GOLDER

REPORT

Remedial Action Plan for 18 Sites

Exploration and Production Pits

Powder Wash Natural Gas Field

Moffat County, Colorado

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1.0 INTRODUCTION

On behalf of Wexpro Company (Wexpro), Golder Associates Inc. (Golder) performed environmental investigations of potential soil impacts existing at 18 former exploration and production (E&P) pits in the Powder Wash Natural Gas Field in Moffat County, Colorado. The 18 pits are located within a five-mile radius of 40.946683°, -108.301703° (the Sites) and are regulated by the Colorado Oil and Gas Conservation Commission (COGCC). The purpose of the investigations was to complete subsurface assessments to delineate E&P-related impacts in and around each former pit. The subsurface investigations were completed between October 16, 2019, and November 21, 2019, at the following Sites:

- HW Stewart 1, Pit 1 (COGCC ID 100668)
- HW Stewart 1, Pit 2 (COGCC ID 100667)
- BW Musser 11 (COGCC ID 100382)
- BW Musser 18 (COGCC ID 100349)
- BW Musser 16 (COGCC ID 100365)
- Carl Allen 20 (COGCC ID 100666)
- JC Donnell 9 (COGCC ID 100638)
- Mtn Fuel Supply 20-1 (COGCC ID 100604)
- JC Donnell 5 (COGCC ID 100634)
- JC Donnell 10 (COGCC ID 100639)
- Jacks Draw 3 (COGCC ID 100608)
- Jacks Draw 2 (COGCC ID 100620)
- Carl Allen 9 (COGCC ID 100689)
- Carl Allen 16 (COGCC ID 100694)
- Carl Allen 11 (COGCC ID 100690)
- Carl Allen 6, Pit 1 (COGCC ID 100687)
- Carl Allen 6, Pit 2 (COGCC ID 100688)
- Carl Allen 7 (COGCC ID 100623)

The conclusions of the 2019 subsurface investigations include that 16 of the 18 former E&P pits that were investigated by Golder in 2019 have E&P-related impacts in excess of applicable COGCC Table 910-1 Concentrations Levels for soil. Groundwater was not encountered at the maximum depth of investigation at any of the 18 sites during the 2019 investigations. The two Sites that do not have E&P-related impacts in excess of COGCC Table 910-1 Concentration Levels are Jacks Draw 2 (COGCC ID 100620) and HW Stewart 1 (COGCC ID 100668). Wexpro is in the process of requesting closure of these two Sites with no further action required.

The sampling and analysis work that was completed in 2019 was done per the requirements of the COGCC Table 910-1. With the January 15, 2021 release of the Table 910-1 replacement, Table 915-1, sampling and analysis work completed through and beyond 2021 will be done per the requirements of Table 915-1.

This Remedial Action Plan (RAP) has been developed to:

1) Describe the procedures to complete vertical and/or horizontal impact delineation, where required.

2) Evaluate and select appropriate remedial technologies with the goal of remediation of E&P-related impacts at the remaining 16 Sites for constituents of concern (COCs) that exist in concentrations exceeding applicable Table 915-1 Concentration Levels. The ultimate goal for each site is to achieve COC concentrations below applicable Table 915-1 Concentration Levels with subsequent reclamation and closure of each Site.

3) Prioritize the 16 Sites for remediation based on wellsite life expectancy and the nature and extent of E&P-related impacts.

2.0 2019 SUBSURFACE INVESTIGATION SUMMARY

Golder provided oversight of the subsurface investigations performed between October 16, 2019, and November 21, 2019. The subsurface investigations were performed by drilling with a Geoprobe 7822 direct-push drill rig operated by Henderson Drilling Inc. of Casper, Wyoming. The Geoprobe advanced 2-inch polyvinyl chloride (PVC) sample liners to collect continuous cores in 5-foot increments. A Golder geologist and technician were present to oversee the drilling activities, classify soils in general accordance with the Unified Soil Classification System (USCS), and perform field screening and soil sample collection. Field screening included photoionization detector (PID) and electrical conductivity (EC) measurements conducted at regular 2-foot intervals. The PID and EC meters were calibrated daily prior to the start of work. Decontamination of downhole tooling was performed between boreholes by rinsing with fresh water and brushing off debris from the core barrel to remove soil and/or contamination from tooling in direct contact with subsurface materials. Select soil samples were retained and submitted for laboratory analysis by Pace Analytical Center for Testing and Innovation (Pace). In general, all samples that were submitted to Pace were analyzed for benzene, toluene, ethylbenzene, and total xylene (collectively referred to as BTEX); total petroleum hydrocarbons (TPH); chloride; sulfate; sodium adsorption ratio (SAR); and specific conductance, and the sample with the highest PID measured in the field was submitted for the full Table 910-1 Constituent List for soil samples. The COGCC Table 910-1 Constituent List and Concentration Levels for soils are summarized in Table 1. Investigation derived waste (IDW) included soil not retained for laboratory analysis and decontamination fluids. All IDW was contained as drilling progressed and managed by Wexpro for disposal in accordance with applicable regulations.

The number of boreholes advanced, drilled depths, and COGCC Table 910-1 exceedances vary from Site to Site. A general summary of the investigation results, recommended additional investigation, and applicable COGCC correspondence number(s) for each of the 18 Sites are presented in Table 2. For specific details of each Site's investigation, refer to the appropriate Field Investigation Summary Technical Memorandum previously issued under separate cover to Wexpro.

3.0 CURRENT UNDERSTANDING OF NATURE AND EXTENT OF E&P-RELATED IMPACTS

This section summarizes the current understanding of the nature and extent of E&P-related impacts at the 18 Sites that were investigated in 2019 and is organized by Sites that do not require additional investigation and/or remediation and Sites that do require additional investigation and/or remediation. The previously reported conclusions and recommendations resulting from the 2019 investigation are based on comparison of the results from the investigation to the COGCC Table 910-1 Concentrations Levels. Future work and subsequent reclamation/remediation will be based on the Table 915-1 Concentration Levels.

3.1 Sites Not Requiring Additional Investigation or Remediation

Two of the 18 sites that were investigated in 2019 do not have E&P-related impacts in excess of the applicable COGCC Table 915-1 Concentration Levels or do not require additional investigation or remediation for other reasons as described herein:

- The HW Stewart, Pit 1, Golder Pit #1 (COGCC ID 100668) Site did not have any exceedances of the COGCC Table 915-1 Concentration Levels for the samples analyzed by the laboratory. No further investigation or remediation is recommended for this Site.

- The Jacks Draw 2, Golder Pit #12 (COGC ID 100620) Site had only one exceedance of the Table 915-1 Concentration Levels. The exceedance was for arsenic at one borehole location with a concentration of 11.2 milligrams per kilogram (mg/kg) compared to the Table 915-1 Concentration Level of 0.68 mg/kg. Naturally occurring arsenic in concentrations that exceed the Table 915-1 Concentration Level for this constituent are not uncommon in the Rocky Mountain region as a result of the erosion of, and deposition from, mineralized deposits high in naturally occurring arsenic. The elevated arsenic at this location is not thought to be attributed to E&P activities. No further investigation or remediation is recommended for this Site.

Because these two sites either do not have E&P-related impacts or have elevated concentrations that are representative of naturally occurring concentrations, no additional investigation or remediation is recommended for either Site.

3.2 Sites Requiring Additional Investigation and/or Remediation

The remaining 16 sites that were investigated in 2019 require some level of additional investigation to complete lateral and/or vertical delineation of impacts in soil and/or bedrock. A general summary of additional investigation required at each of the 16 pits is provided as follows:

- HW Stewart 1, Pit 2, Golder Pit #2 (COGCC ID 100667): Horizontal impacted soil delineation is considered complete. Vertical impacted soil delineation is considered incomplete because soil impacts were encountered at the maximum depth of investigation in the center borehole and bedrock was not recovered to confirm the bottom of soil impacts.
- BW Musser 11, Golder Pit #3 (COGCC ID 100382): Horizontal impacted soil delineation is considered complete. Vertical impacted soil delineation is considered incomplete because soil impacts were encountered at the maximum depth of investigation in the center borehole and bedrock was not recovered to confirm the bottom of soil impacts.
- BW Musser 18, Golder Pit #4 (COGCC ID 100349): Horizontal impacted soil delineation is considered complete. Vertical impacted soil delineation is considered incomplete because soil impacts were encountered at the maximum depth of investigation in the center borehole and bedrock was not recovered to confirm the bottom of soil impacts.
- BW Musser 16, Golder Pit #5 (COGCC ID 100365): Horizontal impacted soil delineation is considered complete. There are reported exceedances of SAR and EC at perimeter boreholes but at depths greater than 6 feet below ground surface (ft bgs). Hydrocarbon impacts have been horizontally delineated. Additional vertical delineation of impacted soil is required. Vertical impacted soil delineation is considered incomplete because soil impacts were observed to the depth of refusal in the center borehole and bedrock was not recovered to confirm refusal occurred at the bedrock surface.
- Carl Allen 20, Golder Pit #6 (COGCC ID 100666): The horizontal and vertical delineation of impacted soil is considered complete. However, impacted bedrock was recovered, and the horizontal and vertical delineation of impacted bedrock could not be delineated with the available drilling equipment. Additional horizontal and vertical impacted bedrock delineation is required.
- JC Donnell 9, Golder Pit #7 (COGCC ID 100638): Horizontal impacted soil delineation is considered incomplete because there are shallow perimeter SAR exceedances of the respective Table 915-1 Concentration Level. Vertical impacted soil delineation is considered incomplete because soil impacts were

observed to extend to the depth of refusal in the center borehole, and bedrock was not recovered to confirm refusal occurred at the bedrock surface.

- Mtn Fuel Supply 20-1, Golder Pit #8 (COGCC ID 100634): Horizontal impacted soil delineation is considered complete. Vertical impacted soil delineation is considered incomplete because soil impacts were observed at the maximum depth of investigation in the center borehole and bedrock was not recovered to confirm the bottom of soil impacts.
- JC Donnell 5, Golder Pit #9 (COGCC ID 100634): Horizontal impacted soil delineation is considered complete. Vertical impacted soil delineation is considered incomplete because soil impacts were observed at the maximum depth of investigation in the center borehole, and the investigation depth in the center borehole was limited to available drill tooling length.
- JC Donnell 10, Golder Pit #10 (COGCC ID 100639): The horizontal and vertical delineation of impacted soil is considered complete. However, impacted bedrock was recovered, and the horizontal and vertical delineation of impacted bedrock could not be delineated with the available drilling equipment. Additional horizontal and vertical impacted bedrock delineation is required.
- Jacks Draw 3, Golder Pit #11 (COGCC ID 100608): Horizontal impacted soil delineation is considered complete. Vertical impacted soil delineation is considered incomplete because soil impacts were observed at the maximum depth of investigation in the center borehole and bedrock was not recovered to confirm the bottom of soil impacts.
- Carl Allen 9, Golder Pit #13 (COGCC ID 100689): Horizontal impacted soil delineation is considered complete. There are reported exceedances of SAR and EC at perimeter boreholes but at depths greater than 6 ft bgs. Hydrocarbon impacts have been horizontally delineated. Vertical impacted soil delineation is considered incomplete because soil impacts were observed at the depth of refusal in the center borehole and bedrock was not recovered to confirm the bottom of soil impacts.
- Carl Allen 16, Golder Pit #14 (COGCC ID 100694): Horizontal impacted soil delineation is considered complete. There is a reported exceedance of SAR at one perimeter borehole at a depth of 4 ft bgs. Hydrocarbon impacts have been horizontally delineated. Vertical impacted soil delineation is considered incomplete because soil impacts were observed to the depth of refusal in the center borehole and bedrock was not recovered to confirm refusal occurred at the bedrock surface.
- Carl Allen 11, Golder Pit #15 (COGCC ID 100690): Additional horizontal delineation of impacted soil is required. Vertical impacted soil delineation is considered complete because impacted soil was observed to extend to the bedrock interface, 26 ft bgs. However, impacted bedrock was recovered, and the horizontal and vertical delineation of impacted bedrock could not be delineated with the available drilling equipment. Additional horizontal and vertical impacted bedrock delineation is required.
- Carl Allen 6, Pit 1, Golder Pit #16 (COGCC ID 100687): Vertical impacted soil delineation is considered complete. Horizontal impacted soil delineation is considered incomplete because there are shallow perimeter SAR and EC exceedances of the respective Table 915-1 Concentration Levels. Three perimeter boreholes are proposed to complete the horizontal delineation of SAR and EC. TPH impacts have been delineated and will be addressed during remediation.

- Carl Allen 6, Pit 2, Golder Pit #17 (COGCC ID 100688): Horizontal impacted soil delineation is considered complete. There are reported exceedances of SAR and EC at perimeter boreholes at depths greater than 4 ft bgs. Hydrocarbon impacts have been horizontally delineated. Vertical impacted soil delineation is considered incomplete because soil impacts were observed to the depth of refusal in the center borehole and bedrock was not recovered to confirm refusal occurred at the bedrock surface.
- Carl Allen 7, Golder Pit #18 (COGCC ID 100623): The horizontal and vertical delineation of impacted soil is considered complete. However, impacted bedrock was recovered, and the horizontal and vertical delineation of impacted bedrock could not be delineated with the available drilling equipment. Additional horizontal and vertical impacted bedrock delineation is required.

In addition to TPH, BTEX, naphthalene, pH, SAR, and EC concentrations in excess of COGCC Table 915-1 Concentration Levels, a number of the Sites listed in this section have arsenic concentrations in excess of the applicable Table 915-1 Concentration Level. Arsenic is not considered a target constituent for remediation at any of the Sites because the reported concentrations are considered reflective of naturally occurring concentrations.

It is recommended that the horizontal and/or vertical delineation of soil and/or bedrock impacts be completed to better understand the nature and extent of E&P-related impacts and to help inform remediation decision making before full-scale selection, design, and implementation of a remedial technology. Additional soil and/or bedrock investigation will be performed with hollow-stem auger with continuous sampler and/or air coring methods. A general Field Investigation Work Plan describing drilling method(s), field screening procedures, and soil sampling and analysis is provided in Appendix A. The methods and procedures specified in Appendix A will apply to all Sites requiring additional investigation. Preliminary proposed additional investigation locations for each of the 16 pits with additional investigation recommended are provided in Appendix A.

It is Golder's understanding that hydrocarbon-related impacts to bedrock, and the extent of these impacts, are controlled by the structural dip of the uppermost bedrock formation. Figure A1-1 of Appendix A shows the location of each of the 16 pits with additional investigation recommended relative to the uppermost bedrock surface, the top of the Cathedral Bluffs tongue of the Wasatch Formation (red mudstone).

Generally, the proposed additional investigation locations shown in Appendix A allow for one borehole in/near the center of impacts to complete soil and/or bedrock vertical delineation of impacts, and a second borehole located approximately 50 feet down-dip of the center borehole to delineate the maximum horizontal extent of hydrocarbon-related impacts to bedrock. The second horizontal bedrock impact delineation borehole may not be necessary if the center borehole does not indicate the presence of bedrock impacts. However, if the second horizontal bedrock impact delineation borehole indicates that the bedrock is impacted at this location, a third borehole may be required to delineate the maximum extent of bedrock impacts. Lateral (side-dip) delineation of bedrock impacts will be recommended based on the maximum distance that hydrocarbons have migrated down-dip from the center of impacts. Up-dip delineation of bedrock impacts is not recommended as it is not expected, and would be highly unlikely, that hydrocarbons would migrate up-dip of the source area(s).

The COGCC does not provide guidance or concentration levels for constituents in bedrock. As such, it is assumed that remedial objectives will be limited to soil remediation and that successful remediation will be based on achieving target concentration levels in soil. The additional investigation described herein is intended solely to better characterize the nature and extent of E&P-related impacts to bedrock and to confirm that groundwater resources are not impacted or threatened.

4.0 REMEDIAL OPTIONS EVALUATION

Golder has completed a remedial options evaluation of technologies applicable to the remediation of E&P-related impacts in the vadose zone (i.e., unsaturated soil above groundwater). Golder has reviewed Colorado's Decision Support System – Division of Water Resources Well Permit Database for permitted and completed water wells in the immediate vicinity of the Sites, and the shallowest wells that have been installed are at approximately 50 ft bgs and are reported as dry. The shallowest confirmed groundwater reported in the database occurs at 103 ft bgs. Based on the current understanding of the lithology in the vicinity of the Sites, groundwater present at 100+ ft bgs would be hydraulically isolated from shallow subsurface impacts by many tens of feet of low-permeability geologic strata (soil and/or bedrock). As such, groundwater remediation has not been considered during this evaluation.

The remedial options evaluation focused on the remediation of TPH (diesel range organics [DRO]+gasoline range organics [GRO]) and BTEX compounds, specifically, benzene, toluene, and total xylenes, as these are the primary COCs identified during investigative efforts. A number of Sites have SAR and EC concentrations in excess of the respective Table 915-1 Concentration Levels, but most exceedances for these two constituents are at depths greater than 4 ft bgs (i.e., below the root zone). SAR and EC exceedances of the Table 915-1 Concentration Levels at depths below 4 ft bgs are not considered to pose a toxicity threat to native flora. Uptake of ions that contribute to high EC and/or SAR (e.g., chloride, sodium) is limited at depths greater than 4 ft bgs as most native flora either do not have root depths exceeding 4 ft bgs, or these species are salt-tolerant. If new data gathered from future investigations indicate that other COCs are present in excess of applicable concentration levels, this evaluation will be revised accordingly.

The remedial options evaluation considered the possible effectiveness of each technology on the COCs and in the geologic conditions (as currently understood) of the Sites, expected timeframe of successful remediation to COC concentrations below applicable concentration levels, relative cost, and feasibility of implementation. Technologies with the highest expected effectiveness in the shortest timeframe are being recommended for further consideration by Wexpro. The comprehensive remedial options evaluation is included in Appendix B, Remedial Options Evaluation Table.

The top two remedial option candidates include in situ soil vapor extraction (SVE) and SVE with in situ soil heating. Excavation and off-site disposal may also be considered, but complete remediation using only this method will not likely be feasible due to the maximum depth of hydrocarbon-related impacts and proximity to other equipment at the facilities. In situ soil heating generally involves heating the subsurface in the immediate vicinity of the core of the contaminant mass to 100+ºC and a number of heating techniques are available. At sites where the shallow subsurface includes hydrocarbon-related impacts, Wexpro may consider excavation and off-site disposal coupled with either SVE or soil heating with SVE to reduce the contaminant mass to be treated with one of the in situ technologies if complete removal by excavation is not feasible.

Golder recommends that additional data be gathered prior to final selection of the remedial technology to be implemented. A critical factor that may limit the effectiveness of one or more of the recommended options is the maximum depth of hydrocarbon-related impacts and the nature of lithology, both soil and bedrock, where applicable. Two important considerations between SVE and SVE with soil heating are the following:

1) SVE is effective at removal of the lighter fraction TPH (i.e., GRO) and BTEX compounds, but less effective on removal of the heavier fraction TPH (i.e., DRO) and can be severely limited by low permeability soil and bedrock. Golder is experienced in both the design, implementation, and monitoring of SVE systems. However, a contractor would be required to provide and install the SVE equipment.

2) Soil heating with SVE can be effective on the COCs, including DRO, at their respective concentrations, and in low-permeability soils. One potential limitation of soil heating with SVE is whether or not these technologies can be safely implemented near existing natural gas infrastructure. Soil heating technologies are typically licensed to the developer/contractor so their input on the design and operation is often required. A number of various soil heating technologies exist, so it will be important to solicit experience from qualified contractors that have implemented their technology at similar facilities.

Considering the different lithologies present, different ratios of light hydrocarbons (i.e., GRO) to heavier hydrocarbons (i.e., DRO), and maximum depth of impacts between the 16 Sites that will require remediation, Golder recommends that Wexpro consider at least one appropriate Site to implement pilot testing of one or both SVE and/or SVE with soil heating technologies before committing to full-scale implementation of either technology at all of the Sites requiring hydrocarbon-related impact remediation. One important consideration while choosing between SVE and SVE with soil heating is that for sites with the TPH concentration dominated by lighter fraction GRO, but heavier fraction DRO being reported at independent concentrations in excess of the composite DRO+GRO TPH concentration level (500 mg/kg), even in the event of 100% removal of the lighter fraction TPH (GRO), which is optimistic, DRO may still exceed the COGCC Concentration Level for TPH. For sites where both GRO and DRO independently exceed the COGCC Table 915-1 Concentration Level for TPH, SVE with soil heating will likely be the most effective remedial technology.

Golder has reviewed the Conceptual Site Model (CSM) and operating records for the SVE system that Wexpro has operating at the Powder Wash North Compressor Station (PWNCS), COGCC Remediation Project #10389. The COCs present at the PWNCS include TPH and BTEX compounds. Golder was not able to find comprehensive analytical data from the initial site investigation performed at the PWNCS, so is unable to confirm the GRO/DRO ratios of the reported TPH concentrations, but generally COC concentrations at the PWNCS are consistent with the COC concentrations reported for the 16 E&P pits requiring remediation that are discussed in this RAP. Effective removal of COCs has been reported for the PWNCS with approximately 8.2 tons of total volatile petroleum hydrocarbons, equivalent to approximately 78 barrels of oil, reported to have been removed in the almost three years of SVE operation. While the subsurface conditions at the PWNCS are generally consistent with the subsurface conditions observed during the 2019 investigations performed at the 16 Sites described in this RAP, the conditions at the PWNCS are somewhat coarser in terms of soil texture, being dominated by sandy silt and clayey/silty sand overlying claystone and sandstone bedrock. The conditions at the 16 E&P pits are dominated by sandy silt, clayey silt, silty/clayey fine sand, and silty clay overlying claystone bedrock. The finer texture of soil observed at the 16 E&P pits may limit the effectiveness of SVE without soil heating.

Considering the relatively low complexity of designing, installing, and implementing an SVE system compared to an SVE with soil heating system, while also considering the relative energy (i.e., electricity) demands/costs, overall design, installation, implementation, operating costs, and critical safety considerations associated with in situ soil heating, Golder recommends performing pilot testing of SVE without soil heating at multiple sites that represent various lithologies and/or COCs, particularly different ratios of DRO/GRO. This will help evaluate the effectiveness of SVE without soil heating on various lithologies and on the heavier fraction DRO, in particular. SVE pilot testing infrastructure (i.e., extraction and injection wells) can be installed during the additional investigation described in Section 3.2 to maximize productivity during the investigation stage while reducing subcontractor mobilization costs. Pilot testing can be performed with relatively low-cost extraction piping that can be assembled by Golder, and vapor extraction can be performed by subcontractors with non-permanent vacuum/suction equipment (e.g., vacuum truck). Depending on the effectiveness of SVE without in situ soil

heating in lower permeability lithologies and on the heavier fraction DRO, SVE coupled with an in situ soil heating technique may be considered at a later time.

4.1 Site Prioritization and Pilot Testing

The 16 Sites requiring additional investigation and remediation have been prioritized based on the remaining production life expectancy and severity of impacts. Wellsites with less than approximately 5 years remaining in life expectancy have been given the highest priority and sites with greater than 20 years remaining life expectancy have been assigned the lowest priority. Wellsites within each grouping have been further prioritized based on the severity of impacts considering TPH concentrations and the highest concentration of each of the BTEX constituents relative to the respective COGCC Table 915-1 Concentration Level. The priority list is provided in Table 3.

Golder recommends that Wexpro perform additional investigation and pilot testing for the top three priority pits 1) BW Musser 16 (COGCC ID 100365, Golder Pit #5); 2) HW Stewart 1, Pit 2 (COGCC ID 100667, Golder Pit #2); and 3) BW Musser 11 (COGCC ID 100382, Golder Pit #3) as the initial stage of remedial action for all 16 Sites requiring remediation. These three Sites are generally representative of the various lithologies and have hydrocarbon-related impacts in the middle to middle-upper range of concentrations of the 16 Sites requiring remediation. While none of these three have reported DRO concentrations greater than reported GRO concentrations, the HW Stewart 1, Pit 2 (COGCC ID 100667, Golder Pit #2) and BW Musser 11 (COGCC ID 100382, Golder Pit #3) pits each have independent DRO concentrations in excess of the COGCC Table 915-1 Concentration Level for TPH. As such, the efficacy of SVE on DRO concentrations at these sites could provide an indication of overall SVE effectiveness on the heavier fraction hydrocarbons at Sites with DRO impacts.

It is recommended that a minimum of three SVE wells be installed at each site for pilot testing purposes. Each well will be constructed on 4-inch-diameter PVC well casing and screen and installed to screen the entire impacted depth. One SVE well would be installed near the center of impacts and two would be installed in line and at distances of approximately 10 and 25 feet away from the central well. This spacing will allow for the evaluation of the radius of influence at 10-, 25-, and 35-foot distances from the point extraction. The proposed SVE pilot test well locations for each of the three Sites are presented in Figures 1, 2, and 3. Each of the three SVE wells would be tested independently, monitoring the suction observed at other two wells (i.e., three pilot tests at each site). This approach will provide critical design parameters (e.g., optimal flow rate, radius of influence) for the full-scale remedial system. PID measurement will be collected from each well before pilot testing is started and from the extraction well piping during testing to get a general idea of volatiles removal. Additionally, one vapor sample will be collected for laboratory analysis prior to termination of each pilot test. The vapor sample will be analyzed for total volatile petroleum hydrocarbons and BTEX. This will provide a preliminary indication of the effectiveness of hydrocarbon removal with SVE.

5.0 CONCLUSIONS

Investigations completed in 2019 indicate that total petroleum hydrocarbons, benzene, toluene, ethylbenzene, total xylenes, and naphthalene, are COCs reported at concentrations in excess of their respective COGCC Table 915-1 Concentration Level for 16 of the 18 pits investigated. The occurrence of these COCs is understood to be related to the release of these compounds from former E&P liquids drain pits. A number of pits also have Table 915-1 exceedances of the respective concentration level for SAR, pH and EC. Most of the SAR, pH, and/or EC exceedances are for depths greater than 4 ft bgs (i.e., below the root zone) and will not require remediation. At locations where SAR, pH, and/or EC exceed the respective Table 915-1 Concentration Level at depths shallower

than 4 ft bgs, the SAR, pH, and/or EC exceedances will be addressed during final site reclamation. Hydrocarbon-related impacts extend to various depths with some sites exhibiting hydrocarbon-related impacts to bedrock. Golder recommends that Wexpro complete additional vertical and horizontal delineation of soil and/or bedrock impacts during initial remedial action implementation to address existing data gaps.

Golder has prioritized the Sites with additional investigation recommended and/or remediation required and has completed a remedial options evaluation of technologies applicable to the remediation of hydrocarbons in the vadose zone. Based on the currently available information, Golder recommends that Wexpro consider performing SVE without soil heating pilot testing at the BW Musser 16 (COGCC ID 100365, Golder Pit #5); HW Stewart 1, Pit 2 (COGCC ID 100667, Golder Pit #2); and BW Musser 11 (COGCC ID 100382, Golder Pit #3) pits. If pilot testing indicates that SVE without soil heating is effective at remediating the COCs in the various lithologies to concentrations that meet the COGCC Table 915-1 Concentration Levels, this remediation technology should be considered the primary method for remediating each of the remaining Sites. This recommendation should be reconsidered upon completion of additional horizontal and vertical delineation of impacts. Additional hydrocarbon-related impacts delineation will also be performed at Jacks Draw 3 (COGCC ID 100608, Golder Pit #11). Passive soil vents may be installed at this pit and at Wexpro's discretion.

6.0 SCHEDULE

The schedule for completing the additional investigation described in this RAP is dependent on a number of factors, including the COGCC's timeline for reviewing and approving this RAP (including time required for Wexpro to address any of COGCC's comments), drilling subcontractor availability, and winter weather. The current plan is to complete the additional investigation by/in spring 2021. SVE pilot testing will be scheduled upon completion of the additional investigation.

Signature Page

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Tables

Table 1: COGCC Table 915-1 Constituent List and Concentration Levels for Soils

Constituent	Units	Table 915-1 Concentration Level
Organic Compounds in Soil		
TPH (DRO+GRO)	mg/kg	500
Benzene	mg/kg	1.2
Toluene	mg/kg	490
Ethylbenzene	mg/kg	5.8
Xylenes, Total	mg/kg	58
Acenaphthene	mg/kg	360
Anthracene	mg/kg	1,800
Benzo[a]anthracene	mg/kg	1.1
Benzo[b]fluoranthene	mg/kg	1.1
Benzo[k]fluoranthene	mg/kg	11
Benzo[a]pyrene	mg/kg	0.11
Chrysene	mg/kg	110
Dibenz[a,h]anthracene	mg/kg	0.11
Fluoranthene	mg/kg	240
Fluorene	mg/kg	240
Indeno[1,2,3-cd]pyrene	mg/kg	1.1
1-methylnapthalene	mg/kg	18
2-methylnapthalene	mg/kg	24
Naphthalene	mg/kg	2
Pyrene	mg/kg	180
Inorganic Compounds in Soil		
Electrical Conductivity	umhos/cm	<4,000
Sodium Adsorption Ratio	-	<6
pH	SU	6-8.3
Metals in Soil		
Arsenic	mg/kg	0.68
Barium	mg/kg	15,000
Boron (Hot Water Soluble)	mg/L	2
Cadmium	mg/kg	71
Chromium (VI)	mg/kg	0.3
Copper	mg/kg	3,100
Lead	mg/kg	400
Nickel	mg/kg	1,500
Selenium	mg/kg	390
Silver	mg/kg	390
Zinc	mg/kg	23,000

Notes:
This table has been replicated from the Colorado Oil and Gas Conservation Commission Series 900 Rules for E&P Waste Management, January 15, 2021.

Table 2: Wexpro - E&P Pits 2019 Investigation Summary

Site Name	COGCC ID	Golder Pit #	GW Encountered?	Hydrocarbon-Related Soil Impacts Vertically Delineated	Hydrocarbon-Related Soil Impacts Horizontally Delineated	Additional Investigation Req'd?	Table 915-1 Exceedances	COGCC Identification Numbers			COGCC Determinations		
								Remediation Project #	Initial Form 27 #	Supplemental Form 27 Document #	Domestic Water Well Within 1/4 mile?	Surface Water Within 1/4 mile?	Sensitive Area?
HW Stewart 1, Pit 1	100668	Pit 1	No	Yes	Yes	No	None	10101	401223990	402330190	No	Yes, 149 ft	No
HW Stewart 1,Pit 2	100667	Pit 2	No	No	Yes	Yes	TPH, B, X, N, pH, SAR	10103	401224001	402330497	No	Yes, 149 ft	No
BW Musser 11	100382	Pit 3	No	No	Yes	Yes	TPH, E, X, N, pH, As*	9792	2526709	402330696	No	Yes, 729 ft	No
BW Musser 18	100349	Pit 4	No	No	Yes	Yes	TPH, E, X, N, As*	8693	2142210	402331410	No	Yes, 395 ft	No
BW Musser 16	100365	Pit 5	No	No	Yes	Yes	TPH, B, E, X, pH, SAR, SC	10102	401227072	402331490	Yes, 455 ft	No	No
Carl Allen 20	100666	Pit 6	No	Yes	Yes	Yes	TPH, B, E, X, N, pH As*	10146	401249495	402331657	No	No	No
JC Donnell 9	100638	Pit 7	No	No	Yes	Yes	TPH, B, E, X, pH, SAR, As*	10078	401223844	402332152	No	No	No
Mountain Fuel Supply 20-1	100604	Pit 8	No	No	Yes	Yes	TPH, B, E, X, pH, SAR, SC, As*	13574	401938777	402333046	No	Yes, 145 ft	Yes
JC Donnell 5	100634	Pit 9	No	No	Yes	Yes	B, E, X, TPH, As*	10089	401223855	402333124	No	Yes, 152 ft	No
JC Donnell 10	100639	Pit 10	No	Yes	Yes	Yes	TPH, B, E, pH, SAR, As*	10068	401217525	402333408	No	Yes, 84 ft	No
Jacks Draw 3	100608	Pit 11	No	No	Yes	Yes	TPH, B, T, E, X, N, As*	10097	401223912	402334024	No	Yes, 97 ft	No
Jacks Draw 2	100620	Pit 12	No	Yes	Yes	No	As*	9240	2315411	402329570	No	No	No
Carl Allen 9	100689	Pit 13	No	No	Yes	Yes	TPH, B, E, N, X, SAR, As*	10105	401227509	402334214	No	No	No
Carl Allen 16	100694	Pit 14	No	No	Yes	Yes	TPH, E, X, As*	12042	401249614	402334300	No	Yes, 319 ft	No
Carl Allen 11	100690	Pit 15	No	Yes	No	Yes	pH, SAR, SC, TPH, AS*	10075	401224019	402334418	No	Yes, 192 ft	No
Carl Allen 6, Pit 1	100687	Pit 16	No	Yes	Yes	No	TPH, pH, SAR, EC, As*	9429	2144777	402336048	No	No	No
Carl Allen 6, Pit 2	100688	Pit 17	No	No	Yes	Yes	pH, SAR, SC, TPH	15255	402181841	402337188	No	No	No
Carl Allen 7	100623	Pit 18	No	Yes	Yes	Yes	TPH, B, E, X, N, pH, SAR, EC, As*	9474	2144903	402335809	No	No	No

Notes:
- "Y" means yes
- "TPH" means total petrolem hydrocarbons and is the sum of the lab-reported results for gasoline range organics (GRO) and diesel range organics (DRO)
- "B" means benzene
- "T" means toluene
- "E" means ethylbenzene
- "X" means total xylenes
- "N" means napthalene
- "SAR" means sodium adsorption raito
- "EC" means electrical conductivity
- "As" means arsenic
- Naturally occurring arsenic concentrations in the Powder Wash area exceed COGCC screening levels. Historical results will be used to demonstrate background conditions.
- The Supplemental Form 27 reference number applies to the Supplemental Form 27 provided for the Field Investigation Summary Technical Memorandums submitted in February 2020.

Table 3: Wexpro - E&P Pits Additional Investigation and Remediation Priority List

Golder Pit #	Site Name	COGCC ID	Remaining Wellsite Life (Years)	TPH (mg/kg)	Highest of BTEX Constituents (mg/kg)		Investigation and Remediation Priority #
5	BW Musser 16	100365	0	5259	2.32	B	1
2	HW Stewart 1, Pit 2	100667	5.3	9050	6.52	B	2
3	BW Musser 11	100382	6.5	9650	1.07	B	3
7	JC Donnell 9	100638	5.3	4612	4.58	B	4
13	Carl Allen 9	100689	5.2	2850	3.73	B	5
11	Jacks Draw 3	100608	9.5	15710	123	B	6
18	Carl Allen 7	100623	9.8	4550	7.88	B	7
15	Carl Allen 11	100690	9.3	1341	1.93	X	8
14	Carl Allen 16	100694	14.5	1356.2	0.477	B	9
10	JC Donnell 10	100639	19.1	4014	7.11	B	10
6	Carl Allen 20	100666	20.8	9250	7.12	B	11
4	BW Musser 18	100349	26	6040	0.544	B	12
9	JC Donnell 5	100634	27.2	4512.7	15.6	B	13
17	Carl Allen 6, Pit 2	100688	30.8	785	5.1	X	14
16	Carl Allen 6, Pit 1	100687	30.8	1758	0.0619	B	15
8	Mountain Fuel Supply 20-1	100604	33.3	15013	61.9	B	16
1	HW Stewart 1, Pit 1	100668	5.3	4.306	0.000788	B	--
12	Jacks Draw 2	100620	35.8	199.01	0.0789	B	--

Notes:

- "B" means benzene

- "X" means xylene

- No additional investigation or remediation recommendedd for the HW Stewart 1, Pit1 or Jacks Draw 2 sites.

Figures

LEGEND

HISTORICAL ANALYTICAL SAMPLE

- EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)
- NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

- PROPOSED SVE PILOT TEST WELL LOCATION
- PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE
- PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

CLIENT
DOMINION ENERGY WEXPRO

PROJECT
EXPLORATION AND PRODUCTION
PIT DELINEATION PROJECT
CRAIG, CO

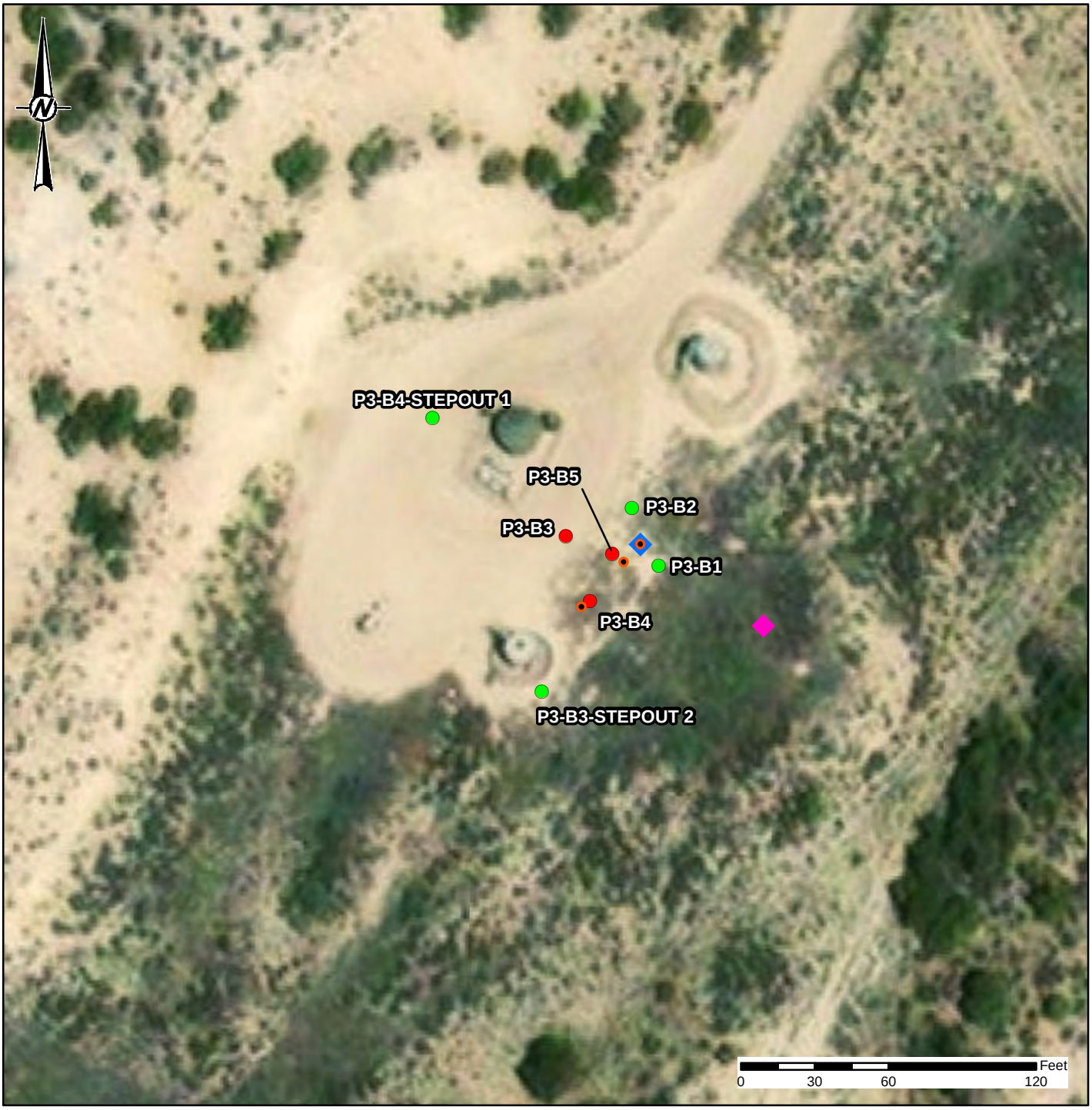
TITLE
SVE PILOT TEST WELL LOCATIONS FOR:
PAD NAME: HW STEWART 1
PIT NUMBER: 2
COGCC ID: 100667

CONSULTANT
GOLDER

YYYY-MM-DD	2021-02-19
DESIGNED	RHG
PREPARED	RHG
REVIEWED	TLH
APPROVED	MKS

PROJECT NO.
19125681

FIGURE
1



LEGEND

HISTORICAL ANALYTICAL SAMPLE

- EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)
- NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

- PROPOSED SVE PILOT TEST WELL LOCATION
- PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE
- PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

CLIENT
DOMINION ENERGY WEXPRO

PROJECT
EXPLORATION AND PRODUCTION
PIT DELINEATION PROJECT
CRAIG, CO

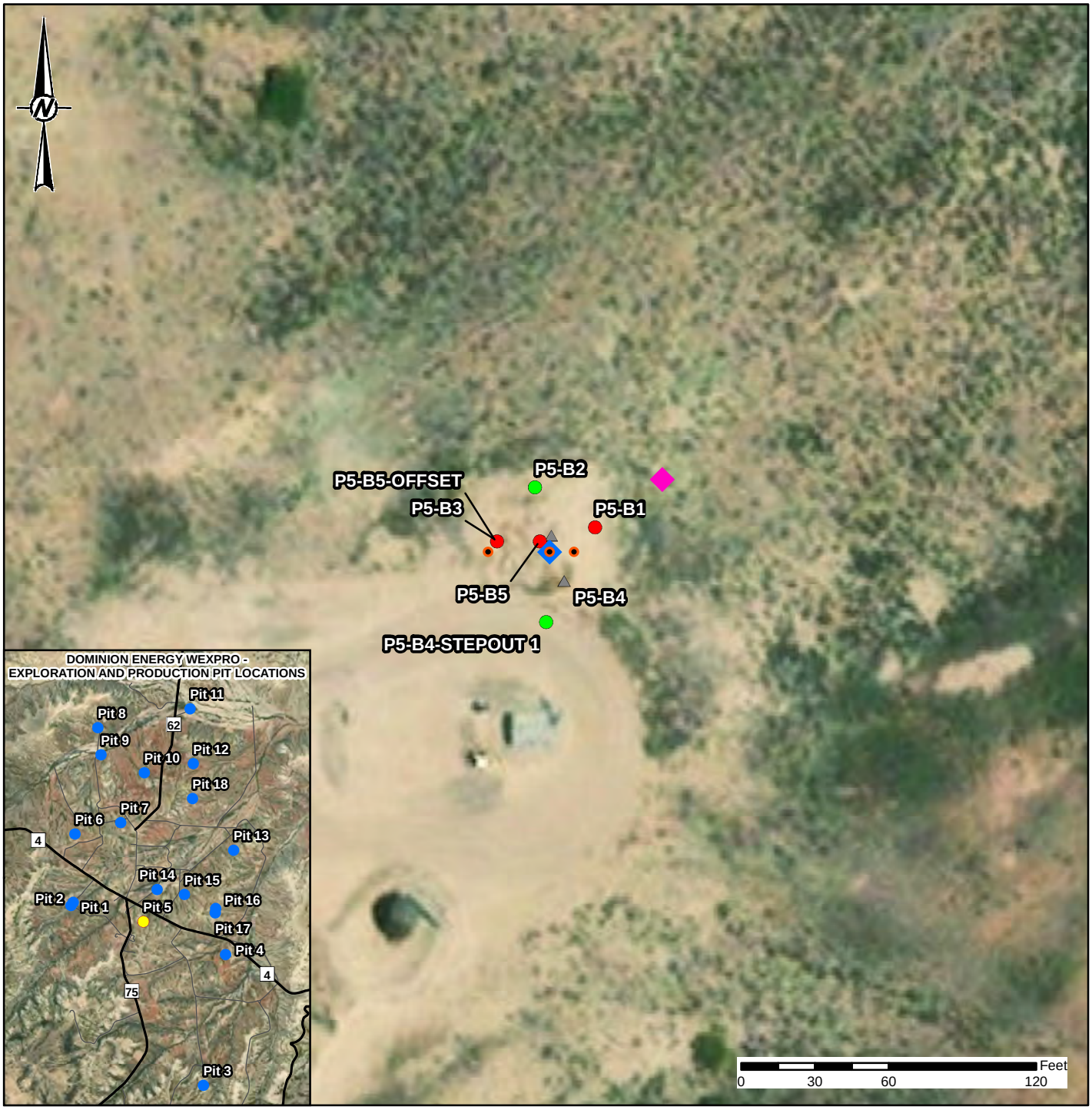
TITLE
SVE PILOT TEST WELL LOCATIONS FOR:
PAD NAME: BW MUSSER 11
PIT NUMBER: 3
COGCC ID: 100382

CONSULTANT
GOLDER

YYYY-MM-DD	2021-02-19
DESIGNED	RHG
PREPARED	RHG
REVIEWED	TLH
APPROVED	MKS

PROJECT NO.
19125681

FIGURE
2



LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

- EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)
- NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

- PROPOSED SVE PILOT TEST WELL LOCATION
- PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE
- PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

CLIENT
DOMINION ENERGY WEXPRO

PROJECT
EXPLORATION AND PRODUCTION
PIT DELINEATION PROJECT
CRAIG, CO

TITLE
BOREHOLE AND SVE PILOT TEST WELL LOCATIONS FOR:
PAD NAME: BW MUSSER 16
PIT NUMBER: 5
COGCC ID: 100365

CONSULTANT
GOLDER

YYYY-MM-DD	2020-09-11
DESIGNED	RHG
PREPARED	RHG
REVIEWED	TLH
APPROVED	MKS

PROJECT NO.
19125681

FIGURE
3

APPENDIX A

Field Investigation Work Plan

REPORT

Exploration and Production Pits Delineation Work Plan

Powder Wash Gas Field, Moffat County, Colorado

Submitted to:

Wexpro Company
2221 Westgate Dr.
Rock Springs, Wyoming, USA 82901

Submitted by:

Golder Associates Inc.
7245 W Alaska Drive, Suite 200, Lakewood, Colorado, USA 80226

+1 303 980-0540

19125681-3-R-1

February 24, 2021

Table of Contents

APPENDICES

1.0 INTRODUCTION

Golder Associates Inc. (Golder) has prepared this Work Plan for Wexpro Company (Wexpro) to outline the general drilling, field screening, sampling, and laboratory analysis methods that will be used to complete the additional exploration and production (E&P)-related impacts to soil and/or bedrock delineation at 16 E&P pits in the Powder Wash Gas Field in Moffat County, Colorado. Golder performed oversight of impacted soil delineation efforts at 18 former E&P pits in the fall of 2019. Additional investigation is required to complete the impacted soil and/or bedrock delineation at 16 of the 18 pits.

This Work Plan has been developed to further characterize conditions and delineate the potential E&P-related impacts at the Sites. This Work Plan defines the protocol for field work related to the environmental investigation, which will include soil and bedrock borehole drilling, environmental field screening, soil and bedrock sample collection, and other field work as needed.

1.1 Health and Safety

Field work will be conducted under a project-specific health and safety program developed by Golder. The health and safety program and requirements will be outlined in documentation, including, at a minimum, field vehicle inspection forms, Work Method Statements (WMS), Job Safety and Environment Analysis (JSEA) forms completed prior to the start of each day's work, and Journey Management Plans (JMPs) for each person visiting a site and/or performing field work. Hard copies of the health and safety documentation will be readily available on site during field work and will identify potential hazards, personal protective equipment (PPE), and communication protocols to ensure a safe work environment.

All field staff will be outfitted with the following PPE:

- Hard hat;
- Hearing protection during drilling activities;
- Safety glasses with side shield;
- Flame retardant clothing;
- Safety toed boots; and
- Gloves as appropriate for the task being performed.

The drilling subcontractor will submit a Colorado One-Call utility location request via the Utility Notification Center of Colorado (UNCC) before the start of work. No field work will be performed until utility location has been completed and confirmed. Golder will coordinate with Wexpro to ensure private utilities and other known subsurface features, such as drilling reserve pits, not marked as part of the One-Call request are located and marked accordingly. If UNCC requires that the proposed borehole locations be marked prior to performing the utility locate, it is assumed that the marking will be performed by Wexpro.

1.2 Background

Additional subsurface investigation is required to compete the delineation of the nature and extent of E&P-related impacts in and around 16 E&P pits in the Powder Wash Gas Field. Additional investigation will be performed at the following sites:

- Carl Allen 7 (COGCC ID 100623)
- HW Stewart 1,Pit 2 (COGCC ID 100667)
- BW Musser 11 (COGCC ID 100382)
- BW Musser 18 (COGCC ID 100349)
- BW Musser 16 (COGCC ID 100365)
- Carl Allen 20 (COGCC ID 100666)
- JC Donnell 9 (COGCC ID 100638)
- Mtn Fuel Supply 20-1 (COGCC ID 100604)
- JC Donnell 5 (COGCC ID 100634)
- JC Donnell 10 (COGCC ID 100639)
- Jacks Draw 3 (COGCC ID 100608)
- Carl Allen 9 (COGCC ID 100689)
- Carl Allen 16 (COGCC ID 100694)
- Carl Allen 11 (COGCC ID 100690)
- Carl Allen 6, Pit 1 (COGCC ID 100687)
- Carl Allen 6, Pit 2 (COGCC ID 100688)

These pits may have been used as produced water or blowdown pits and have been previously abandoned and backfilled with clean fill material. The actual dimensions of the pits are not well documented. Wexpro has provided Golder with general location information for each pit, including approximate coordinates of each pit, data from the last sample collected from the interior of each pit, and the Colorado Oil and Gas Conservation Commission (COGCC) facility number for each pit.

The horizontal extent of E&P-related impacts in soil delineation has been completed for each of the 16 sites listed herein with the exception of Carl Allen 11 (COGCC ID 100690) and Carl Allen 6, Pit 1 (COGCC ID 100687). All 16 sites will require vertical extent of E&P-related impacts in bedrock and may require horizontal extent of E&P-related impacts in bedrock as described in the Remedial Action Plan.

1.3 Statement of Objectives for Pit Delineation

This E&P Pit Delineation Work Plan will be implemented to complete the delineation of petroleum impacts in soil and/or bedrock around each of the 16 pits that will be investigated. The objectives of the pit delineation work include:

- Advancing boreholes at each of 16 former E&P pits. It is expected that as many as three boreholes, possibly more, will be required at each of the 16 pits. Boreholes will be advanced to a depth greater than the maximum depth of observed E&P-related impacts to soil/bedrock. Drilling will be completed with a hollow-stem auger rig equipped with a continuous soil sampler and the ability to switch over to air coring, if necessary, to complete impacted bedrock delineation;
- Field screening of subsurface soils/bedrock using a photoionization detector (PID) and/or electrical conductivity (EC) meter;

- Collecting soil and groundwater (if encountered) samples for laboratory analysis;
- Reporting of findings, including field methods, field screening (i.e., PID) results, and analytical laboratory results; and
- Recording observations made of the soil/bedrock returned from each borehole location. Significant observations may include petroleum staining, petroleum odor, or occurrence of salt precipitates.

2.0 FIELD PROCEDURES

The following sections describe the procedures that will be used to complete the pit delineation, including drilling procedures, field screening procedures, sample collection procedures, decontamination procedures, and waste management procedures.

2.1 Drilling Procedures

Drilling will be performed by a qualified subcontractor under contract to Golder. Drilling will be performed with a CME-75, or comparable, drill rig. The CME-75 will advance 4.25-inch inside diameter (8.5-inch outside diameter) hollow-stem augers with a continuous soil sampler capable of collecting a continuous core in 5-foot increments. Soil cores will be retrieved in reusable split-type soil sleeves. The hollow-stem auger and continuous soil sampler are expected to be effective at drilling through soil and into the upper weathered bedrock interval. If hollow-stem auger refusal is met before delineating the vertical extent of E&P-related impacts, the CME-75 rig will switch over to air coring methods to complete the vertical delineation. Air coring, if required, will be performed with a core barrel no less than size “AQ,” approximately 1 inch in diameter.

It is Golder’s understanding that E&P-related impacts to bedrock, and the extent of these impacts, are controlled by the structural dip of the uppermost bedrock formation. Figure A1-1 shows each of the 16 pits with additional investigation recommended relative to the uppermost bedrock surface, the top of the Cathedral Bluffs tongue of the Wasatch Formation (red mudstone).

One borehole will be advanced near the center of the former pit to complete the vertical delineation of soil/bedrock impacts. A second borehole will be advanced approximately 50 feet down-dip of the center borehole to delineate the maximum horizontal extent of hydrocarbon-related impacts to bedrock. The second horizontal bedrock impact delineation borehole may not be necessary if the center borehole does not indicate the presence of bedrock impacts. However, if the second horizontal bedrock impact delineation borehole indicates that the bedrock is impacted at this location, a third borehole may be required to delineate the maximum extent of bedrock impacts. Lateral (side-dip) delineation of bedrock impacts will be recommended based on the maximum distance that hydrocarbons have migrated down-dip from the center of impacts. Up-dip delineation of bedrock impacts is not recommended as it is not expected, and would be highly unlikely, that hydrocarbons would migrate up-dip of the source area(s).

The proposed borehole locations are presented in Figures A1-2 through A1-17. The actual borehole locations will be based on the location of utilities, topography, access constraints, ongoing operations, or other conditions encountered in the field. Additionally, prior to commencement of the investigation, Golder will coordinate with Wexpro to ensure the site investigation activities are conducted within facility lease boundaries.

Boreholes will be identified with naming convention “Px-Bx”. The “P” represents pit numbers 2 through 18 and the B represents the borehole number at each pit. The borehole numbers will resume from the last borehole number completed in 2019. The pit number 2 through 18 will be correlated to each pit name and facility number in a sample

identification table that will be included in the report. No samples identified as “P1-Bx” or “P12-Bx” will be collected as the horizontal and vertical delineation of E&P-related impacts to soil is considered complete and no additional investigation is proposed for these two pits.

Each borehole location will be logged in the field with a handheld GPS with approximately ±1 meter lateral accuracy and ±2 meters vertical accuracy. When practical, boreholes will be backfilled with cuttings, taking care to place suspected impacted material at the same depth from which it was retrieved. Bentonite chips will be available to backfill the boreholes in the event that backfilling with cuttings is not feasible. Soil lithology will be classified and boreholes will be logged during the drilling effort in general accordance with the Unified Soil Classification System (USCS).

2.2 Field Screening Procedures

Soil cores will be field screened for volatile organic compounds (VOCs) using a PID. The one site requiring horizontal delineation of EC and sodium adsorption ratio (SAR) will include field screening of EC. The EC and PID meters will be calibrated at the start of each working day, when significant changes in weather occur, and if erroneous readings are suspected. Screening will be performed on approximately 2-foot intervals and when significant changes in the soil profile occur. Observations pertaining to moisture, appearance, visual indicators of chemical impact, field screening readings, and other pertinent information will be recorded in soil borehole logs.

2.3 Sampling and Analysis Procedures

At each down-dip borehole location and side-dip location (if applicable), one soil sample will be collected for laboratory analysis. At each interior (i.e., center) borehole location, two samples will be collected for laboratory analysis. Soil samples will be collected directly from the soil core with gloved hands, or with a clean stainless-steel scoop/trowel and gloved hands, placed directly into laboratory-provided containers, and immediately stored on ice. Nitrile or latex gloves will be used for sample collection and will be changed between samples. The soil sample selection depth/interval will be based on the following criteria:

- Down-dip/side-dip boreholes: One analytical soil sample will be collected from each down-dip sampling location from soils indicating the highest PID measurement.
- Interior boreholes: Two analytical samples will be collected from each interior sampling location:
  - One soil sample will be collected from the interval below the maximum drilled depth completed in 2019 indicating the highest PID measurement; and
  - One sample will be collected from below the base of E&P-related impacts, from an interval expected to be clear of contamination.

If no elevated PID reading(s) are recorded, soil samples for analytical testing will be determined based on professional judgement, historical information, and conditions observed (e.g., occurrence of staining, odor).

No quality control samples will be collected. Golder understands that Wexpro has sufficient data characterizing background soil conditions in the Powder Wash Gas Field, and no additional background samples will be required.

Analytical samples will be stored on ice immediately after collection and will be transported to the analytical laboratory under chain-of-custody procedures.

Golder will contract with Pace National Center for Testing and Innovation (Pace), a State of Colorado-certified environmental laboratory located in Mt. Juliet, Tennesee (certification number TN100003) to perform the analytical laboratory analysis.

Samples will be named as follows:

- Soil samples: pit number – borehole number – depth (e.g., P1-B1-2'); and
- Groundwater samples (if applicable): pit number – borehole number – GW – depth (e.g., P1-B1-GW-20')

All of the soil samples, with the exception of samples collected from the Carl Allen 6, Pit 1 (COGCC ID 100687) will be analyzed for the following constituents:

- Total petroleum hydrocarbons: diesel range organics (TPH-DRO) (method 8015M)
- Total petroleum hydrocarbons: gasoline range organics (TPH-GRO) (method 8015M)
- Benzene, toluene, ethylbenzene, and xylene (BTEX) (method 8260)

The horizontal and vertical delineation of hydrocarbon impacts in soil at Carl Allen 6, Pit 1 (COGCC ID 100687) is complete, but this site requires additional perimeter delineation of EC and/or SAR. As such, all samples collected from this site will be analyzed for the following constituents:

- EC (specific conductance) (method 2510)
- SAR (saturated paste extraction)

One soil sample per pit, with the exception of the Carl Allen 6, Pit 1 (COGCC ID 100687), will be collected from the interior (i.e., center) borehole interval exhibiting the highest PID reading and will be submitted for the full COGCC Table 915-1 constituent list, summarized as follows:

- TPH-DRO (method 8015M)
- TPH-GRO (method 8015M)
- BTEX (method 8260)
- EC (specific conductance) (method 2510)
- SAR (saturated paste extraction)
- Polynuclear aromatic hydrocarbons: acenapthene, anthracene, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3,c,d)pyrene, naphthalene, and pyrene (method 8270SIM)
- pH (method 9045C)
- Arsenic, barium, cadmium, chromium, copper, lead, nickel, selenium, silver, zinc (method 6020)
- Mercury (method 7471A)
- Boron (hot water soluble extract)
- Hexavalent chromium (method 3060A/7196A)
- Trivalent chromium (method 6010B, 3500 Cr-B)

The sample exhibiting the highest PID measurement is expected to be the shallower of the two interior borehole samples. However, in the event that the highest PID measurement is recorded for a down-dip borehole, the sample for analysis of the full Table 915-1 list will be collected from that borehole.

Groundwater sampling will be performed if groundwater is encountered before the terminal depth at the interior borehole location. Groundwater samples will be submitted for analytical laboratory analysis of constituents identified in COGCC Table 915-1 for groundwater.

In addition to the laboratory testing that will be performed to satisfy the COGCC Table 915-1 requirements, additional testing of soil and bedrock samples will performed to aid in soil vapor extraction (SVE) system design and to demonstrate the relative mobility of E&P-related contaminants through the impacted bedrock strata. A representative subset of impacted bedrock samples will be submitted for laboratory analysis of the Synthetic Precipitation Leaching Procedure (SPLP) for TPH (DRO and GRO) and BTEX constituents. The results of the SPLP testing will help develop an understanding of the potential leachable concentrations of the target constituents from the impacted bedrock. Soil samples representative of the general lithologies present at each of the sites will also be submitted to a geotechnical laboratory for grain size distribution, unit weight (i.e., bulk density), and specific gravity (i.e., particle density). Results from these tests will aid in SVE system design and be used to evaluate pore volume exchange rates.

2.4 Decontamination Procedures

Decontamination will be performed on all non-dedicated, reusable drilling and sampling equipment. Decontamination will include a wash with an environmental detergent solution (Alconox or similar) followed by a double rinse with distilled water. It is expected that decontamination will be required on downhole drilling equipment that is in direct contact with subsurface soil (e.g., outer core barrel, soil/bedrock sample sleeve) and reusable soil sampling equipment (e.g., stainless steel scoop). Decontamination will occur within a dedicated decontamination containment system.

2.5 Waste Management Procedures

Investigation-derived waste (IDW) generated during drilling and sampling will be containerized in Wexpro-provided containers (e.g., 55-gallon steel drums, 5-gallon buckets, or other rigid container with a lid) for appropriate characterization and disposal by Wexpro. Expected IDW includes, but is not limited to, decontamination wash water, drill cuttings, soil cores, soil core liners, and groundwater.

3.0 REPORTING

Upon receipt of final laboratory results, Golder will prepare a brief report for each Site (i.e., pit) summarizing the subsurface investigation field methods, sample results, and laboratory data quality. The report(s) will include:

- A brief narrative describing the drilling and sampling methods, field screening procedures and results, decontamination procedures, problems and resolutions (if applicable), deviations from the Work Plan, and results of the data quality review;
- Applicable photos from each site/borehole;
- Map(s) showing drilling and sampling locations;
- Table(s) comparing field and laboratory results to applicable COGCC Table 915-1 Concentration Levels; and

Final laboratory report(s).

Signature Page

Golder Associates Inc.

Matt Somogyi
Senior Hydrogeologist, Project Manager

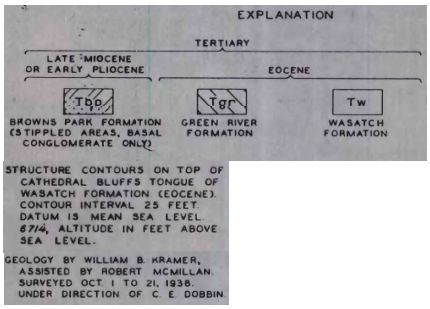
Jeremy Yeglin, PE
Associate, Senior Consultant

MKS/JLY/rm

https://golderassociates.sharepoint.com/sites/111388/project files/6 deliverables/reports/3-r-rap_for_18_sites/3-r-1/appa/appa_drillingworkplan_24feb21.docx

APPENDIX A-1

Figures A1-1 through A1-17



NOTE(S)

1. THE PIT NUMBERS SHOWN HERE REFER TO THE GOLDER-ASSIGNED PIT NUMBER

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. GEOLOGIC STRUCTURE CONTOURS FROM: GEOLOGIC MAP AND SECTION OF POWDER WASH DOME, MOFFAT COUNTY, COLORADO, UNITED STAES DEPARTMENT OF THE INTERIOR, GEOLOGIC SURVEY, 1939

CLIENT
DOMINION ENERGY WEXPRO

PROJECT
EXPLORATION AND PRODUCTION
PIT DELINEATION PROJECT
CRAIG, CO

TITLE
EXPLORATION AND PRODUCTION PIT LOCATIONS RELATIVE TO STRUCTURAL GEOLOGY

CONSULTANT
GOLDER

YYYY-MM-DD	2020-08-31
DESIGNED	RHG
PREPARED	RHG
REVIEWED	TLH
APPROVED	MKS

PROJECT NO.
19125681

FIGURE
A1-1

LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

- EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)
- NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

- PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE
- PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: HW STEWART 1
PIT NUMBER: 2
COGCC ID: 100667

CONSULTANT
GOLDER

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DESIGNED	RHG
PREPARED	RHG
REVIEWED	TLH
APPROVED	MKS

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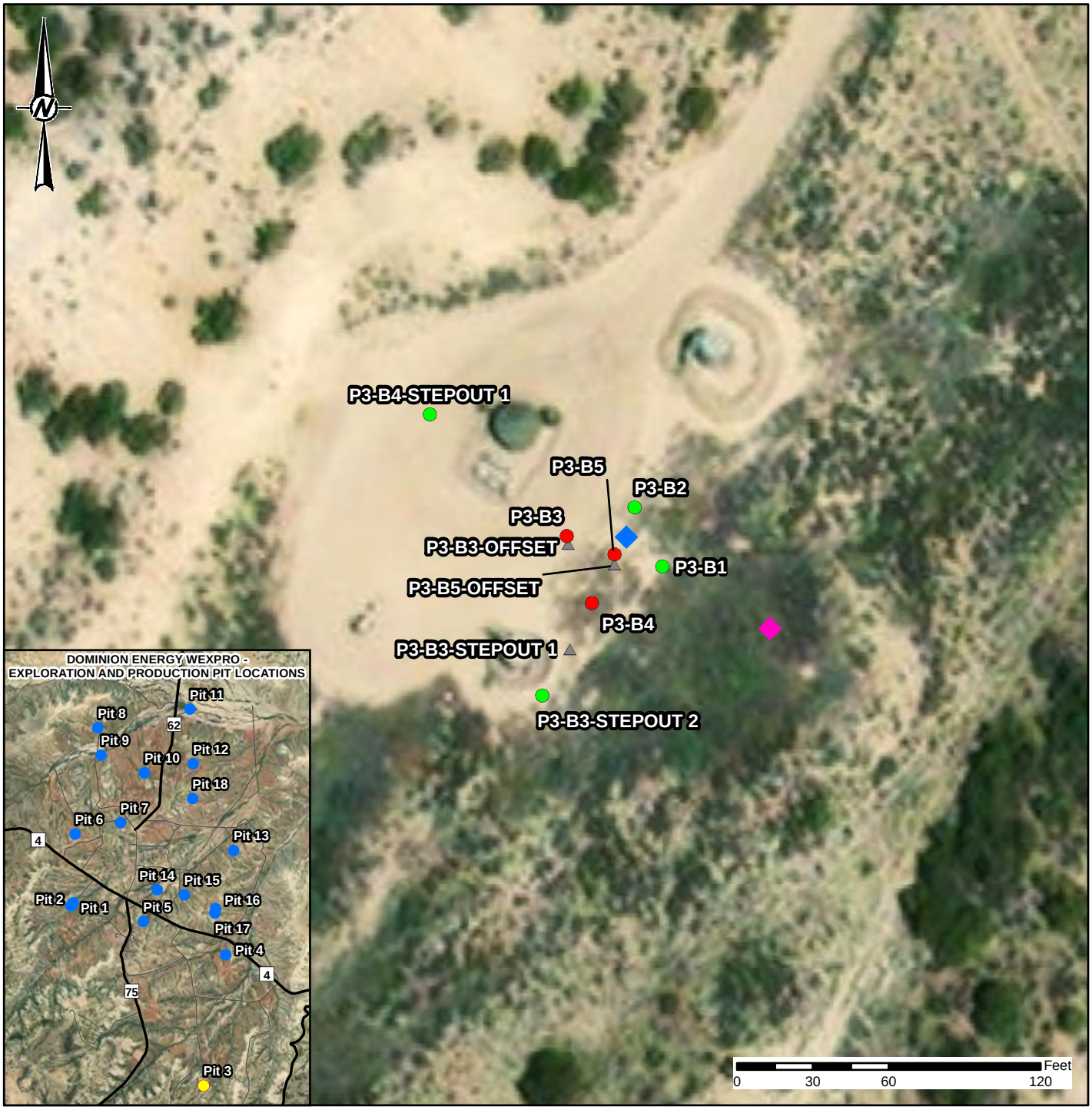
FIGURE
A1-2



LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

- EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)
- NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

- PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE
- PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: BW MUSSER 11
PIT NUMBER: 3
COGCC ID: 100382

CONSULTANT
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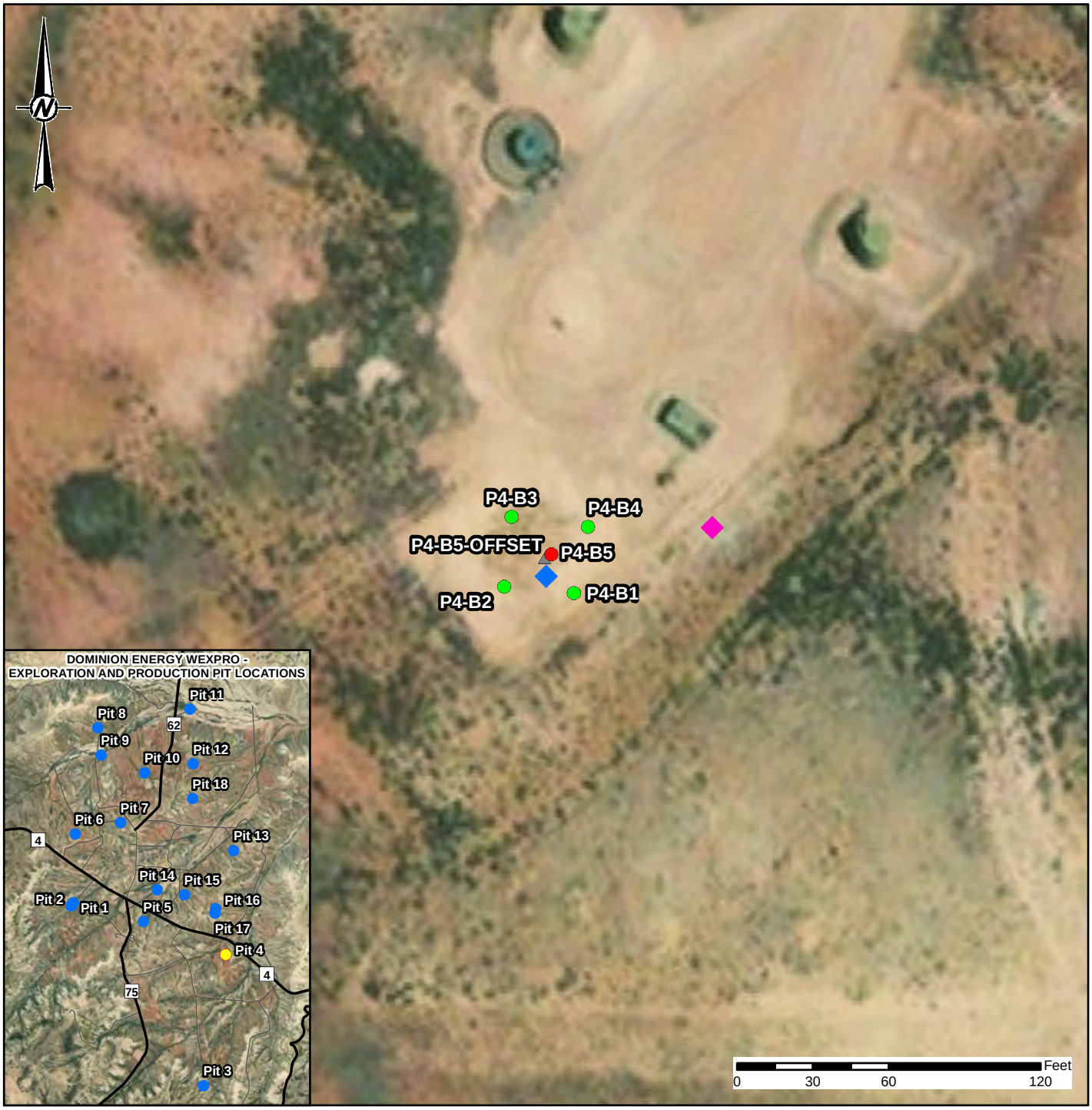
FIGURE
A1-3



LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

- EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)
- NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

- PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE
- PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: BW MUSSER 18
PIT NUMBER: 4
COGCC ID: 100349

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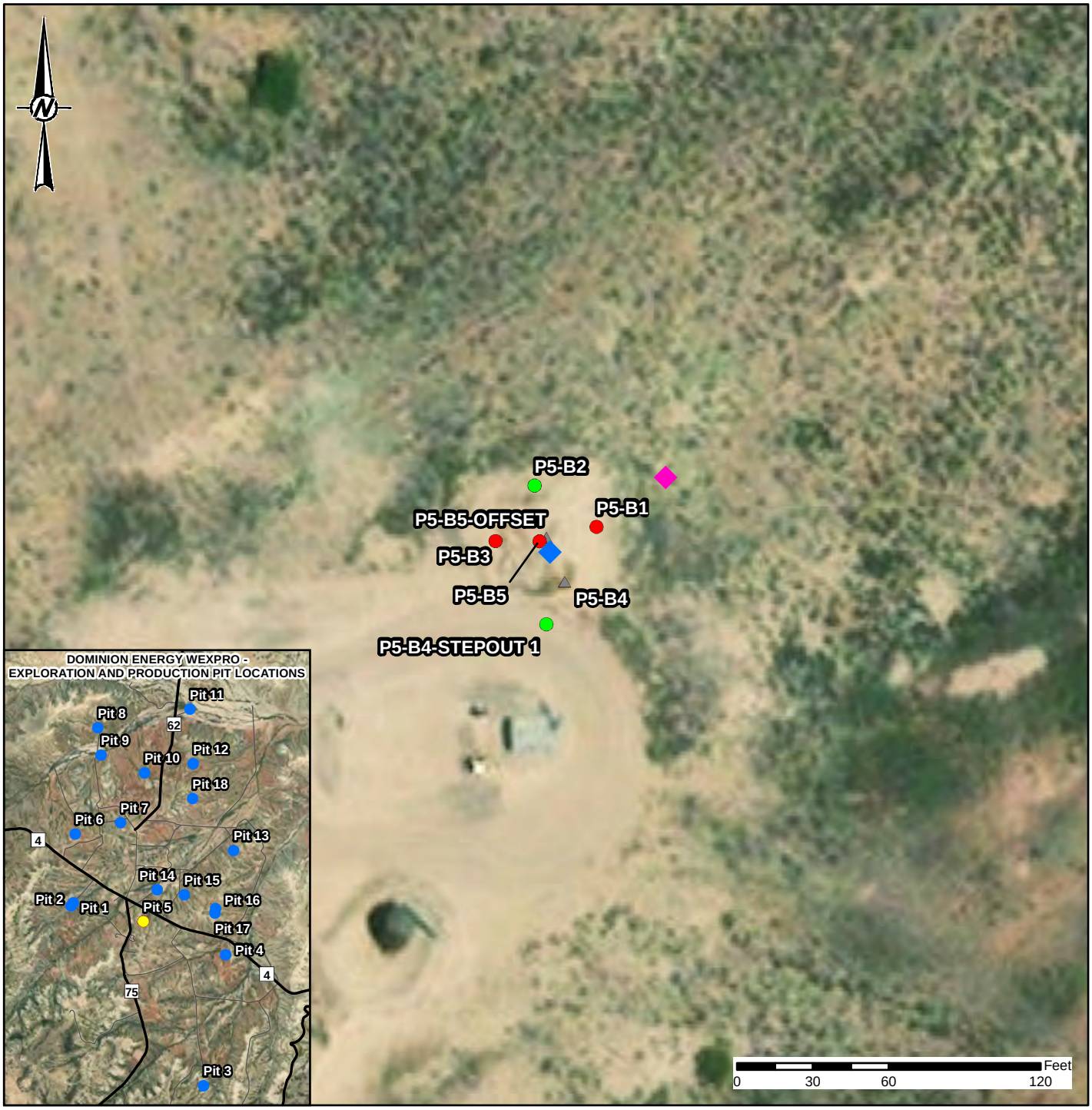
FIGURE
A1-4



LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

- EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)
- NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

- PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE
- PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: BW MUSSER 16
PIT NUMBER: 5
COGCC ID: 100365

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FIGURE
A1-5

LEGEND

NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: CARL ALLEN 20
PIT NUMBER: 6
COGCC ID: 100666

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FIGURE
A1-6

LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

- EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)
- NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

- PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE
- PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: JC DONNELL 9
PIT NUMBER: 7
COGCC ID: 100638

CONSULTANT
GOLDER

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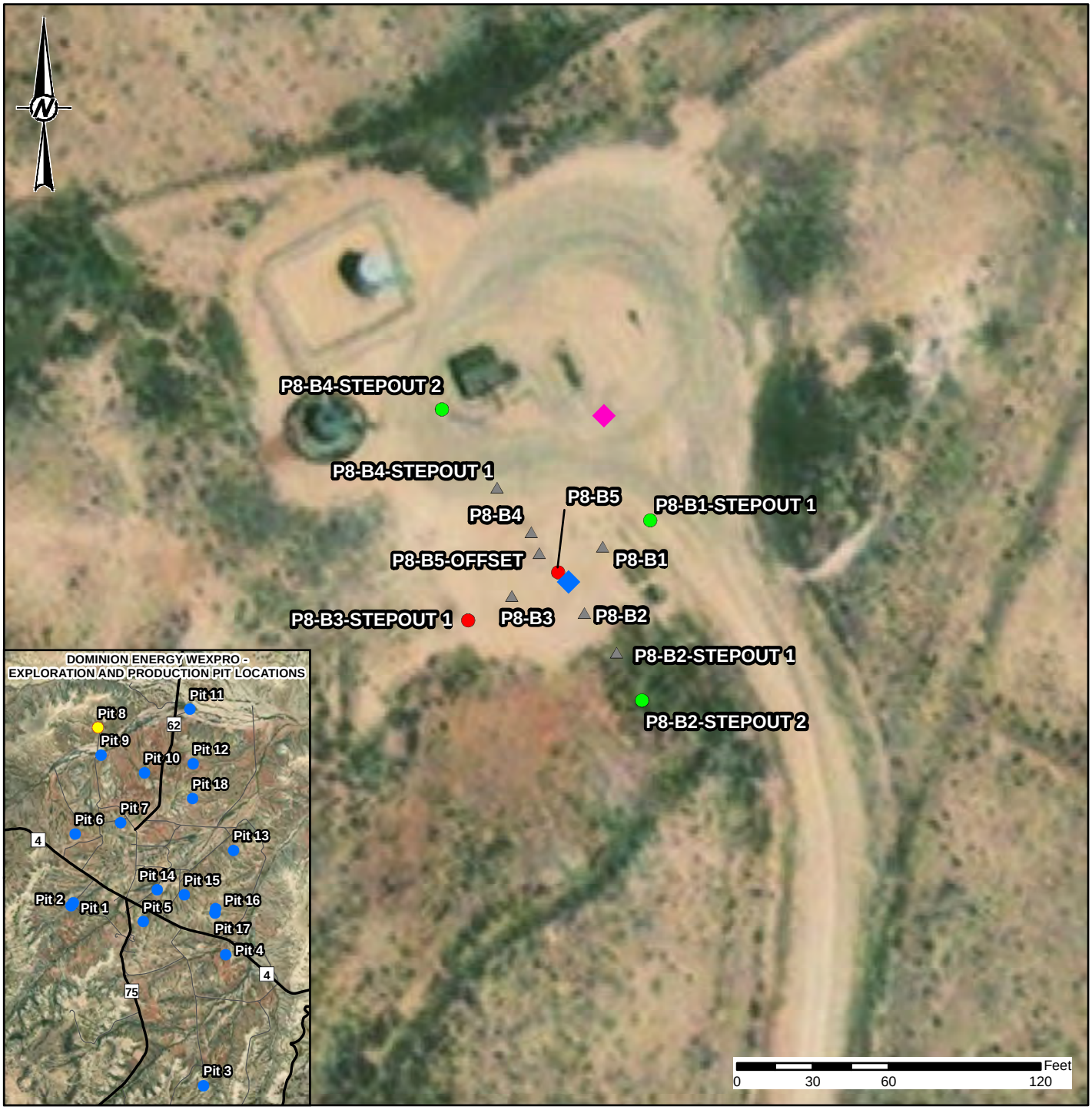
FIGURE
A1-7



LEGEND

NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE

PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: MTN FUEL SUPPLY 20-1
PIT NUMBER: 8
COGCC ID: 100604

CONSULTANT
GOLDER

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FIGURE
A1-8

LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

- EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)
- NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

- PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE
- PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: JC DONNELL 5
PIT NUMBER: 9
COGCC ID: 100634

CONSULTANT
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APPROVED	MKS

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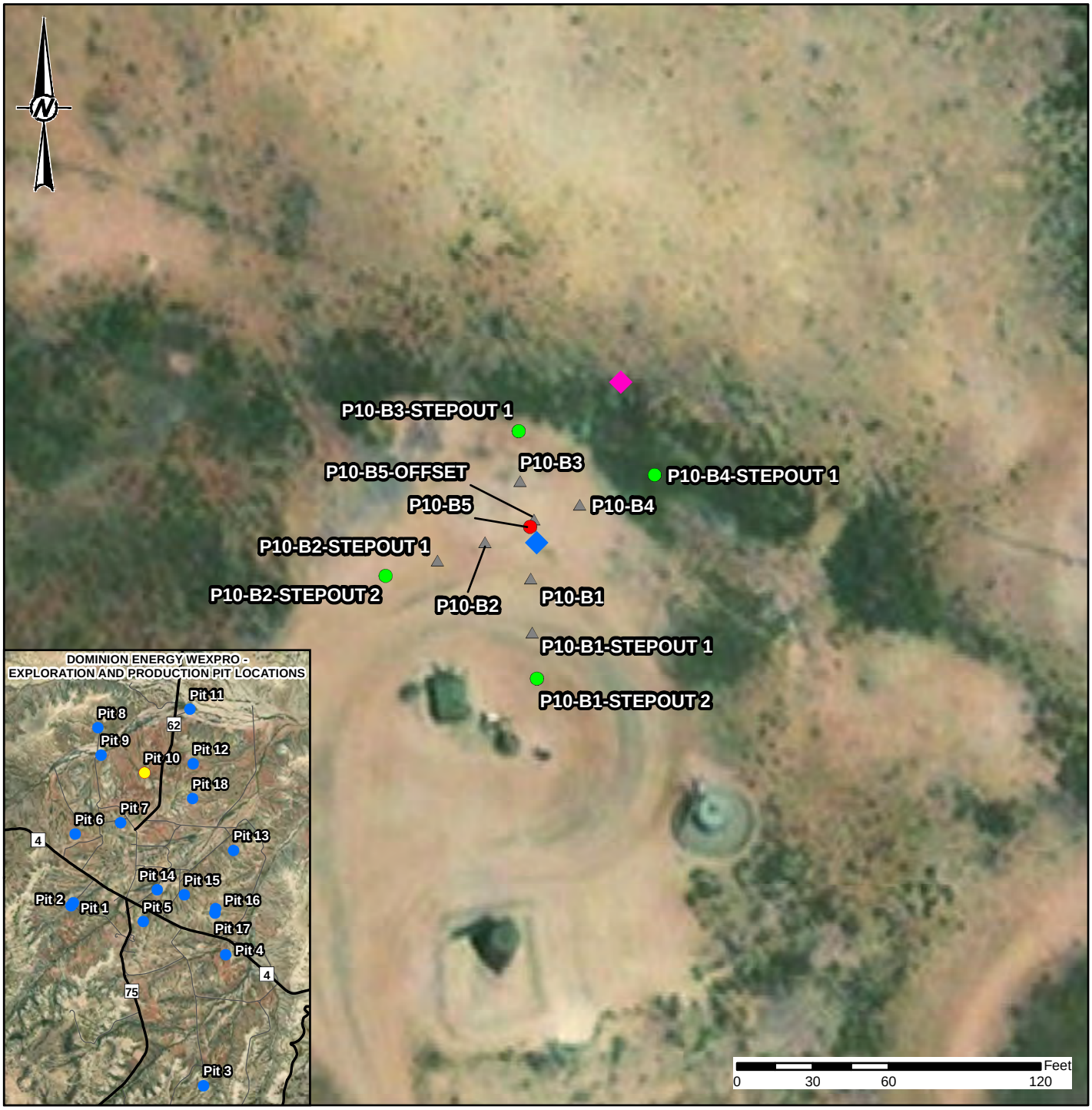
FIGURE
A1-9



LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

- EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)
- NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

- PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE
- PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: JC DONNELL 10
PIT NUMBER: 10
COGCC ID: 100639

CONSULTANT
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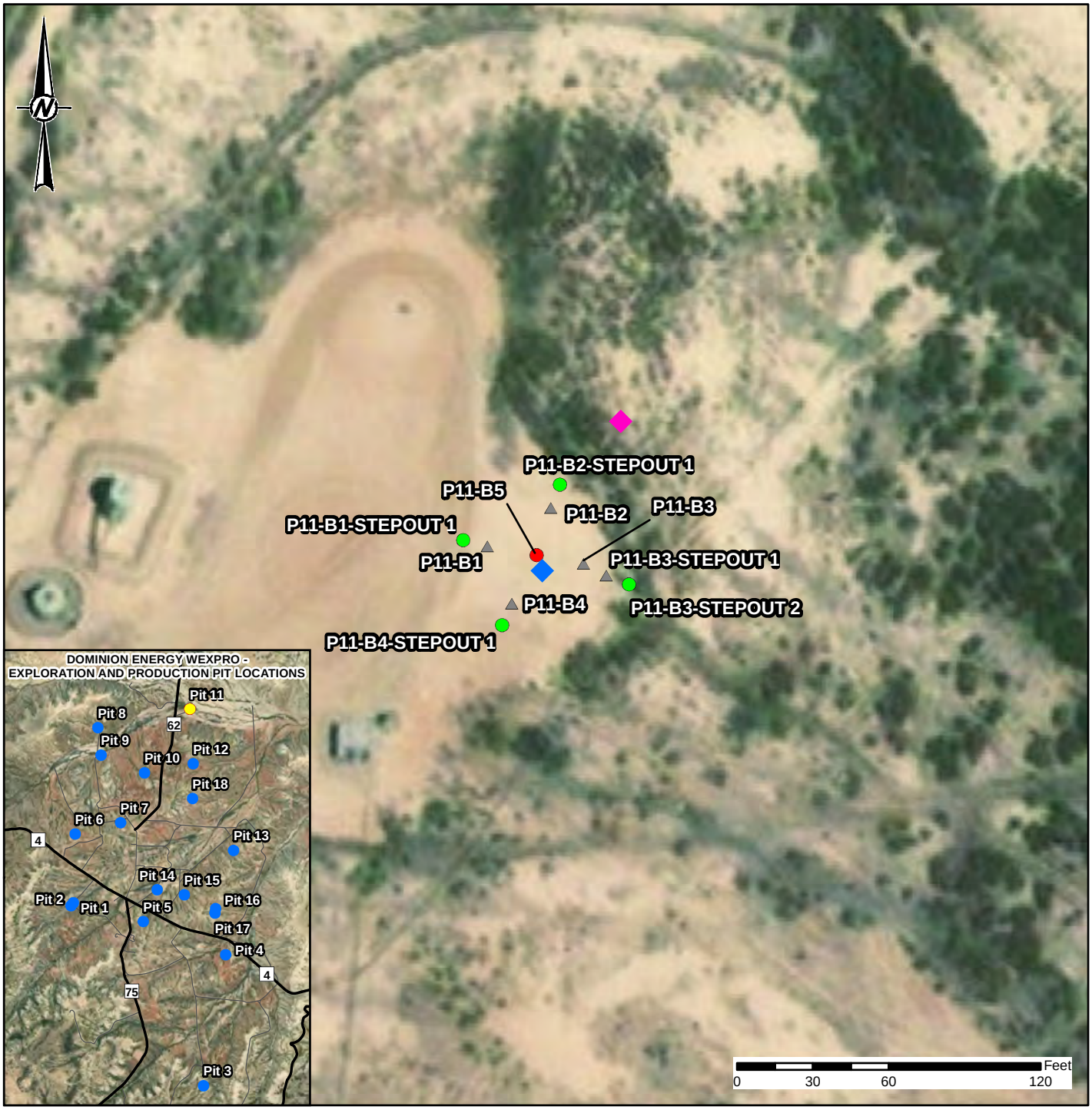
FIGURE
A1-10



LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

- EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)
- NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

- PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE
- PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

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2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: JACKS DRAW 3
PIT NUMBER: 11
COGCC ID: 100608

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FIGURE
A1-11

LEGEND

NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE

PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: CARL ALLEN 9
PIT NUMBER: 13
COGCC ID: 100689

CONSULTANT
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FIGURE
A1-12

LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

- EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)
- NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

- PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE
- PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: CARL ALLEN 16
PIT NUMBER: 14
COGCC ID: 100694

CONSULTANT
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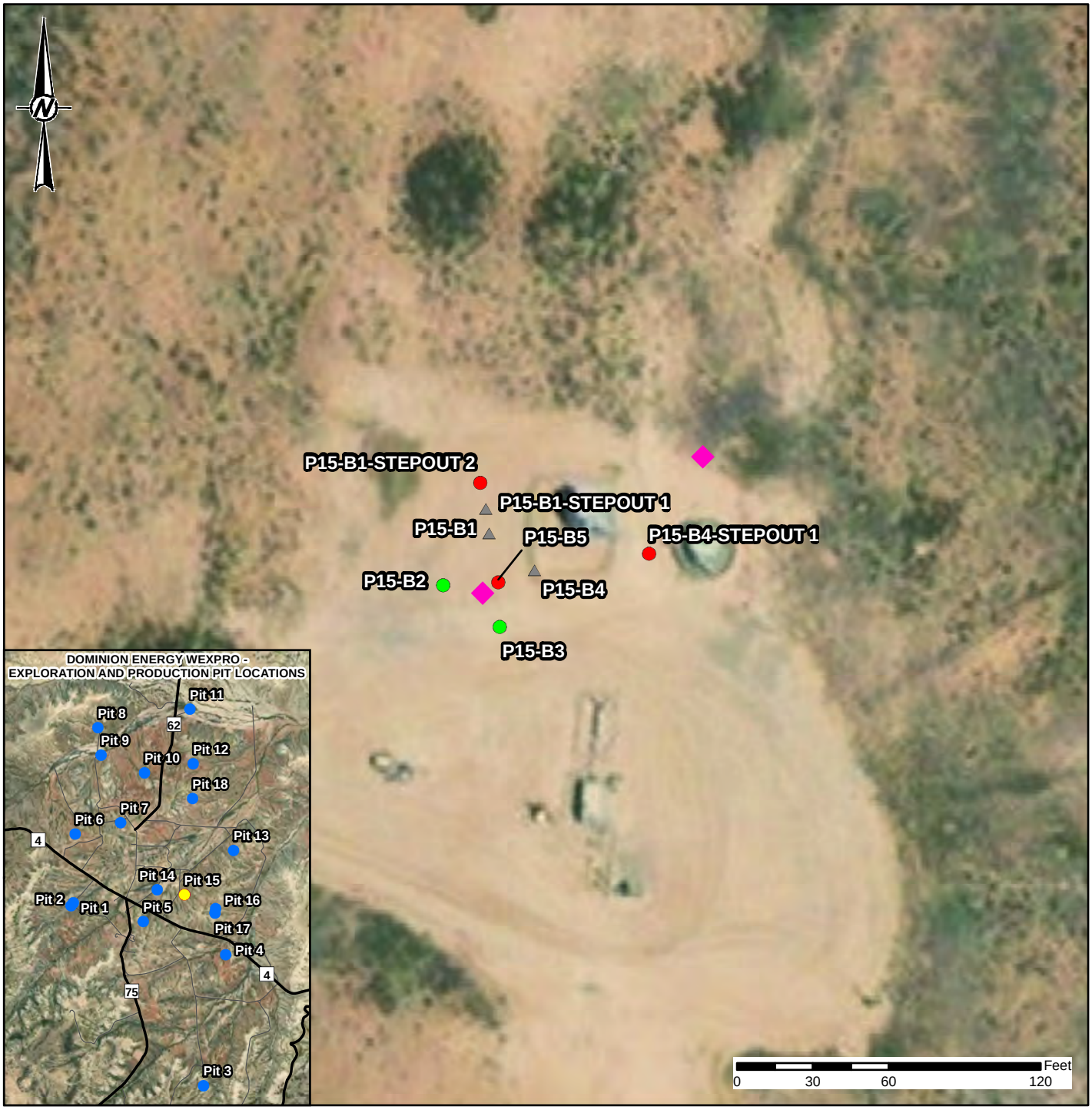
FIGURE
A1-13



LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

● EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

● NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

◆ PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

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2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: CARL ALLEN 11
PIT NUMBER: 15
COGCC ID: 100690

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FIGURE
A1-14

LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

● EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

● NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

◆ PROPOSED SOIL HORIZONTAL DELINATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: CARL ALLEN 6
PIT NUMBER: 16
COGCC ID: 100687

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FIGURE
A1-15

LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

- EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)
- NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

- PROPOSED SOIL/BEDROCK VERTICAL DELINEATION BOREHOLE
- PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: CARL ALLEN 6
PIT NUMBER: 17
COGCC ID: 100688

CONSULTANT
GOLDER

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FIGURE
A1-16

LEGEND

▲ NO ANALYTICAL SAMPLE (2019)

ANALYTICAL SAMPLE

● EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

● NO EXCEEDANCE OF COGCC TABLE 910-1 CONCENTRATION LEVEL (2019)

PROPOSED SAMPLE POINTS

◆ PROPOSED BEDROCK DELINEATION BOREHOLE

NOTE(S)

1. THE PROPOSED BEDROCK HORIZONTAL DELINEATION BOREHOLE LOCATION IS LOCATED DOWN-DIP OF THE BEDROCK STRUCTURE BASED ON USGS GEOLOGIC STRUCTURE MAP OF THE POWDER WASH DOME, 1939.

REFERENCE(S)

1. GPS POINT DATA COLLECTED BY GAI IN OCTOBER AND NOVEMBER OF 2019.
2. AERIAL IMAGERY: ESRI BASEMAP SERVICE, DIGITAL GLOBE, VIVID IMAGERY CAPTURED ON 5/26/2013.

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TITLE
BOREHOLE LOCATIONS FOR:
PAD NAME: CARL ALLEN 7
PIT NUMBER: 18
COGCC ID: 100623

CONSULTANT
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FIGURE
A1-17

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APPENDIX B

Remedial Options Evaluation Table

Attachment 2: Remedial Options Evaluation Table

Technology for Hydrocarbons	Description of the Technology	Effectiveness	Advantage	Disadvantage	Likelihood of Success	Relative Costs	Major Conditions/Limitations for Success
In-Situ Soil Vapor Extraction (SVE) and bioventing	SVE/bioventing consists of extracting and/or injecting air in unsaturated soils to volatilize or biodegrade the volatile organic contaminants, the extracted air being treated above ground by means of activated carbon filtration or biofilters.	Low to high depending on soil permeability and compound molecular weight. Most effective on VOCs and lighter fraction TPH (i.e. GRO, less effective on SVOCs and heavier fraction TPH (i.e. DRO). Also, limited effectiveness in low permeability soils.	■ Proven and fairly simple technology. ■ Can be applied in situ to large volumes of soils. ■ Do not produce by-products if off gases are treated by biofilters.	■ Limited to unsaturated soils. ■ High vacuum will be required in the low permeability soils. ■ Soils near the ground surface will require capping to direct airflow.	Medium to Low: caused by the difficulty of introducing air in low permeability soils and to biodegrade heavy hydrocarbons.	Medium	The low to medium effectiveness expected due to low permeability soils and the presence of heavy hydrocarbons (i.e DRO). Wexpro has an SVE system(s) operating at another site(s). Performance of that system could be evaluated to better understand limitations in similar compound and geologic conditions.
In-situ Soil Heating and SVE	Heat is introduced in the soils using heater wells (conduction heating), an electric current (electric resistance heating), electromagnetic energy (radio frequency heating), or other technology to volatilize hydrocarbons. The process must be coupled with an extraction system (i.e. SVE) to remove volatilized compounds from the subsurface.	Very High	■ Can remediate all compounds found on the site ■ Short term process ■ Heavy fraction TPH (i.e DRO) will require higher temperature heating ■ Effective in almost any soil type	■ Contaminants are transferred in gas phase and have to be collected and disposed of. ■ Requires large scale equipment and specialized contractors ■ Most thermal remediation technologies are licensed ■ High energy demand	Very High	High	Proximity to existing natural gas infrastructure. The risks of using various thermal technologies need to be better understood prior to implementation near subsurface natural gas infrastructure. Likely to be the most costly, but most effective, remediation option. High energy demand.
Excavation and Off-Site Disposal (dig and haul)	Impacted soil is excavated and disposed of at an appropriate off-site facility	Very High. Impacted soil is physically removed from site. Confirmation sampling ensures that soil exceeding regulatory standards has been removed.	■ Conventional equipment readily available in the Lower Mainland and methods are well understood. ■ Relatively low-cost dependent on access restrictions. ■ Potential to hot-load directly into disposal trucks – reduces double handling costs and temporary space requirements. ■ Good control of excavation works	■ May be necessary to expand or improve existing roads to accommodate increased truck traffic. ■ Increased traffic on access roads. ■ Need to establish a temporary laydown area if 'hot-loading' not feasible at the excavation point. ■ Environmental monitoring required. Health and safety considerations with respect to staff working around vapor-generating material need to be addressed. ■ Proximity to permitted waste disposal facility. ■ Need to identify source of backfill material.	Low to High depending on the maximum depth of impacts	Low to medium, various factors to consider	Ex-situ process may not be applicable at the depths of impacts found on site. Proximity to a waste disposal facility permitted to accept petroleum impacted waste. Proximity to source of backfill material. Can be combined with other remediation technologies to reduce contaminant mass to be treated by other in-situ technology. Excavation of impacted bedrock may not be feasible.
Ex-Situ Thermal Desorption	Ex-Situ thermal desorption is a remediation technology which separates through a thermal process the organic contaminants from excavated soil by volatilization. Operating temperature will be raised depending upon the contaminants, the soil type and the soil moisture in order to achieve an efficient desorption of the contaminants. The contaminated exhaust gases will be treated afterward in a secondary unit to control air emissions.	High:	■ Can treat compounds in high concentrations ■ Homogenous output ■ Short treatment time	■ High O & M costs ■ Energy intensive ■ Additional permitting and safety consideration ■ High land and heavy equipment use	Medium to High	High	Mobilization cost and risk of increasing costs with increasing volume. External vendors are used. May be an effective alternative to in-situ soil heating. Ex-situ process may not be applicable at the depths of impacts found on site.

Attachment 2: Remedial Options Evaluation Table

Technology for Hydrocarbons	Description of the Technology	Effectiveness	Advantage	Disadvantage	Likelihood of Success	Relative Costs	Major Conditions/Limitations for Success
Ex-Situ soil washing	Contaminants are separated from soil in an aqueous-based system on the basis of particle size with the help of a basic leaching agent, surfactant, pH adjustment, or chelating agent to remove organics and heavy metals	Medium The effectiveness depends on the amounts of silts and clays	■ Can remediate all compounds found on the site ■ Short-term process ■ Effective in almost any soil type	■ Since it is a phase transfer process, the concentrated fines with the contaminants will need to be disposed of. ■ Process can be complex with contaminant mixtures.	Medium to low	High	High cost and medium effectiveness. Ex-situ process may not be applicable at the depths of impacts found on site.
In-Situ Chemical Oxidation	In-Situ Chemical Oxidation (ISCO) consists of degrading a contaminant by chemical oxidation process that produces non-toxic end products such as carbon dioxide and water. The chemicals that are commonly used in ISCO include hydrogen peroxide, permanganate, ozone and more recently sodium persulfate.	High for hydrocarbons and high molecular weight PAHs, however, low permeability soils may limit delivery of oxidants.	■ Simple technology using small scale equipment. ■ Treatment time is fast ■ Most of oxidants do not produce any by-products and contaminants are destroyed in situ.	■ Health and safety issues with the use of strong oxidants. ■ High cost variations can occur with only small changes in soil conditions. ■ Not effective in unsaturated soils and low permeability soils. ■ Not adapted for large soil volumes	High: for saturated zone. Low: for unsaturated zone.	High for large amounts of hydrocarbons	High cost and poor chance of success in unsaturated zone
Ex-Situ Biopiles	Similar technology to bioventing except that the soils are treated aboveground in a control cell where treatment parameters such as oxygen diffusion humidity and nutrients are better controlled than in situ.	Medium to High. Heavy fraction TPH (i.e. DRO) may not be readily biodegradable or may require long treatment periods.	■ More uniform media to be treated ■ Could be applicable to all compounds found on site ■ Controlled environment for the treatment ■ Proven and accepted technology by the regulators	■ Requires the excavation of the soils and installation of a treatment pad	Medium to High	Medium	Low effectiveness on heavier fraction TPH (i.e. DRO). Ex-situ process may not be applicable at the depths of impacts found on site.
Ex-Situ Co-composting	Soils excavated and mixed with an organic substrate to enhance the porosity of the mixture to be decomposed and to degrade the organics aerobically at thermophilic conditions. Maximum degradation efficiency is achieved through maintaining oxygenation (e.g., daily windrow turning), irrigation as necessary, and closely monitoring moisture content, and temperature.	High	■ Adding the organic matter increases biodegradability ■ Increase bioavailability and solubility by the increase in temperature ■ Diverse population of bacteria provided by the organic matter	■ Requires substantial space ■ Results in a volumetric increase in material because of the addition of amendment material ■ Requires heavy equipment ■ Re-use of the organic soils on site may be difficult	High	Medium to High	Available space, difficulty in the re-use of the soils on site. Medium- to long-term treatment period that requires frequent maintenance. Ex-situ process may not be applicable at the depths of impacts found on site.
Phytoremediation	Phytoremediation uses plants to clean contamination. The mechanisms used by plant include enhanced rhizosphere biodegradation, hydraulic control, phyto-degradation and phyto-volatilization	Low	■ Requires little equipment ■ Sustainable technology ■ Low annual cost ■ The TreeWell system could be adapted for hydraulic control	■ Requires large surface areas ■ Slow process ■ High concentrations may be toxic to plants ■ Limited to shallow soils and groundwater	Low to Medium	Low	Not applicable for highly contaminated soils or for those at greater depths. Long treatment period. Semi-arid climate may not support appropriate flora.
In-Situ Bioremediation (saturated conditions)	Aerobic or anaerobic biodegradation in saturated conditions. In aerobic degradation, oxygen is injected to provide the natural occurring bacteria with an electron acceptor. In anaerobic processes, a carbon source is used as the electron donor to produce hydrogen (electron acceptor) by fermentation.	Very Low for this application. Effectiveness increases if distribution of electron acceptor and nutrients can be provided at sufficient rate and natural bacteria are present.	■ Technology relying on natural occurring bacteria to degrade contaminants. ■ No by-products to handle since the contaminants are degraded ■ Proven technology easily accepted by regulators	■ Treatment times can be long. ■ Biofouling can alter the process ■ Injection of oxygen dissolved or in gas form as well as viscous fluids as carbon sources could be difficult in low permeability soils	Medium: depends on the capacity to inject different products in the saturated zone targeted for treatment.	Medium	Not applicable to unsaturated soils. Low permeability will limit effectiveness.

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Technology for Hydrocarbons	Description of the Technology	Effectiveness	■ Advantage	■ Disadvantage	Likelihood of Success	Relative Costs	Major Conditions/Limitations for Success
Zero Valent Iron	Zero valent iron in the form of micron nanoparticles is injected in the groundwater to degrade chlorinated organics or mixed with excavated soils and placed in cells or piles.	High. Micro or nanoiron is very reactive and can also contribute to enhancing the biodegradation by providing highly reducing conditions	■ Two processes can be triggered, degradation by direct contact and biodegradation ■ Do not require large scale equipment	■ New technology not widely accepted by regulators. ■ Only applicable to chlorinated solvents ■ Even at nanoscale, injection of iron may be limited by low permeability soils.	Medium to High: For chlorinated solvents only and depends on potential injection rate. Higher success if used in an ex-situ process.	Medium to high	Not applicable for hydrocarbon mixtures. Applicable to groundwater or soils only contaminated with chlorinated organics and in the saturated zone or in ex-situ cells or piles.

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