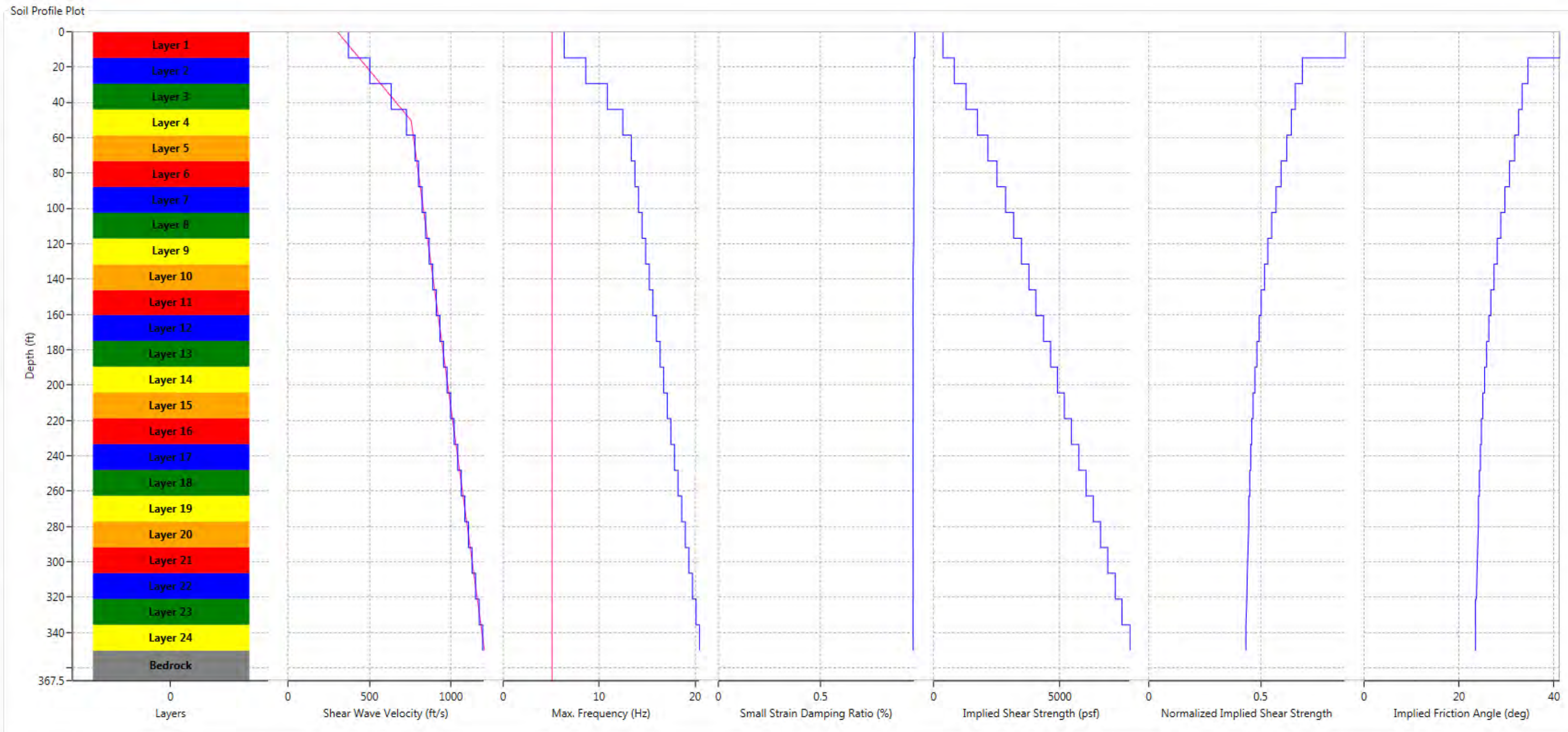
Soil shear wave velocity profile was determined using the below model assuming b=26 for clays[1]:

$$V_s(m/s) = \alpha b N_{60}{}^{0.215} \sigma'_{v0}{}^{0.275}$$
$$\alpha = Age\ Scaling\ Factor = 1.0\ Quaternary$$
$$b = soil\ type\ factor = 26\ clays$$
$$\sigma'_{v0}(kPa) = insiut\ effective\ stress$$

[1] Wair, DeJong and Shantz (2012), Guidelines for Estimation of Shear Wave Velocity Profiles, PEER Report 2012/08

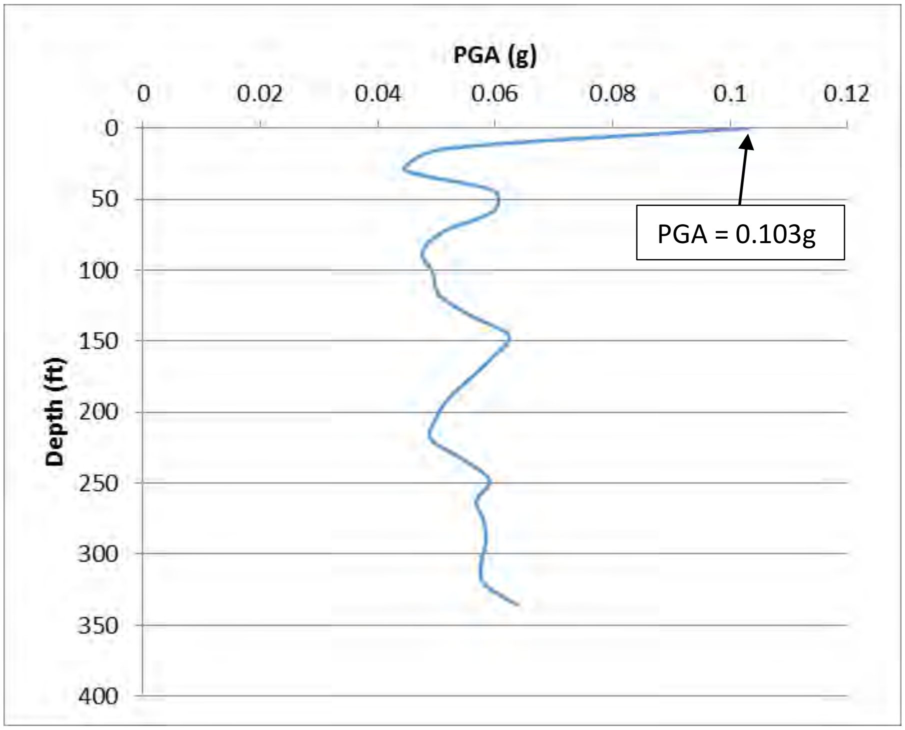


Input Firm Soil Profile for Site Response Analysis



Input Very Stiff Soil Profile for Site Response Analysis

The equivalent linear properties were modeled using conventional modulus and damping curves from Vucetic & Dobry (1991) with a plasticity index of 10 to model cohesive materials. Two profiles representing firm and very stiff soil conditions were selected. The natural periods for the profiles are 3.1 seconds and 1.66 seconds respectively. These natural periods are well above the period range that is associated with the most significant ground motion; therefore, significant amplifications should not be expected. A plot of PGA with depth is provided. The resulting profiles were compared and the profile resulting in the higher PGA and cyclic stresses are presented below.

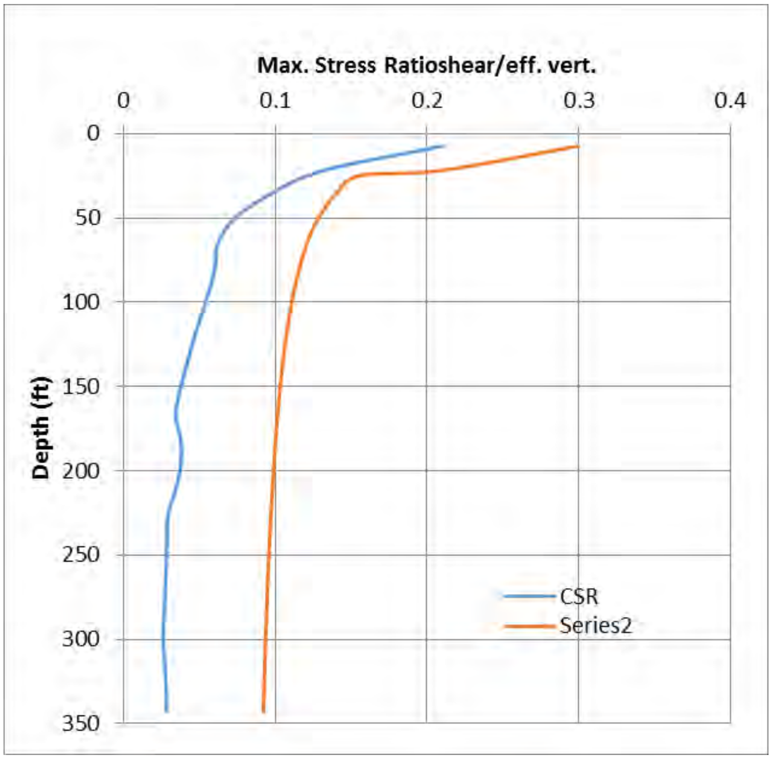


PGA vs. Depth for Mineral, VA Ground Motion Measured at Reston, VA for the stiff profile

The cyclic resistance (CRR) was estimated by considering the performance of the expected compaction for the Reclamation Fill and compared to the calculated cyclic shear stress ratio (CSR) from the site response analysis. Since soil materials are not known at this time and cannot be predicted, using a lumped insitu parameter to estimate soil properties, such as N-value, is reasonable. A field N-value of 7 blows per foot (bpf) was assumed for the initial portion of the reclamation fill (from pit bottom to 20ft below final surface) and a field N-value of 10 bpf was assumed for the final portion of the reclamation fill (from 30ft below final surface to the final surface). The variation was implemented to account for the higher level of compaction and testing that will be implemented in the upper 30 feet of fill as described in the Reclamation Fill Plan. Appropriate corrections were applied to the assumed field N-values. Based on these assumptions, the CRR was estimated using the method described by NCEER, 1996[2] for the Standard Penetration Test (SPT).

$$CRR_{7.5} = \frac{1}{34 - (N_1)_{60}} + \frac{(N_1)_{60}}{135} + \frac{50}{[10 \cdot (N_1)_{60} + 45]^2} - \frac{1}{200}$$

[2] Youd, T.L., et. Al. (2001), Liquefactin Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Reisstance of Soils, ASCE Journal of Geotechnical and Geoenvironmental Engineering, 817-833.



CSR for Mineral Virginia at Reston vs. CRR

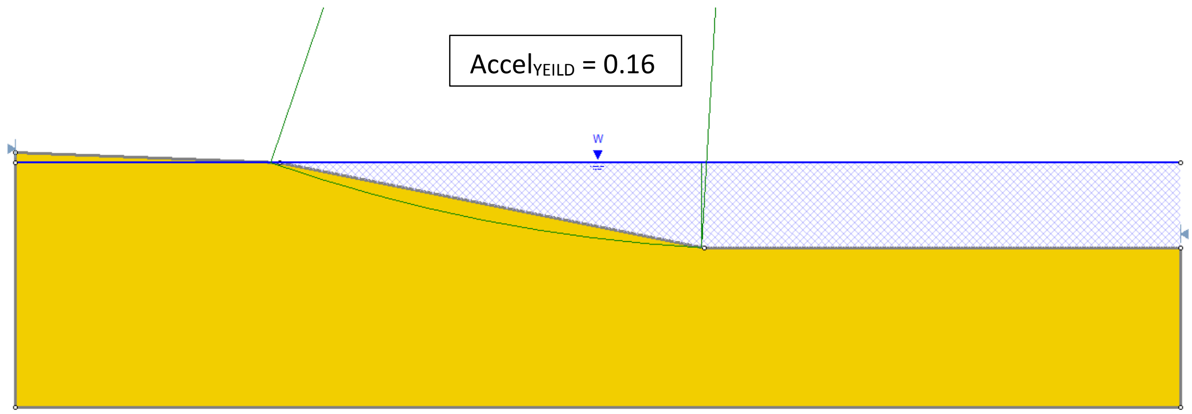
Based on the above analysis, liquefaction is not expected to occur.

SLOPE STABILITY FOR FINAL POND CONFIGURATION

Slope Design Parameters: In order to evaluate the seismic stability of the final pond configuration, the final pond configuration is modeled to calculate the yield acceleration under seismic conditions. The following soil parameters were assumed for the reclamation fill.

SOIL PARAMETERS FOR SLOPE STABILITY ANALYSES			
Material Description	**Moist/Sat Unit Weight (pcf)**	**Cohesion (psf)**	**Friction Angle**
New Reclamation Fill	115/125	50	30°

Slope Stability Analyses: The global stability analyses were performed using the commercially produced two-dimensional computer slope stability program SLIDE (version 2018 8.032). The failure surfaces were modeled based on potential circular failure surfaces using Spencer's method. A summary of the slope stability analysis is presented below.



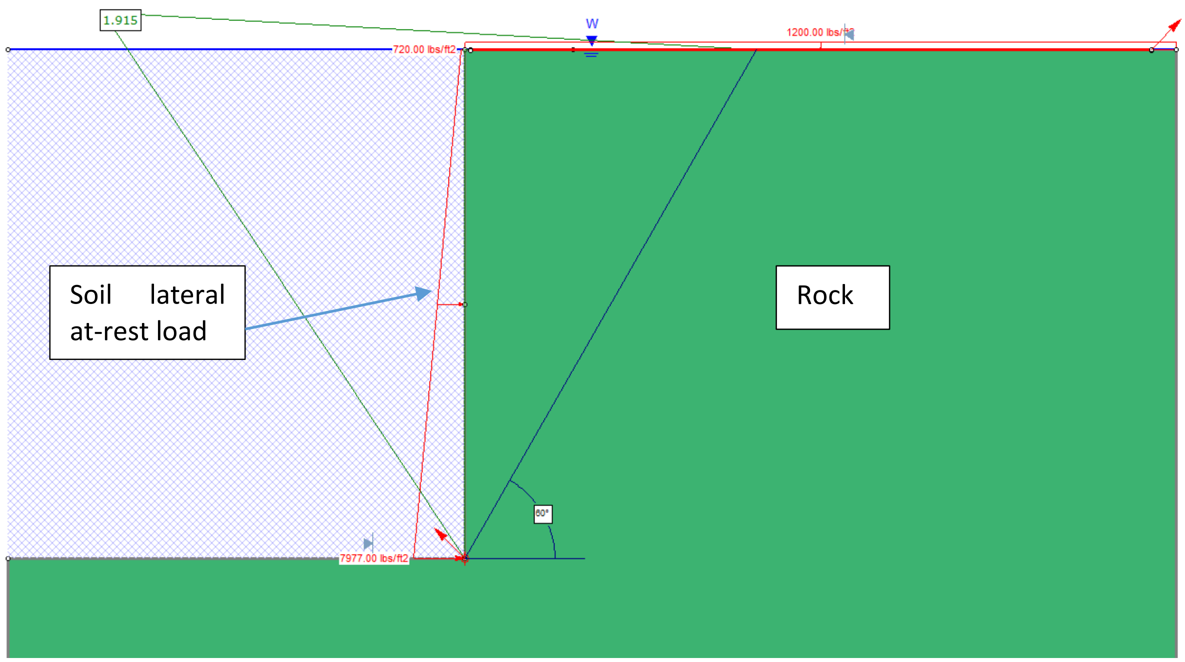
Based on the results above, the proposed slopes at the design grades indicated have a higher yield acceleration compared to the calculated peak ground accelerations at the site indicating that slope failure due to seismic forces is not expected.

SLOPE STABILITY FOR HIGH WALLS AFTER RAISING THE WATER TABLE

Slope Design Parameters: For the purposes of evaluating stability of the high walls after filling the quarry and allowing the water table to rise, the following rock and discontinuity parameters were developed.

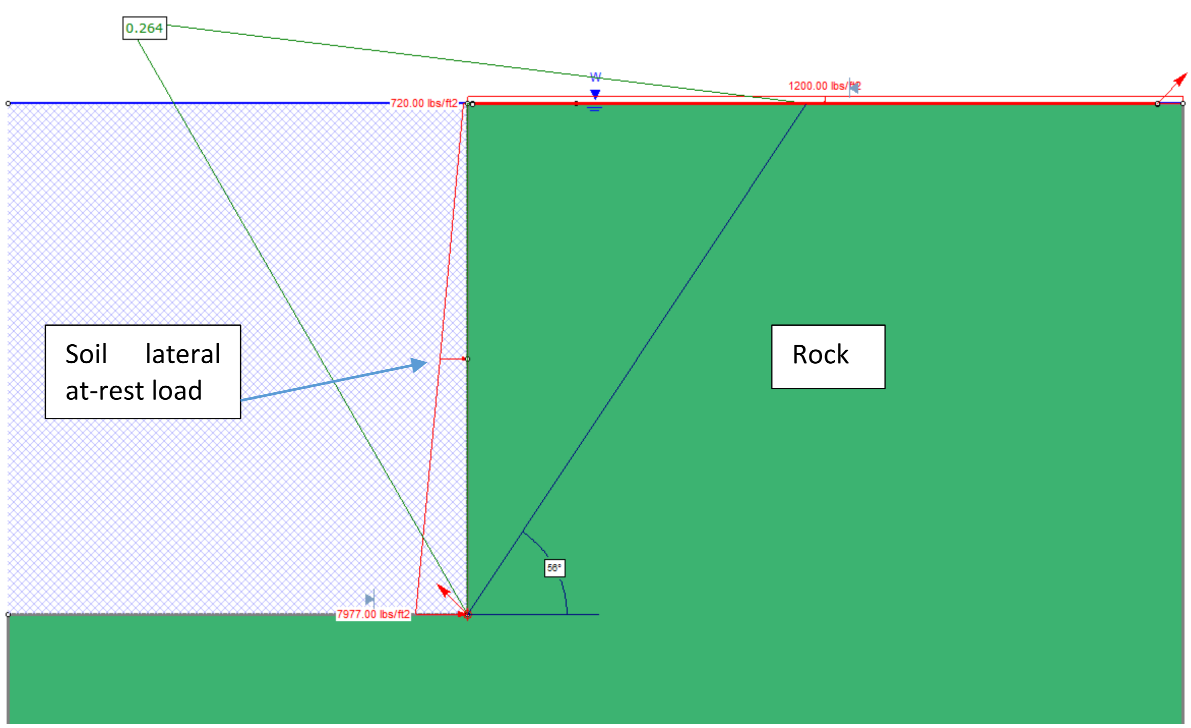
SOIL PARAMETERS FOR SLOPE STABILITY ANALYSES			
Material Description	**Unit Weight (pcf)**	**Cohesion (psf)**	**Friction Angle**
Rock Joint (Rough Joint)	190	200	54°
Rock Joint (Assumed minimum)	190	0	48°

Residual friction angle from a triaxial test on intact rock sheared to residual to represent slightly rough planar joint conditions was utilized from an ECS geotechnical project in similar geologic conditions. The effect of the soil fill was incorporated into the model using distributed loads equivalent to the soil lateral at rest pressure considering a horizontal stress coefficient equal to 0.6 and buoyant soil. Additionally a vertical surcharge equal to 10 feet of soil (not submerged) was included as a driving force in the model. The water table was positioned at the top of the rock.



Limit Equilibrium Soil Model with Resulting Minimum Factor of Safety

After various analyses were performed, it is evident that the critical failure angle is at 55-60 degrees for the specified parameters. The factor of safety against block sliding failure is approximately 1.9 under static conditions. The yield acceleration was calculated to be 0.264g with failure angles of about 52-56 degrees. The calculated yield acceleration is greater than the calculated peak accelerations for the soil profile indicating that failure due to seismic loading is not likely.



Seiche

Merian's equation was used to calculate the fundamental period of the standing wave in the proposed lake.

$$T = \frac{2L}{n(gd)^{0.5}}$$

n = number of modes, g = gravitational force, d = depth of the lake (16 feet), L = length

n	1	1	1	1	
L	775	1450	775	1000	ft
d	16	16	16	16	ft
g	32.2	32.2	32.2	32.2	ft/s/s
T	68.29	127.76	68.29	88.11	sec
Freq	0.0146	0.0078	0.0146	0.0113	Hz

Since the fundamental period is much larger than the ground motion period associated with the most significant ground shaking, significant wave action from ground shaking is not expected.